

Smart Shopping Cart with Automatic Billing System through RFID and ZigBee

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Abstract—Contemporary embedded systems are habitually based on microcontroller's i.e. CPUs in the company of integrated memory as well as peripheral interfaces but ordinary microprocessors by means of external chips for memory and peripheral interface circuits are also still common, especially in more complex systems. Radio frequency identification (RFID) technology may not only be useful for streamlining inventory and supply chains: it could also make shoppers swarm. ZigBee is based on an IEEE 802.15 standard. ZigBee devices often transmit data over longer distances by passing data through intermediate devices to reach more distant ones, creating a mesh network; i.e., a network with no centralized control or high-power transmitter/receiver able to reach all of the networked devices. This paper provides centralized and automated billing system using RFID and ZigBee communication. Each product of shopping mall, super markets will be provided with a RFID tag, to identify its type. Each shopping cart is designed or implemented with a Product Identification Device (PID) that contains microcontroller, LCD, an RFID reader, EEPROM, and ZigBee module. Purchasing product information will be read through a RFID reader on shopping cart, mean while product information will be stored into EEPROM attached to it and EEPROM data will be send to Central Billing System through ZigBee module. The central billing system gets the cart information and EEPROM data, it access the product database and calculates the total amount of purchasing for that particular cart. Main aim of this paper was to provide an automatic billing to avoid queue in malls and super markets.

Keywords—*Product Identification Device, EEPROM, RFID, ZigBee, Central Billing System.*

I. INTRODUCTION

Programmers build up software applications every day in order to augment efficiency and productivity in a mixture of situations. A system is a way of working, organizing or doing one or many tasks according to a fixed plan, program, or set of rules. A system is also an arrangement in which all its units assemble and work together according to the plan or program. An embedded system is one that has computer-hardware with software embedded in it as one of its most important component. It is a dedicated computer-based system for an application(s) or product. It may be either an independent system or a part of a larger system. As its software usually

embeds in ROM (Read Only Memory) it does not need secondary memories as in a computer. These systems are designed with a single 8- or 16-bit microcontroller; they have little hardware and software complexities and involve board-level design. They may even be battery operated. When developing embedded software for these, an editor, assembler and cross assembler, specific to the microcontroller or processor used, are the main programming tools. Usually, 'C' is used for developing these systems.

Radio frequency identification (RFID) is a rapidly growing technology that has the potential to make great economic impacts on many industries. While RFID is a relatively old technology, more recent advancements in chip manufacturing technology are making RFID practical for new applications and settings, particularly consumer item level tagging. These advancements have the potential to revolutionize supply-chain management, inventory control, and logistics. At its most basic, RFID systems consist of small transponders, or tags, attached to physical objects. RFID tags may soon become the most pervasive microchip in history. When wirelessly interrogated by RFID transceivers, or readers, tags respond with some identifying information that may be associated with arbitrary data records. Thus, RFID systems are one type of automatic identification system, similar to optical bar codes.

ZigBee is built on top of the IEEE 802.15.4 standard. ZigBee provides routing and multi-hop functions to the packet-based radio protocol. ZigBee technology is a low data rate, low power consumption, low cost; wireless networking protocol targeted towards automation and remote control applications.

Supermarket is the place where customers come to purchase their daily using products and pay for that. So there is need to calculate how many products are sold and to generate the bill for the customer. Cashier's desks are placed in a position to promote circulation. At present, many supermarket chains are attempting to further reduce labor costs by shifting to self-service check-out machines, where a single employee can oversee a group of four or five machines at once, assisting multiple customers at a time.

II. HARDWARE IMPLEMENTATION AND DESIGN OF CART

The given fig.1 shows hardware modules for the device which is attached to shopping cart of supermarket. It consists of a microcontroller, display unit (LCD), an EEPROM, RFID reader, ZigBee transceiver and a battery power source. The battery power source increases the mobility of the device.

A liquid crystal display is special thin flat panels that can let light go through it, or can block the light. Each block is filled with liquid crystals that can be made clear or solid, by changing the electric current to that block. Liquid crystal displays are often abbreviated LCDs.

A. Microcontroller

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry standard 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be

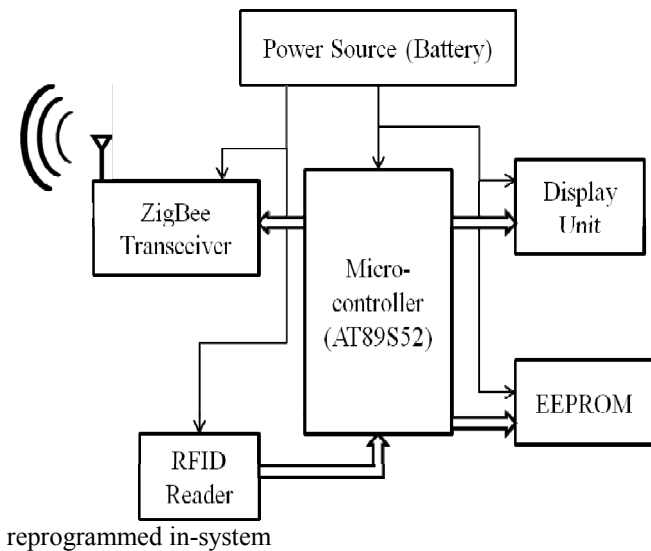
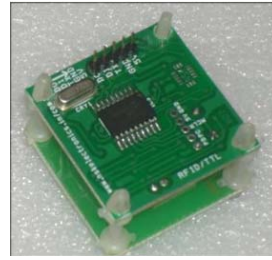


Fig. 1. Hardware Implementation of Shopping Cart

or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM con-tents

but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

B. ZigBee



ZigBee is expected to provide low cost and low power connectivity for equipment that needs battery life as long as several months to several years but does not require data transfer rates as high as those enabled by Bluetooth. In



Fig. 2. ZigBee Module

addition, ZigBee can be implemented in mesh networks larger 2 than is possible with Bluetooth. ZigBee compliant wireless devices are expected to transmit 10-75 meters, depending on the RF environment and the power output consumption required for a given application, and will operate in the unlicensed RF worldwide (2.4GHz global, 915MHz Americas or 868 MHz Europe).

