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Research Paper

Smart Goods Billing Management and Payment System for Shopping Malls

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Abstract

In the present scenario, it is essential to have an automatic billing system for shopping malls, supermarket and other wholesale & retail stores. Numerous billing systems like barcode scanning mechanism-based systems or tag-based systems are available in the market. It is important to replace such existing system with better and robust systems so hereby we proposed "Smart Goods Billing Management and Payment System for Shopping Malls". In this system, the basic fundamental is barcode scanning for products, but we replace the conventional barcode scanner for faster and better results. In our prototype, the android phone is being used as a barcode scanner for simple, better and portable barcode scanner. This scanner is connected wirelessly to MCU via Bluetooth module. MCU is also connected to PC/Laptop for creating the database of all customers, their products, and bills. This database also tracks the total sale and number of goods sold per day. In addition, RFID technology is implemented in this system for payment through card-based system. Simulation and hardware-based results are proposed in this paper.

Keywords: *Barcode Scanning, Bluetooth, Database, RFID, Smart Devices.*

1. Introduction

Day by day, the lifestyle of today's generation is changing which enforce to have more number of shopping malls, supermarkets and retail outlets. It is common to see huge rush at malls on holidays and weekends. The scenario is even worse when there are special offers and discount [1]. It is essential to have efficient billing management system in shopping places so that customers can avoid long queue on billing counter, save time and shop comfortably. Hereby "Smart Goods Billing Management and Payment System for Shopping Malls" is proposed to achieve this goal. This paper describes the detailed research on this topic as simulation along with hardware experimental setup results are shown. In our proposed method barcode scanning phenomenon is used but unlike conventional billings system, any smartphone can be used as a barcode scanner. Rear camera of the mobile phone is used to scan the barcode using "Scan to Arduino" android application which is open source and freely available from google play store [2]. This scanned barcode can be sent wirelessly using Bluetooth of smartphone. A microcontroller is interfaced with Bluetooth module for receiving the barcode reading from smartphone and processes this information. Database is automatically maintained on laptop using PLX-DAQ application as microcontroller updates the data from time to time via the serial port. While detailed information is shown and saved in MS Excel but at the same time, it also being displayed on LCD about the current customer, product and price.

2. Literature Survey

The Number of methods is proposed by researchers in this domain. B. Ananthabarathi proposed High Speed Billing System in which RF detector is placed inside the shopping cart which is linked to the server for billing [3]. R.Rajeshkumar, R.Mohanraj, M.Varatharaj proposed Smart Trolley in which they have used RFID cards for each product and RFID reader with MCU on each trolley for calculating the bills while shopping [4].
P. Chandrasekar, T. Sangeetha have proposed Smart Shopping Cart with Zigbee and RFID in which they utilize RFID cards for each product along with Product Identification Device (PID) for the trolley which is used for calculation of products and bill. This approach used Zigbee for transmitting the billing details to central billing system [1]. Few more researchers have proposed system for billing management but most of the methods are similar in nature and used MCU plus communication module based system for each trolley [5], [6], [7].

3. Proposed Method

The basic problem in existing research proposals is using the separate system for every trolley and then makes it communicate to the billing system using some wireless communication module. Such proposals make the system complex, inefficient and expensive. Electromagnetic interference is another factor which makes such

