A Low Cost Smart Shopping Facilitator for Visually Impaired

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***Abstract*-Disability is the state of a person in which one has to depend on others for their own needs. Visual impairment is one of the disabilities of a human being. To date numerous methods had been proposed to enhance the life style of visually impaired and blind people. Still purchasing products in the supermarket without others support is tricky one for them. The proposed system provides the guidance for them to identify and purchase their products in the supermarket. Radio Frequency Identification (RFID) technology is implemented to identify the products. The audio instructions will assist them inside the supermarket based on the real time situations. To make the supermarket in a smarter way the billing system is automated. The autonomous billing system uses zigbee transceiver to transmit/receive the product information. Hence it eliminates the existing queuing system in the supermarket. The ultimate aim of this system is to eliminate others support for visually impaired people in shopping and provide them a convenient and sophisticated environment. On implementing this system, it facilitates the blind people shopping, save the customer's time and promotes business sales.**

Keywords- Visually impaired people, RFID, Zigbee, Smart Shopping, PIC, Embedded product

I. INTRODUCTION

In this smart world, no one can end up the day without using any kind of embedded system products. It makes our human life very smarter and to feel comfortable. In worldwide, the great regret factor is visual impairment. Based on the statistics of World Health Organisation (WHO) in 2012, 285 million people are visually challenged in the world. Among them 39 million people are blind and 246 million having low power vision. About 90% of them are living in developing countries [1]. Lot of electronic products are introduced for visually impaired but all having some sort of drawbacks such as complexity in operation, need of more practice, higher cost, expensive design methodology and installation, non optimized data, more time consuming and tough maintenance. By considering these issues, if the embedded product is used for visually impaired and blind people, it will be really worthy [2].The identification systems are already available for them. At present in the case of shopping there is no such embedded product. Shopping is one of the interesting things for every human. But this simple task cannot be easily achieved by the blind. They need others help for satisfying their own requirements. RFID is the simplest and efficient technology which can be used for object detection and identification in many applications such as supply chain management, objects tracking, antitheft applications, logistics, warehousing etc [3]. This can be used effectively for blind at the time of shopping and greatly improves the life style of them [4]. The goal of every product is nothing but to attain the top position in the market. For that, the product should have some basic qualities such as low cost, portability, easy working and maintenance. So the proposed system is effectively designed by considering these aspects in mind. To provide the low cost and efficient embedded product, PIC microcontroller is preferred. RFID technology and PIC microcontroller are co-ordinately used to design the system [5]. It can be easily implemented in the supermarkets where all kind of things available under one roof. The system using two zigbee transceiver modules, one interfaced with microcontroller and the other one connected with PC for data transmission. The identification and wireless techniques are implemented to determine and transmit the product information automatically.

II. RELATED WORK

Mohsin Murad et al. [4] describe RFID Based Navigation and Object Recognition Assistant which use online location monitoring and server for collecting database. It was implemented for home and office buildings. The design methodologies of this system require Visual Basic as front end language and database management tools. It was designed by using FM transmitters and receivers which leads to practical design problems.

Mohamed Manoufali et al. [6] developed an intelligent guiding system for blind people. It facilitates a blind person to move freely in the outdoor environment by knowing about nearby obstacles. PIC microcontroller and ultrasonic sensors were used to provide the obstacle information. It mainly identifies the obstacles and not specifically used for application.

Willis et al. [7] implemented a system for visually impaired using RFID technology. It uses the concept of formation of information grid and encoding schemes for installation. It is self-describing and not depends on wireless infrastructure or centralized database.

978-1-4673-6217-7/13/$31.00 ©2013 IEEE

B. Ando [8] produced a method to assist unsighted people in navigation. It needs more design schemes such as sonar module and signal processing for its operation. It mainly requires more algorithms for device characterization and optimizing the system design.

Priya Narasimhan implemented a system called TRINETRA based on Assistive Embedded Technologies [9]. It provided the barcode based solution for the blind to identify the products in the supermarket. Barcode systems need line of sight to retrieve product information. At the time of implementing this, RFID was used at heavy cost. So they designed by using bar code-scanning pencil, smart cell phone and Bluetooth headset.

