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Wireless passive RFID based smart trolley with APP for billing solutions

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ABSTRACT

Purchasing a large number of goods from wholesale markets has become a commotion. People select different items and then needs to go to the billing counter for payment. At the billing counter, the wholesale retailer prepares the bill using barcode reader which can be time-consuming. To provide more efficient shopping experience we are proposing a smart trolley, which provides smart shopping as well as better stock management. It will consist of RFID active reader passive tag system in replacement to the barcode, the mobile application will be used for self-checkout and GSM module will be used along with the database to manage the stock of the wholesale.

Keywords: *RFID, Embedded C, Arduino IDE, IR Sensor.*

1. INTRODUCTION

Wholesale is a place where goods are sold in large quantity to the customers. These products can be food items, clothing, electrical appliances, footwear etc. In the wholesale market, customers have to go to billing counter to pay the bill. At billing counter, they use barcode system which scans each product one by one which is time-consuming, and the number of people is also required for the same. New technologies are used in addition to the traditional billing system to improve the quality of shopping experience to the customers. [1]

To provide self-checkout and stock management we are designing an innovative concept of Smart Shopping and Billing. [1] RFID tags are attached to the products and a system consisting of RFID reader, MICROCONTROLLER, LCD display, GSM module, IR sensor, and BLUETOOTH are attached to the shopping trolley. The Microcontroller is used to calculate the total amount to be paid after purchasing. LCD is used to display all the necessary information. When the selection of items is finished a button is pressed then the total amount displayed on the LCD is transferred to the APP via BLUETOOTH. BLUETOOTH is the component through which the mobile app and system will communicate. IR sensor will keep a count of the number of items purchased. A database is maintained for stock management. Whenever the bill amount is deducted by the App, the remaining quantity of the item is updated in the database and GSM module is used to send the message to the wholesale owner regarding it. Our system saves the time of customers and manpower required in the wholesale shop.

2. LITERATURE SURVEY

2.1 RFID based Smart Multitasking Shopping Trolley System published in International Journal for Scientific Research and Development in 2015 [2]

In this paper, Authors makes use of Alf and Vegard's RISC microcontroller linked with LCD display and RF module. The author discusses the interfacing of RFID and barcode reader with the microcontroller. As the item is placed in the trolley, the reader reads

the tag and sends the signal to the microcontroller which then compares the item with the look-up table, storing the information in the memory. If matches are found, the details of the item with its price is displayed on the LCD also the totaling of the bill amount is done. This paper proposes the software part to be embedded c which will be interfaced with the hardware. Also, a Visual basic is used as the front end of the display to display the final billed amount and to display the total bill due to pay at the point of exit. The hardware requirements include Arduino 328 microcontroller, 16X2 LCD display, RF module, RFID, 12 v power supply.

2.2 Smart Shopping Cart for Automated Billing Purpose using Wireless Sensor Networks published in The Seventh International Conference on Sensor Technologies and Applications in 2013 [3]

As the customer enters in a shopping complex they collect a smart shopping cart, which has a unique id along with it. When the customer picks a product and keeps it in a slab which is placed just above trolley, a camera present on the top scans the barcode of the product and takes a picture of it. Before entering the trolley, the camera takes another picture and slides the product into the trolley. Both the pictures go through image processing algorithm for verification. The product details (price and weight) are again verified with the base station using single Zigbee packet by the sensor mote. This process is repeated for every product purchase. After the shopping is completed the customer takes the trolley to the billing counter for payment purpose. At the end of shopping if it shows the green symbol the customer has to pay the respective amount if it shows a red symbol which indicates that an attendant has to request the customer to wait for the checkout process.

2.3 Automated Shopping Trolley for Super Market Billing System published in International Journal of Computer Applications (0975 – 8887) International Conference on Communication, Computing and Information Technology (ICCCMIT-2014) [4]

The Automated Shopping cart system integrates a Shopping cart (trolley) with 2 sets of barcode scanners placed at 2 different checkpoints – the entry and exit points respectively. It facilitates the user to self-scan the barcode of the purchased products which he intends to purchase. Wrongful entries can be corrected by making use of a keypad that changes the functionality of the machine from the addition of products to the removal of products and activates the other barcode scanner at the opposite end.

From the study of all the above paper we figured out some major problems:

- Customer needs to go to billing counter to pay the bill and the mandatory 12V power supply is used even when there is the need of 5V only.
- There is no required component to avoid the fraud in the supermarkets if the tags are removed.
- Barcode is used for product identification which needs to be in the proper line of sight and they are not efficient in self-checkout.
- The proposed system of all the above papers is for supermarkets which is not economically feasible.