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system unreliable as the number of wireless communication modules used for every trolley. Moreover, sometimes customer may need to buy only a few items in which he/she may not require a trolley so such systems are failed in such scenarios. In this paper, we proposed a robust and superior technique which can overcome the existing proposed methods. The smartphone is utilized as barcode scanner using android application and connected to the main system wirelessly for purpose of updating the information about products, bills, payment and sales record. PIC16F877A 8- bit Microcontroller is used for controlling every process in this approach [8], [9]. Scan to Arduino application is used for turning a smartphone into wireless barcode scanner [2]. Bluetooth module is interfaced for providing communication between MCU and barcode scanner (Smart Phone). PLX-DAQ by Parallax is computer application which is used for maintaining the database on laptop/PC by communicating with MCU using serial port [10]. It keeps the track record of the product, individual product price, the total price for items purchased by customer, name of customer, date & time of products sold, Method of Payment, sales record etc. RFID reader is used for card based payment system as RFID cards are used in this prototype for payment. Alphanumeric LCD has used for display the information related to product, bill or payment. Block Diagram of proposed method is shown in Figure 1. This approach can be very beneficial by utilized it in the real world by understanding and implemented it in following described way. Customers entered in shopping malls firstly need to open the "Scan to Arduino" Application and then connect their smartphone to the cash counter using Bluetooth [2]. After this, customer needs to scan his/her membership card from the smartphone. After the customer identification, the user will receive the feedback from the MCU and welcome them for shopping. The customer can now take the trolley and manually scan the items using their barcode and place them in the trolley. There is no limit of scanning goods so the customer can buy any number of items and quantity as per requirement. Once shopping is complete then the customer will notify the system by sending some text about the completion of shopping. Now the database will update the total amount of shopping along with individual items and their cost. This total amount information will be sent back to customer's smartphone.

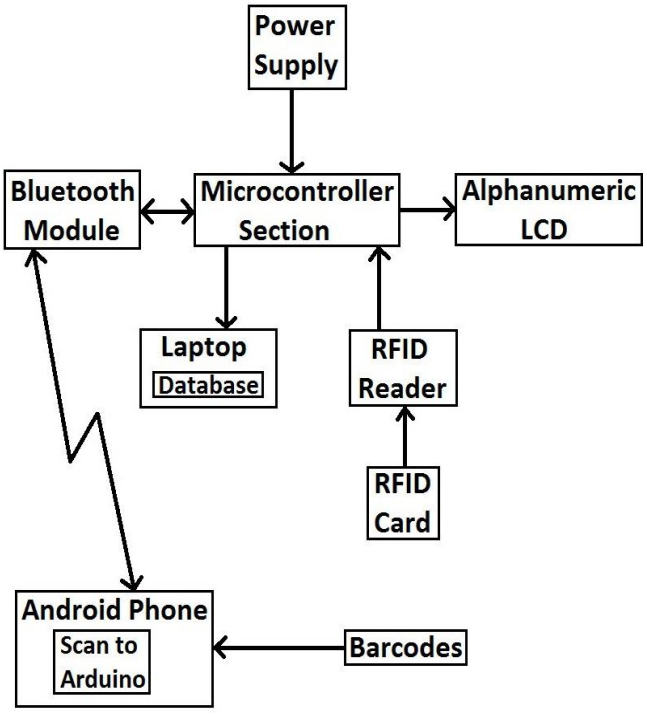


Fig.1 Block Diagram

Customers can pay for the total amount via cash or card based systems. We have developed the card based payment system for our proposed model and RFID cards are utilized for it. When customer will swipe his/her card then has to type the 4 digit PIN on their smartphone using the same application. Once payment is made successfully then the customer gets notified about deducted amount and balance amount. It also informs the customer about the wrong PIN entered and insufficient amount if in any case. It is important to provide the control flow of proposed method for making it more descriptive and useful for researchers. Flow control of the proposed method is shown in figure 2.