III. SYSTEM ARCHITECTURE

A. RFID System

It comprises of two components, a tag and reader which operates in certain frequency range. Normally it operates in ultra high, high and low frequencies such as 860-960 MHz, 13.56 MHz and 125 kHz respectively. It is very important to select exact frequency range for our application. In this system the tags and readers communicate at a frequency range of 125 kHz [5]. Based on the properties and functionalities, RFID tags are classified as active-passive tags and read only-rewritable tags respectively. The read only tag is non-editable, while using rewritable tags the data stored can be modified easily. Then this system prefers passive tags over active tags because it can be operated without battery, less expensive, smaller, and more powerful. It can be majorly used in shorter range of communication. It gets the power from RFID reader by means of radio frequency waves. These kinds of tags are classified under class 0 to 3 [10]. Sometimes there will be a chance for collision between reader and tag communication. It can be rectified by anti collision protocol e.g. collision tree protocol.

B. PIC Microcontroller

The entire system is controlled by PIC16F877A. It is 8 bit PIC microcontroller and adopts RISC architecture which makes the system design less complex. This series is widely available, cost efficient and reliable in operation. It has 14.3 kB of program memory, an inbuilt ADC and Watchdog timer. It consumes low power with voltage range of 2.5V to 6V [11]. USART port in the controller is enabled for serial communication with RFID and zigbee.

C. APR9600 IC

It is a non-volatile, low-cost and effective IC which is used for conveying the product information to visually impaired people through audio instructions. It is connected with speaker which

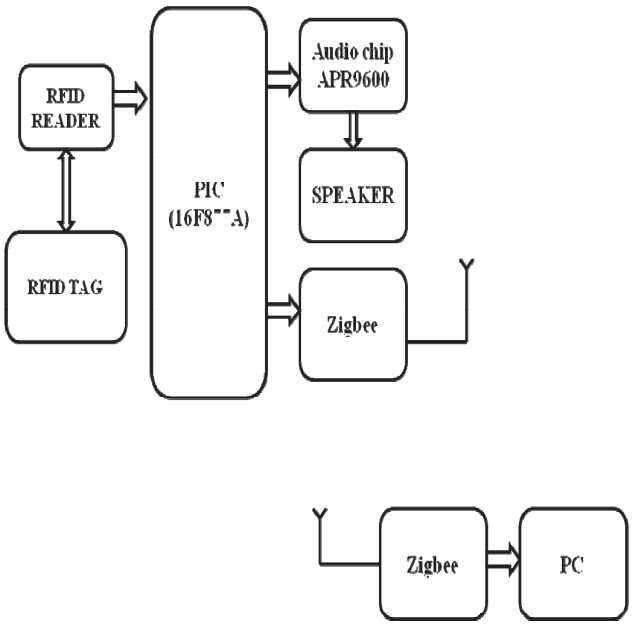

Fig. 1. Functional block diagram

provides high quality and low noise audio signal. It can be operated in serial and parallel modes. In recording time of 60s, sampling rate and bandwidth is 4.2 kHz and 20 Hz to 2.1 kHz respectively. High sampling rate such as 8 kHz in 32s can also be achieved by adjusting an oscillation resistor. It has a Dual In line Package with 28 pins [12]. It makes use of flash analogue technique for storage and performs both recording and replaying effectively. At the time of recording and replaying, current consumption is 25 mA. This module contains microphone which is used to pick up audio, supporting components such as pre-amplifier, filters, mode selection switches (M1 to M8) and other keys. By using this IC, sound tracks can be recorded (when RE=0) as well as replayed (when RE=1) in both the modes. With the help of 8 Ohm speaker the speech clarity and sound replay quality can be improved [13].