The data rate is 250kbps at 2.4GHz, 40kbps at 915MHz and 20kbps at 868MHz. The below fig 2 shows the ZigBee module CC2500 transceiver.

C. EEPROM

The AT24C02 provides 2048 bits of serial electrically erasable and programmable read-only memory (EEPROM) organized as 256 words of 8 bits each. The device is optimized for use in many industrial and commercial applications where low-power and low-voltage operation are essential.

TABLE I. EEPROM PIN CONFIGURATION

Pin Name	Function
A0 - A2	Address Inputs
SDA	Serial Data
SCL	Serial Clock Input
WP	Write Protect

NC	No Connect
GND	Ground
VCC	Power Supply

D. RFID Reader

RFID Proximity OEM Reader Module has a built-in antenna in minimized form factor. It is designed to work on the industry standard carrier frequency of 125 kHz. This LF reader module with an internal or an external antenna facilitates communication with Read-Only transponders—type UNIQUE or TK5530 via the air interface. The tag data is sent to the host systems via the wired communication interface with a protocol selected from the module Both TTL and Wiegand Protocol.

Fig. 2. RFID Reader

Radio-frequency identification (RFID) is a technology to electronically record the presence of an object using radio signals. It is used for inventory control or timing sporting events. RFID is not a replacement for the bar-coding, but a complement for distant reading of codes. The technology is used for automatically identifying a person, a package or an item.

III. CENTRAL AUTOMATED BILLING SYSTEM

The fig shows the concept of Central Automated Billing System. Since each cart is attached with product identification device (PID), through ZigBee communication PID sends its information to central automated billing system, there it calculates net price for the purchased products. Customer can get their billing information at the packing section according to their Cart Identification Number. Even there's is no need for a cash collector, in case customer uses their debit/credit for bill payment. The Automated central billing system consists of a

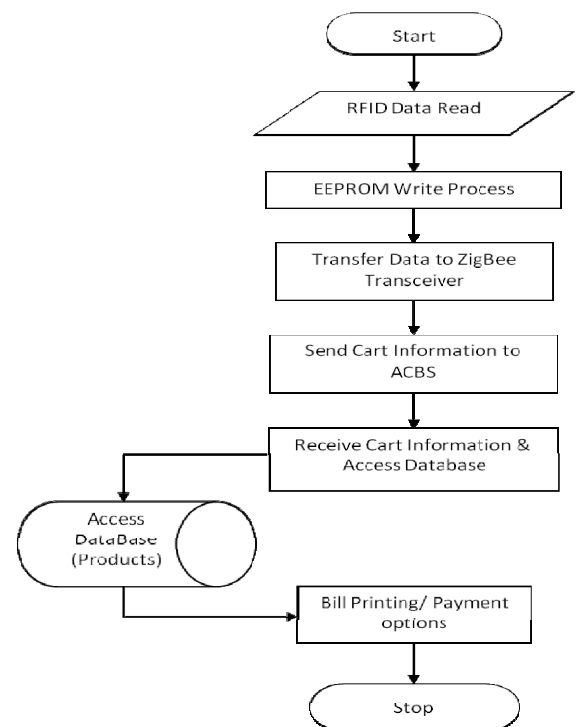


Fig. 3. Central Automated Billing System

product database. The automated billing system will be developed using visual basic. Visual Basic was designed to accommodate beginner programmers. Programmers can not only create simple GUI applications, but to also develop complex applications. Programming in VB is a combination of visually arranging components or controls on a form, specifying attributes and actions for those components, and writing additional lines of code for more functionality. Since VB defines default attributes and actions for the components, a programmer can develop a simple program without writing much code. Programs built with earlier versions suffered performance problems, but faster computers and native code compilation has made this less of an issue.

IV. I2C PROTOCOL

The data transfer between microcontroller and EEPROM is made through I2C serial protocol. Since AT24C02 is two line serial I2C enabled IC. Generation of clock signals on the I2C-bus is always the responsibility of master devices; each master generates its own clock signals when transferring data on the bus. Bus clock signals from a master can only be altered when they are stretched by a slow-slave device holding-down the clock line, or by another master when arbitration occurs. Due to the variety of different technology devices (CMOS, NMOS, bipolar) which can be connected to the I2C-bus, the levels of the logical '0' (LOW) and '1' (HIGH) are not fixed and depend on the associated level of VDD. One clock pulse is generated



for each data bit transferred.

Fig. 4. Control flow diagram

V. CONCLUSION AND DISCUSSION

This application creates an automated central bill system for supermarkets and mall. Using PID, customers no need to wait near cash counters for their bill payment. Since their purchased product information is transferred to central billing system. Customers can pay their bill through credit/debit cards. The 8- microcontroller used here has the capability of receiving 8-bit data from RFID reader.

The AT89S52 doesn't have inbuilt I2C protocol, programmer has to create a separate EMBEDDED C program to communicate with EEPROM. This may create some difficulties in writing program for programmers to synchronize with EEPROM. Some of other microcontrollers and microprocessors have inbuilt I2C protocol features. Those can be used as further improvement in efficiency and compatibility of this application.

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