Hence, from the drawbacks of the papers, we came to our proposed system trying to eliminate almost all the above-mentioned difficulties.

3. TECHNOLOGY USED

3.1. RFID Technology [5]

RFID stands for Radio Frequency Identification. It is a technology in which RFID tags are encoded with digital data which are captured by RFID reader via radio waves. RFID automatically identify and track tags that are attached to the objects using electromagnetic fields. RFID is one method for Automatic Identification and Data Capture (AIDC). RFID tags contain an integrated circuit and an antenna which transmits data to RFID reader and then radio waves are converted to the more usable form of data by the reader. Information that is collected from the tags is transferred to a host computer system through the communication interface. In host computer system data is stored in the database and can be analyzed later. Tags contain electronically stored information. There are two types of tags. First is the **passive tags** which collect energy from the nearby (up to 30cm) RFID readers via radio waves. Second is the **active tags** that operate hundreds of meters from the reader and uses local power source (such as the battery). There are three types of RFID system depending on the type of reader and tag. **Passive Reader Active Tag (PRAT)** system contains passive reader that receives signal only from active tags whose reception range can be adjusted from 1-2000 feet (0-600m). It can be used for protection and supervision. **Active Reader Passive Tag (ARPT)** system contains passive tags that send authentication replies in response to the interrogator signals send by the active reader. **Active Reader Active Tag (ARAT)** system contains active tags that work only in response to the interrogator signal that comes from the active reader. In place of active tags, Battery Assisted Passive (BAP) tags can be used which acts like passive tags but uses the small battery for tag's return reporting signal.

3.2 Arduino IDE Platform [6]

Arduino is an open-source computer hardware and software company, project, and user community that designs and manufacture single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The Arduino project provides the **Arduino integrated development environment** (**IDE**), which is a cross-platform application written in the programming language Java. It contains code editor which includes features like text cutting and pasting, text searching and replacing, automatic indenting, brace matching, and syntax highlighting and compile and upload programs on Arduino board by one click mechanism. Additionally, it contains message area, text console, a toolbar with buttons for various functions and operations menu. It supports c and c++ languages. The smallest Arduino c/c++ program consist of only two functions. They are:

- **setup():** This function is called only once whenever sketch starts either after power-up or reset. It initializes variables, input and output pin modes and other libraries that are used in the sketch.
- **loop():** This function is executed repeatedly after setup(). It is used to control the board until the board is either power off or is reset.

3.3 Embedded C [7]

There are many embedded systems like digital camera, mobile phone, a washing machine that contains some processors that are working within the system. Along with each processor, there is an embedded software associated. Hardware acts as a body, an embedded processor as brain and embedded software as its soul. **Embedded C** is a set of language extensions for the C programming language by the C Standards Committee to address commonality issues that exist between C extensions for different embedded systems. It uses the syntax and semantics of standard C. C in the embedded system is used because of the following advantages:

- It is small and simple to learn, understand, program and debug.
- There are many experienced C programmers and C compilers are available for almost every embedded devices.
- C has a benefit of processor independence. It is not specific to any particular microprocessor / microcontroller or any system. This gives the user the advantage to develop programs that run on most of the systems.
- It supports access to I/O and helps to ease the management of large embedded projects.

4. PROPOSED SYSTEM

In our proposed system we are mainly using the RFID technology to enhance the shopping experience. As a customer enters a wholesale, on entering, she/he first picks up a trolley.

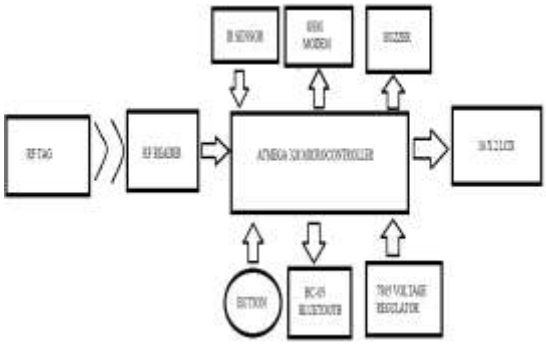

Fig 1: Proposed system block diagram

Each trolley has required circuit fixed in it.
Block diagram of the components required in the circuit is shown in Figure 1.

When the customer selects a product and places it in the trolley the product with RF tag is automatically scanned by the RF reader placed in the trolley.