D. Zigbee

Zigbee is a communication protocol for wireless networks used to transmit/receive the information between two or more nodes. It is designed on the basis of IEEE 802.15.4 and adopts direct sequence spread spectrum technique to achieve simple operation, low cost, secure data communication and low consumption of power [14]. This system uses zigbee networking technology, due to its automatic end-to-end acknowledgement property. It enhances reliability and battery life through mesh networking, multicasting and acknowledgements. Zigbee network includes a master/co-ordinator node and number of

client nodes/end devices. The system uses Tarang-F4 version of zigbee module which operates in ISM 2.4 GHz and data rate of 250 Kbps. Here the client nodes are used to transmit the product information (like price, weight) in the supermarket. Once the blind person decided to acquire the item, its information is transmitted to master node connected with billing system.

IV. SYSTEM DESIGN

Fig.2 shows the entire system design to be installed in the supermarket. In the supermarket, the commodities are isolated and placed in shelves. The passive RFID tags mounted in each shelf are powered by radio waves from RFID reader while making contact. To identify the required product an audio file is recorded by using APR9600 IC which is interfaced with the microcontroller. The audio file is unique for each shelf. The reader reads the tag information which has a unique code and sent to microcontroller. The microcontroller receives the unique EPIC (Electronic Product Identification Code) and process the code. Then the received code is matched with the corresponding audio file and played through the speaker [5]. Once the blind people decided to purchase a product, they have to select the switch in the module. Two push type switches are used in the module. Then the product information is sent to the billing system through zigbee.

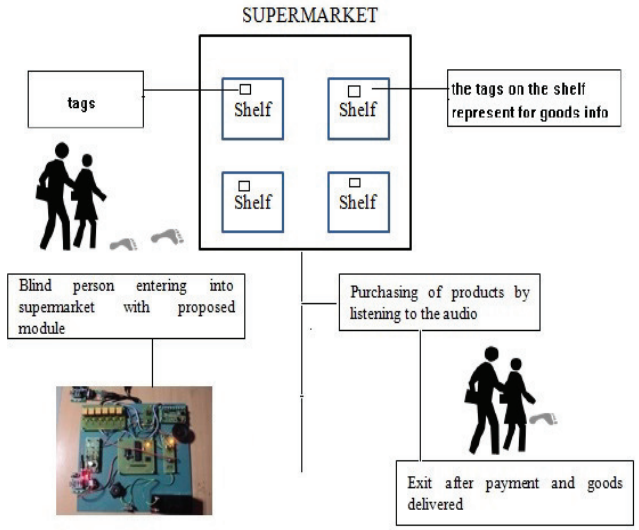

Fig. 2. Design of supermarket

The pseudo code of the system is as follows.

Begin

Initialize desired baud rate

Set the desired frequency

Configure WDT & LVP & PWRT & BOR

Initialize MC

Set the control register value

Enable output PORTC

Initialize USART

Assign control bits for serial transmission

Set TX and RX pins for data communication

Enable baud rate generator

Main

Assign pins for MC initialization and serial transmission

While (submit flag! =true)

Wait for switch

If (tag id== data stored)

Retrieve recorded audio

If (RC=1)

Transmit the product information

Else

Read the next tag

End main

End

V. EXPERIMENTAL TESTBED

Fig.3 shows the hardware module of the proposed system. Power supply unit consists of a +12V rechargeable battery and voltage regulator IC (LM7805). The voltage regulator used to stabilize DC voltage according to the requirement of devices connected to it. The microcontroller used here is PIC16F877A with operating frequency of 4MHz. RX and TX pins of USART port in the controller are connected to RFID reader and zigbee module respectively. The microcontroller is programmed in embedded C platform using MPLABIDE. In the microcontroller PORTs C and D are used as output ports. The unique tag ID is

matched with the respective audio file stored in the APR9600 IC and played through the external speaker. The IC requires the supply voltage between 4.5V to 6.5V and has the ability to playback the voice as it recorded previously. The output pins of the microcontroller (RD4-RD7) are connected to APR9600 to enable voice recording and replaying. The blind people can make a decision to acquire the product by listening to the audio file. Buzzer beep indicates the purchase of a particular product by the customer and the information sent to billing system through zigbee. When the buzzer is powered, it produces an output audible tone of 2 kHz. The zigbee module operates between 3.3V-3.6V and its output can be viewed in HyperTerminal. It is configured by using AT commands and interfaced with the PC through USB interface board. The decision making switches are interfaced with the microcontroller and buzzer to make the system more automated. The output of the billing system which displays product name, weight and price is shown in Fig.4.