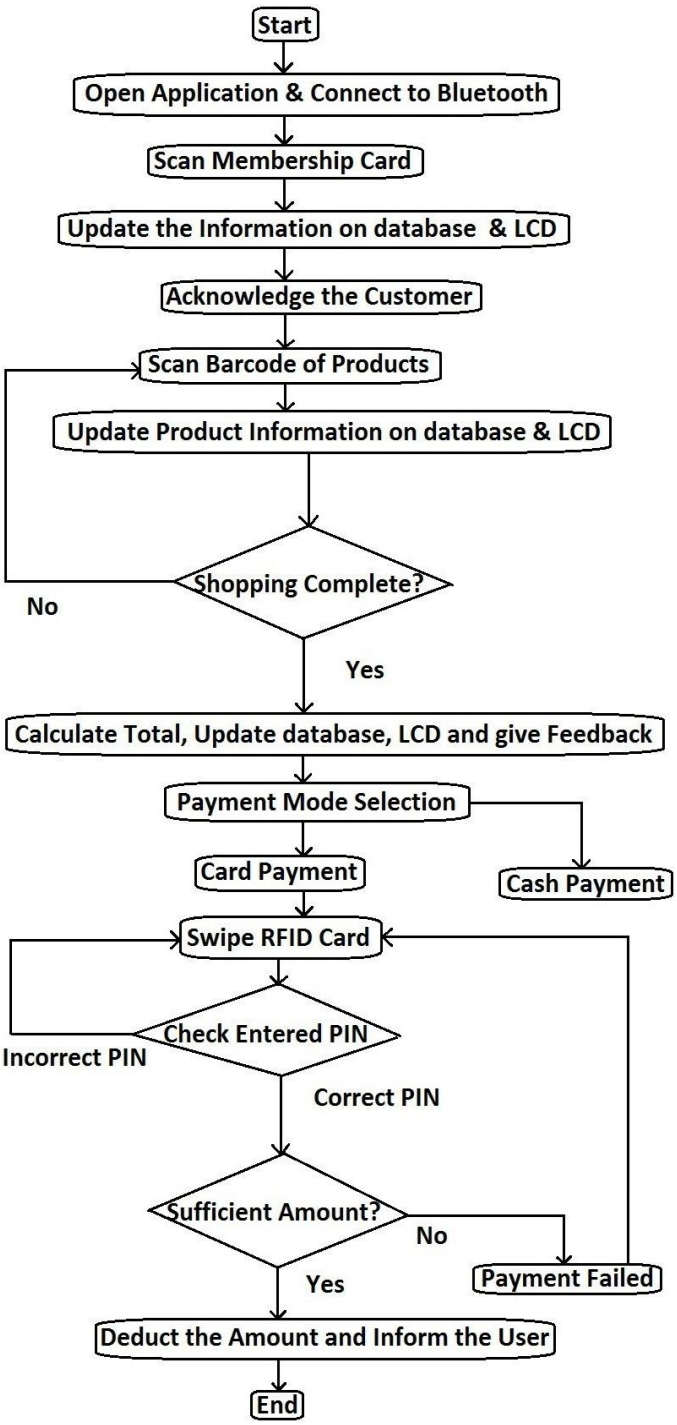


Fig.2 Control Flow

PIC16F877A microcontroller belongs to PIC16 family and is 8-bit microcontroller developed by Microchip Technology [8], [9].

Source code for PIC16F877A is developed using embedded C language. MikroC Pro for PIC compiler by Mikroelektronika is used in this as it offers a large number of libraries which helps in the quicker development of systems [11]. As shown in figure 3, MCU is interfaced with Bluetooth Module, RFID reader, Alphanumeric LCD and Max232. Bluetooth module used in our prototype is HC-05 which requires UART for communicating to MCU. HC-05 can be configured in master or slave mode of communication. AT commands are required for the purpose of the configuration of Bluetooth module like setting of baud rate, the name of Bluetooth module etc. RFID module used in this prototype is EM-18 which is 125 KHz RFID Reader. A reader is a device capable of communicating with a RFID tag. It can recognize the presence of a RFID tag and communicate with it. Tag-reader communication protocols are often specified in RFID standards [12]. Max232 is level converter which converts TTL signals to RS-232 and vice versa for appropriate communication between MCU and Laptop. Max232 also require UART for communication purpose. Three UART are required for RFID, Max232, and Bluetooth but PIC16F877A supports only one internal UART port so additional two UART is made using Soft UART library of MikroC Pro for PIC [9], [11].