After scanning the RF tag of the product, the tag id is stored in system's memory. Data stored in system's memory is compared with the lookup table. If matches are found then cost, the name of the respective product, and other required information gets displayed on the LCD. Here we have used IR sensor for counting purpose. Counting is mainly done for security purpose. If in the case while wandering around the wholesale market, someone removes the RFID tag and puts the product in the trolley, then counting the number of items helps to get information about items purchased. Thus, counting is done but there is no addition of cost respective product in the bill. This shows the increase in the number of products but not increase in the bill. If an unwanted product is removed from the trolley, then it decreases the number of products as well as the bill amount. After completion of shopping, a key is pressed indicating final billing of all the products. Thus, the final bill amount is automatically sent to the app by means of Bluetooth, from where the bill amount is deducted.

For our proposed system, we are using passive RFID tags since they are smaller in size and economical as they have no battery and do not require significant scanning range. Also, in our proposed system, the tags used are read-only tags.

RFID System can be classified by the type of tag and reader. It can be Passive Reader Active tag, Active Reader Passive tag or Active Reader Active tag. In our proposed system we are using an Active Reader Passive tag since the tag is passive and the reader is provided with power supply. The microcontroller used in our proposed system is ATMEGA 328. The main objective of using a microcontroller in our system is for calculating the total bill amount. The microcontroller is fed with the information or data from RFID reader and is the one which, after all the calculations, will generate the total amount due to pay. ATMEGA 328 is a 28-pin configuration. It has several features as 32K FLASH, 2K SRAM,1K EEPROM, 23 General purposes I/O lines, 1 USART, 8 ADC channels, two 8bit counter/timer, one 16-bit counter/timer, has on-chip PWM and so on. Also, it has advanced RISC architecture as

131 powerful instructions, 32X8 general purpose working registers, up to 20 MIPS throughput at 20 Mhz. It has a speed of 20 MHz with 1.8- 5.5 V power supply range. These all features lead us to select ATMEGA 328 as our proposed system microcontroller.

An Infra-Red sensor is an electronic instrument which is used to sense certain characteristics of its surrounding by either emitting or detecting infrared radiation. IR sensors can measure the heat being emitted by an object and detecting motion. IR sensor can also be implemented as counters. IR Sensors can sense object up to 0-20 cm of its range. We are using IR sensors mainly for counting purpose. For this, we need to know when IR Sensor changes its state from HIGH to LOW and count how many times this transition happens. When an object is placed in the trolley consisting of IR Sensor, it interrupts the IR beam, the IR sensor's receiver module produces a high output pulse and as a result, the internal transistor conducts to activate and the count increases by one.

Bluetooth is a wireless technology standard for exchanging data over a short distance of 10 meters from fixed/variable and mobile device by building Personal Area Network. In our proposed system Bluetooth is used for short-range wireless transmission of data, which is the total amount deducted from the app to the system. For this purpose, we are using an HC-05 Bluetooth device which is a fully qualified Bluetooth V2.0+EDR of 3Mbps modulation with complete 2-4 GHz radio transceiver and baseband. The HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Its features include typical -80 dBm sensitivity, up to 4 dBm RF transmit power, 3.3 to 5 v I/O, 9600 baud rates. This is a 6-pin configuration module. Its range lies up to 10 cms.

As our proposed system also serves the purpose of stock management, GSM module is used. GSM module can be a mobile device or simply a modem consisting of SIM card working over a certain range prescribed by the service provider. In our proposed system GSM900 modem is used. The SIM900 is a complete Quad-band GSM/GPRS solution in an SMT module. The SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mm x 24mm x 3 mm, SIM900 can fit almost all the space requirements. SIM900 is designed with a very powerful single-chip processor integrating AMR926EJ-S core, Quad - band GSM/GPRS module with a size of 24mmx24mmx3mm, SMT type suit for customer application, An embedded Powerful TCP/IP protocol stack. It is compatible with AT cellular command interfacing. AT commands are instructions used to control a modem. AT is the abbreviation of attention. We are maintaining a database to manage stock. Whenever some quantity of an item is purchased and the database is updated, GSM module sends a message to the wholesale owner regarding it.

Liquid Crystal Display screen is an electronic display module which finds a wide range of application. We are using a 16X2 LCD display which is a very basic module, and which means it can display 16 characters per line and there are 2 such lines. The LCD has two registers namely command and data.

Command register stores command instruction given to LCD like initializing it, clearing its screen etc. Data register stores data to be displayed on LCD. Data is the ASCII value of the character to be displayed on the LCD. It is a 16-pin configuration module.

Also, for the required power supply, the 12 v DC power is converted to 5 v DC power and is applied to various pins.