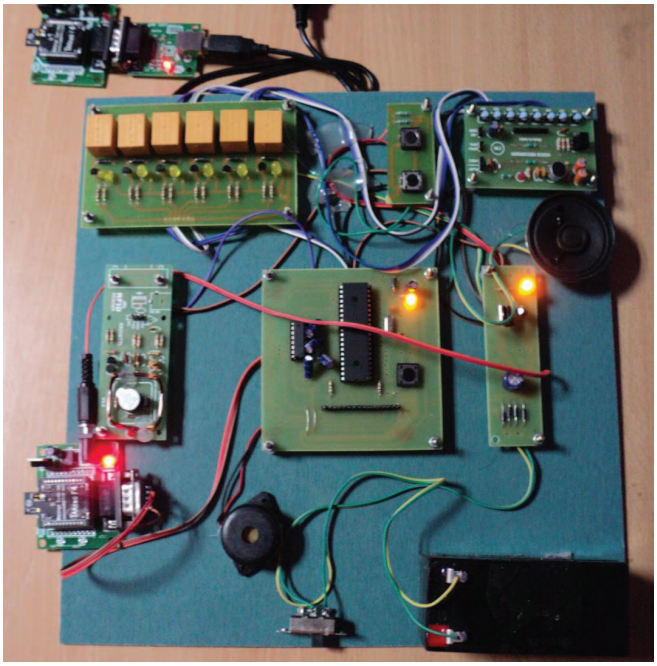

Fig. 3. Hardware module

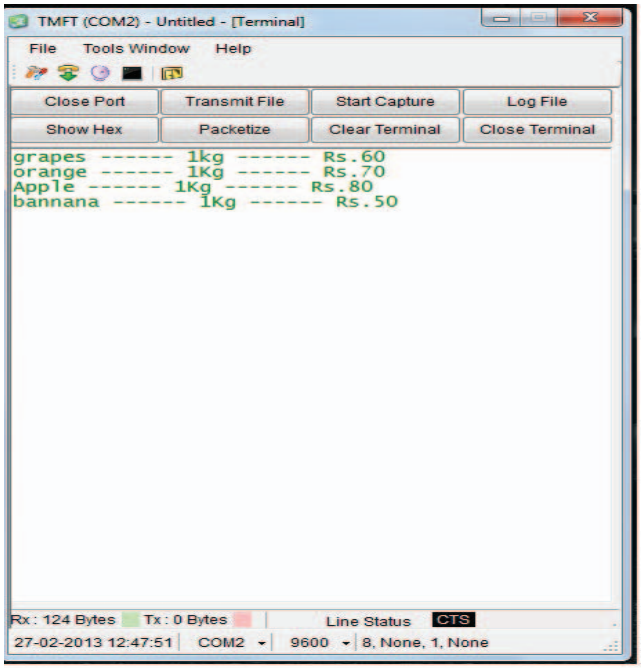

Fig.4. Zigbee output

VI. CONCLUSION

The system is very innovative, practically useful for the visually impaired people and realized as a prototype. By using this fully automated product, they can stand on their own leg at the time of shopping. It does not need more skills to operate, overcomes the hesitation and giving confidence for purchasing their shopping needs. With the help of RFID readers and tags, visually impaired people can get to know the objects information easily. The proposed system effectively implemented by using PIC microcontroller for providing simplicity, efficiency and portability with low cost. It makes the better use of RFID and Zigbee technologies for providing the smart environment for visually impaired. This will be the efficient real time embedded product in supermarkets and improves the business sales. In future the proposed system will be designed as a portable device and integrated with the trolley (used to dump the purchased products in the supermarkets). To avoid collision among the blind people and for obstacle detection, ultrasonic sensors will be mounted in the trolley.

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