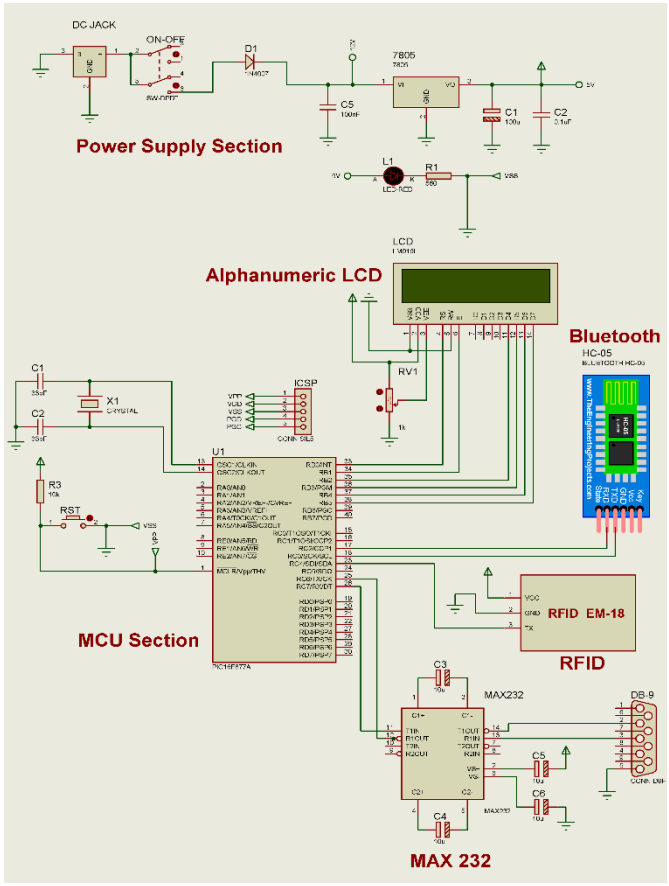


Fig.3 Circuit Diagram

4. Simulation Results

Simulation-based results are proposed for this approach using Proteus software which is quite popular for simulation of both digital and analog electronics systems. Proteus 7.10 is used in this simulation result for analyzing and verifies the behavior of proposed method [13]. Virtual Terminal is used in the simulation for the purpose of serial communication with various modules. Barcode scanning is the basic process used for scanning various products and membership cards as shown in figure 4.

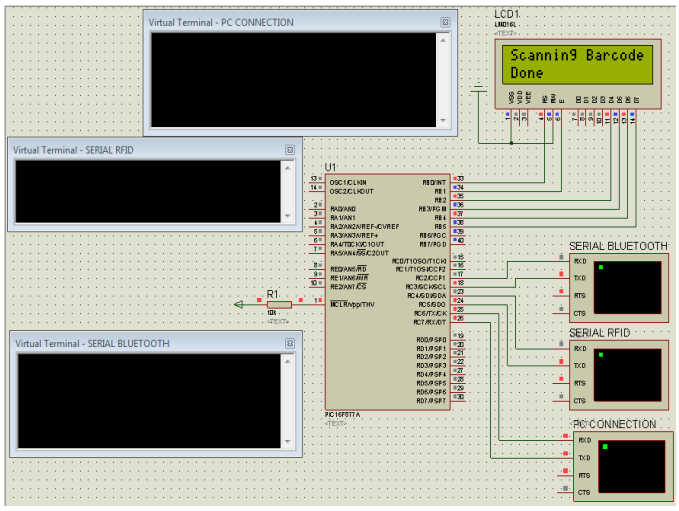


Fig.4 Barcode Scanning Process

When any item is scanned by smartphone then correspondent data is transmitted to MCU via Bluetooth. After receiving any valid data, MCU updates the database as well as LCD with item name and price. As shown in figure 5 and 6, the database is updated with date, time, and product name with the price. At the same time, LCD is updated with product name and price. PLX-DAQ application based database saved in a computer contains historical and real-time data whereas LCD only displays real-time data [10].