For this, the components include a battery, which will provide a 12v DC power, a DC jack for supplying direct current power and a voltage regulator for stable DC voltage. In our proposed system we are using 7805 voltage regulator since it provides +5 v regulated power supply to various pins.

For self-checkout android based mobile application is used. This app will consist of some amount of which the amount to be paid will be deducted. This application is connected to the system via Bluetooth.

ALGORITHM:

Step 1 : Start
Step 2 : Initialize System
Step 3 : Search for RFID
Step 4 : Check RFID tag
Step 5 : Read related data from memory
Step 6 : Display data on LCD
Step 7 : Add item cost as items are added
Step 8 : IR sensor is used for counting purpose
Step 9 : When button is pressed, total amount appears on LCD
Step 10 : From App bill is deducted
Step 11 : Deducted quantity is updated in database and a message is sent to the owner regarding the same
Step 12 : Stop

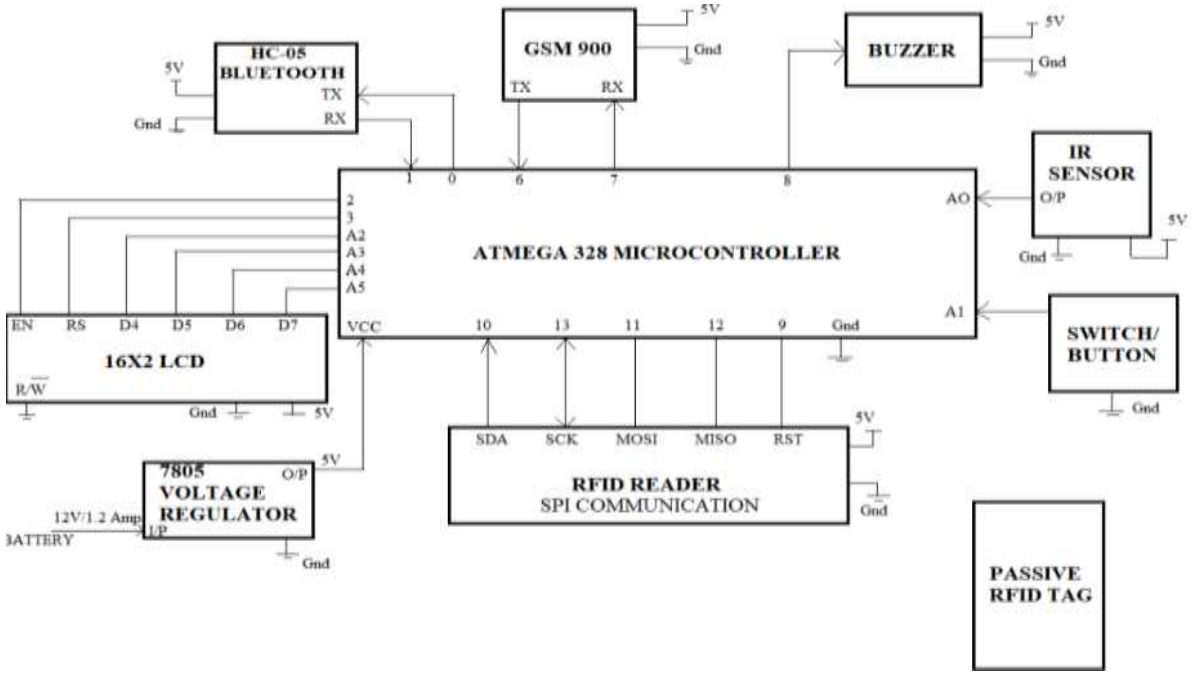

Fig 3: Circuit Diagram of Proposed System

5. CONCLUSION AND FUTURE SCOPE

By means of the proposed system, we intend to simplify the billing process. This will take the overall shopping experience to a different level. The prototype model developed successfully achieved the objectives of the project. The developed product is easy to use and economical. Although, there are certain aspects which can be changed in order to make the system more efficient. In the developed prototype, low-frequency RFID system is used which allowed a scanning range of the tag to be not more than 10cms. Instead, a high-frequency RFID system can be used which has a range of 1m. Also, GSM modem and Bluetooth are used separately to perform two different tasks, instead, Bluetooth could have been neglected and GSM modem itself could have been triggered to perform Bluetooth's action - sending data, i.e., bill amount, from system to App. Further, a more sophisticated micro-controller and larger display system can be used to provide better consumer experience.

The future scope of this paper can be Inclusion of discount offers in the wholesale market. Also, this system can be used to track the items in the market by triggering the GSM modem to perform the same.

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