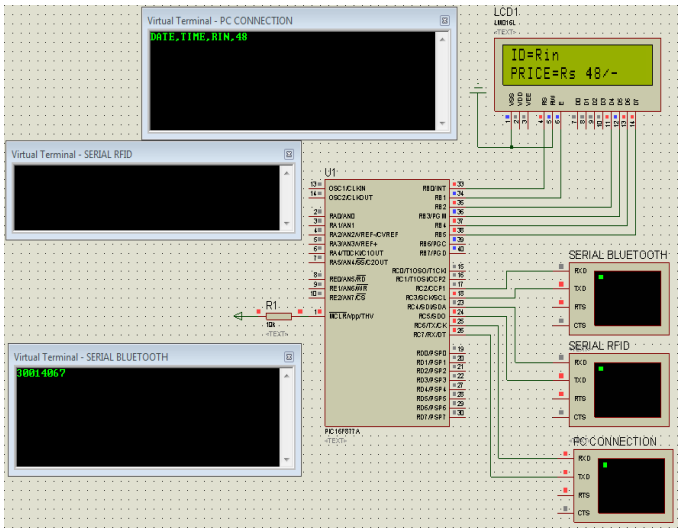


Fig.5 Product-1 display after scanning

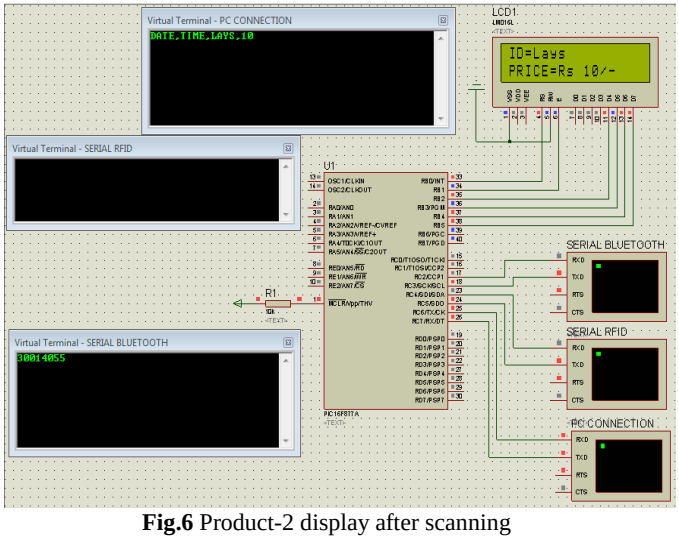


Fig.6 Product-2 display after scanning

After the scanning of all the products, next step is payment. The customer can pay via cash or card based payment. A RFID tag consists of a wireless transducer, an antenna, and an encapsulating material. These tags can be active or passive. While the active tags have on-chip power, passive tags use the power induced by the magnetic field of the RFID reader [4]. In card based payment, passive RFID cards are used which generate unique 12 bytes codes when swiping to RFID reader. This 12 bytes unique code is received by MCU after card swiping then received data is used to identify the card owner and PIN. RFID card scanning process is shown in figure 7.

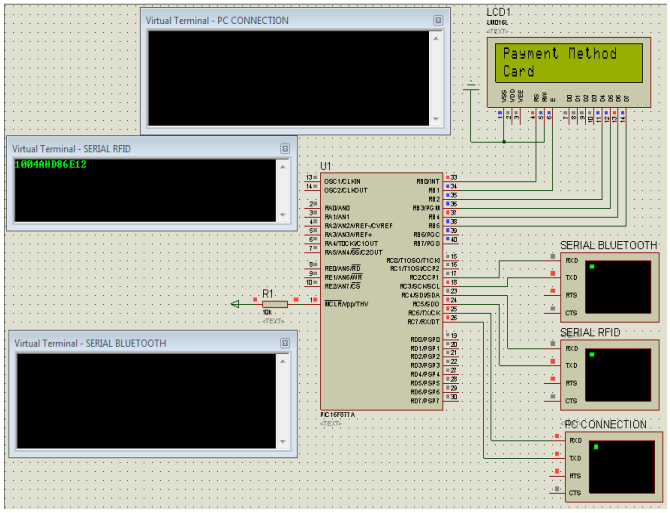


Fig.7 RFID Card Scanning Process

If card successfully identified then the system will ask for PIN by sending a message to the smartphone. The customer then enters the PIN on smartphone application and sends it. Payment is successful if entered PIN is matched with the actual PIN of the card. In case the wrong PIN is entered then the user needs to swipe the card again and enter correct PIN. If the amount is insufficient on the card then it is notified to the customer via smartphone application so that customer can pay with another card.

5. Hardware Results

Hardware results are essential for implementing any real time embedded system. These kinds of results explore the behavior of systems in real world. Hardware experimental setup for proposed system is shown in figure 8. This setup includes HC-05 Bluetooth Module, EM-18 RFID reader and 40-pin DIP PIC microcontroller which contain MAX232, USB to serial converter, LCD and PIC16F877A. PCB of this development board is designed in Proteus ARES software and fabricated using screen printing technique [13].

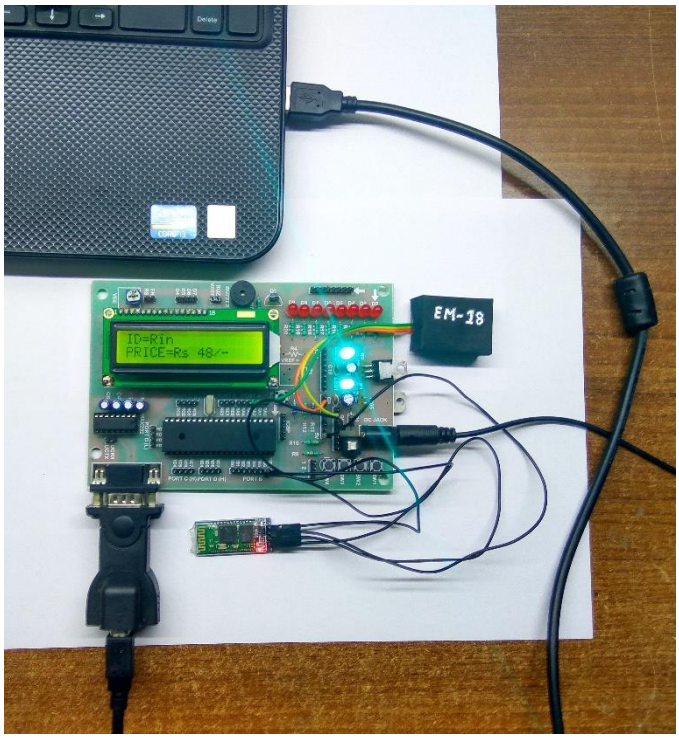


Fig.8 Hardware Setup

In the hardware implementation of our proposed method, each and everything is implemented in step by step approach. Firstly membership card is made for this prototype as shown in figure 8.



Fig.9 Membership Cards

Next step is to open the “Scan to Arduino” application on smartphone and connect it to the Bluetooth module.
Once the application is connected to the Bluetooth module successfully then it will show the status connected. It also shows options like scan the barcode, send the string and received data from MCU as shown in figure 10.

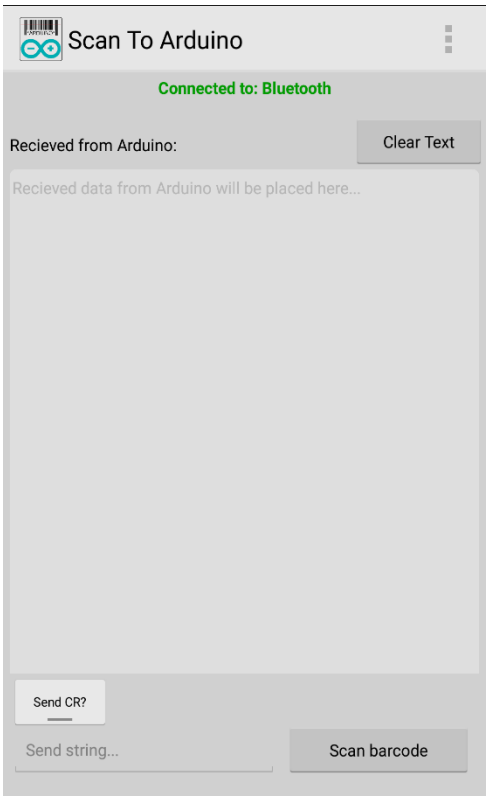


Fig.10 Scan to Arduino Application View

When smartphone application is opened and connected to Bluetooth then firstly membership cards will be scanned. The customer is authorized to begin his/her shopping after scanning of membership cards. The customer simply needs to click on scan barcode button on the application which begins the scanning via the rear camera of mobile as shown in figure 11.



Fig.11 Barcode Scanning Process

The next step is to transmit this scanned barcode to MCU via Bluetooth. MCU will recognize this barcode data from lookup table written in the program. If received data is valid then it will display the details of the product accordingly. The number of products can be purchased by the user as per the requirement. The same product can also be purchased a number of times. After successfully data received, MCU updates the LCD display as shown in figure 12.

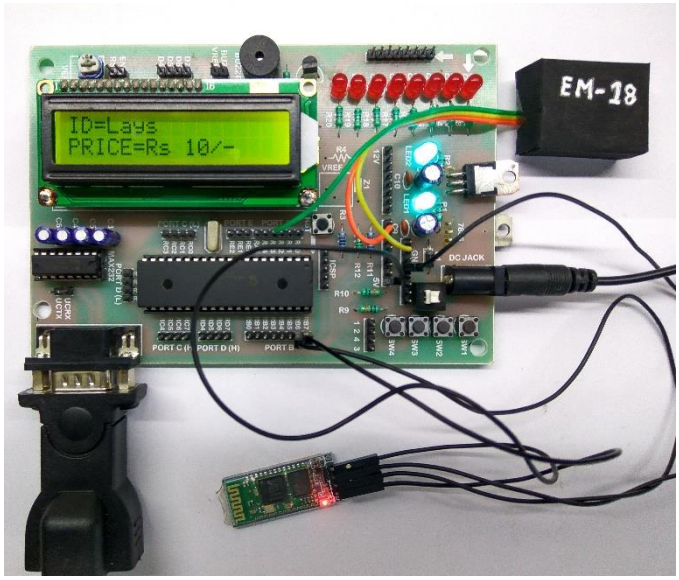


Fig.12 Display of Product Detail

Next important thing is to transmit the data to the laptop via MAX232 and USB to serial converter cable. For this firstly PLX-DAQ application should be opened and connected to particular in which serial to USB converter cable is connected. Now MCU has to send serial data via internal UART which is on RC6 and RC7 pin. PLX-DAQ will keep updating the MS excel file as per MCU data. Date, Time is automatically taken from laptop date & time by sending DATE and TIME commands by MCU via UART. Rest of the details depends on the customer and products purchased. PLX-DAQ database along with payment details is shown in figure 13.

	A	B	C
1	Customer Name	Jatin Arora	
2			
3	Date, Time	Product	Price (INR)
4	21/10/2016 3:25:10 PM	Tide Detergent	90
5	21/10/2016 3:26:20 PM	Detol Liquid Soap	80
6	21/10/2016 3:26:50 PM	Tooth Brush	40
7	21/10/2016 3:27:35 PM	Fogg Deo	120
8	21/10/2016 3:28:15 PM	LPG Lighter	70
9	21/10/2016 3:28:50 PM	LAYS	10
10	21/10/2016 3:29:25 PM	Chocolate Candy	20
11	21/10/2016 3:30:05 PM	RIN	48
12	21/10/2016 3:30:42 PM	PEN	25
13	21/10/2016 3:31:50 PM	Steel Wool	10
14	21/10/2016 3:32:13 PM	Dish Wash Soap	40
15	21/10/2016 3:33:00PM	Total	553
16	21/10/2016 3:45:04 PM	Payment Method	Card
17			
18	21/10/2016 3:46:10PM	Payment Status	Paid
19			

Fig.13 PLX-DAQ Database Result

Once the shopping is complete, total will be automatically calculated by MCU and send the amount to the database. Now customer will choose the payment method. Cash-based payment will take place manually but in the case of card-based payment, customer needs to swipe RFID card. Now user needs to correct PIN for payment. The database will be updated with payment successfully if paid otherwise it will display payment failed in the case of insufficient balance.

6. Conclusion and Future Work

In this paper, we have demonstrated a method which makes the billing of goods in efficient, easier and fast way. Existing system makes use of hardware barcode scanners on billing counters results in a long queue. Many researchers proposed methods to overcome this problem but there is a lack of efficiency and realistic in their work so we have proposed better method along with simulation and hardware results so as to check the behaviour in the real world. Although we have observed good results in our approach but we have used Bluetooth module in our approach which can be connected to a limited number of devices and range is limited. So there is a possibility

to make use of algorithms which can bring the concurrency for all the users and reduce the waiting time. In our next work, we are working on scheduling algorithm for providing services to large number of customers simultaneously.

Acknowledgement

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