Smart Shopping Trolley Using RFID Tag Automated Billing System

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Abstract— The global surge in shopping demands a reevaluation of traditional methods that often appear slow and cumbersome in the context of rapidly advancing world. Embracing the evolving landscape of technology and automation, this paper aims to revolutionize the shopping experience in malls by introducing the Smart Shopping Trolley [1][2]. The Smart Shopping Trolley incorporates RFID tags to streamline the billing process, eliminating the need for human intervention. Arduino is used to program all the requirements for auto generation of the bill with all product details at the counter. This innovative approach ensures a smoother and more efficient shopping experience for customers, allowing them to navigate through the supermarket without the need for human interaction or enduring long waiting times at the billing counter.

Keywords—RFID Tag, RFID Reader, LCD Moule, Arduino IDE, Software Tool

I. INTRODUCTION

Most of the shopping done for daily needs of consumers is still done in a physical manner and not through online mode. This introduces the challenge of long queues and atrocious waiting times at the billing counter. This can be seen as a huge waste of time and resources which can be put to better use somewhere else. To make shopping more pleasant and ease the overall working environment of the people at the billing counters, an automated shopping trolley[11] can be incorporated to be used. Automated shopping trolley consists of an RFID reader and tags which are to be placed on every item controlled[3] by Arduino instead of the traditional barcode readers. The reader scans this tag every time a product enters the cart. An LCD will display the price of the product along with its name and total bill of the scanned items. If the customer wishes to remove the items from the bill he simply needs to scan it again and the item will get deleted. A master card is provided to all customers which acts as a unique identity and key. After the master card is scanned a welcome text with account balance details is displayed on the LCD screen. A buzzer is used to provide the shopper with audio stimulus every time a new product is added or removed or master card is used. Buzzer beeps once the product scanning is successful. Visual stimulus can also be provided with the use of LED's. LED's will blink every time a product is scanned or master card is used. At the end of shopping, the shopper has to scan the master card, when done the final bill details will be displayed on the LCD screen. This helps in reducing the overall workload of the supermarkets and helps save consumer's precious time boosting the shopping experience.

II. WORKING PRINCIPLE

The working principle behind the smart shopping trolley is the use of RFID technology. Arduino is used to interface all the components working. RFID reader uses the radio waves to identify the RFID tags. The system works better than the traditional barcode based system as there is no need to optically scan the product, the product just needs to be in the range of the reader. Barcodes are also more susceptible to physical damage which can render them unreadable. The module when powered up first goes to master card detection mode, the master card is yet another RFID tag which basically consists of a unique id. As soon as the tag gets into reader's range, the reader reads the unique identification number and transmits the data to microcontroller's memory which is interfaced with the LCD screen on which the information is displayed. Now one by one all the products (RFID tags) to be bought are scanned and the billing information is displayed on the LCD screen. The price value of the products is pre set using the Arduino IDE [5] and can be modified accordingly. Removing a product from the bill can be done by scanning the product again and it will get deleted from the bill and the total value will change accordingly to reflect it.

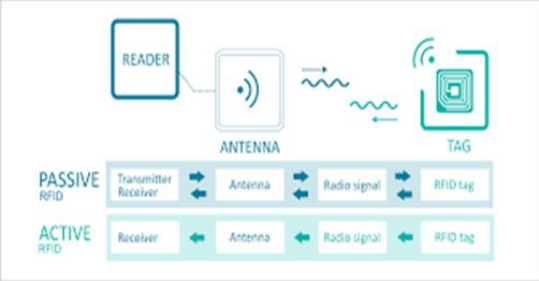

Fig 1. RFID Working

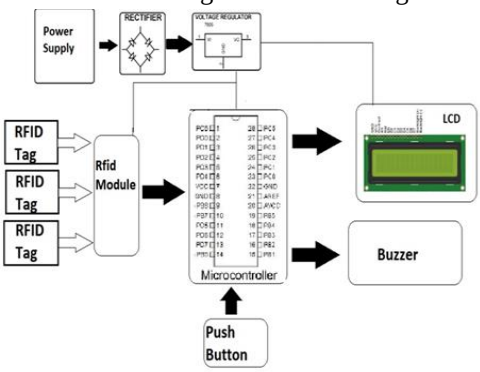

Fig 2. Block diagram of Auto-Billing Trolley

III.HARDWARE DISCRIPTION

- Micro ATmega328P: The ATmega328[16] is a single-chip microcontroller created by Atmel in the mega AVR family (later Microchip Technology acquired Atmel in 2016). It has a modified Harvard architecture 8-bit RISC processor core. The Atmel ATmega328P is a 32K 8-bit microcontroller based on the AVR architecture. Many instructions are executed in a single clock cycle providing a throughput of almost 20 MIPS at 20MHz. The ATMEGA328-PU comes in an PDIP 28 pin package and is suitable for use on our 28 pin AVR Development Board.
- RFID Module: Radio frequency Identification (RFID) is a wireless identification technology that uses radio waves to identify the presence of RFID tags. Just like Bar code reader, RFID technology is used for identification of people, object etc. presence. In barcode technology, we need to optically scan the barcode by keeping it in front of reader, whereas in RFID technology we just need to bring RFID tags in range of readers [7][8]. Also, barcodes can get damaged or unreadable, which is not in the case for most of the RFID. RFID is used in many applications like attendance system in which every person will have their separate RFID tag which will help identify person and their attendance. RFID is used in many companies to provide access to their authorized employees. It is also helpful to keep track of goods and in automated toll collection system on highway by embedding Tag (having unique ID) on them.
- LCD: Liquid crystal display (LCD) has material which combines the properties of both liquid and crystals. They have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an order form similar to a crystal. For an 8-bit data bus, the display requires a +5V supply plus 11 I/O lines. For a 4-bit data bus it only requires the supply lines plus seven extra lines. When the LCD display is not enabled, data lines are tri-state which means they are in a state of high impedance (as though they are disconnected) and this means they do not interfere with the operation of the microcontroller when the display is not being addressed.
- INVERTER IC 7404:The 7404 is a high-speed CMOS Logic Quad NOT Gate[15] NOT gate consists of only one input and one output. A NOT gate is used to output the Boolean inverse of the applied input. Hence the name ‘Digital Inverter’ or ‘Inverting buffer’. The most commonly used NOT gate IC is 7404.NOT gate IC is an inverter, the output is represented by a “-“ (bar) symbol over the input. The Boolean expression can be written as $Y = \overline{X}$. That is, if X is the input and Y is output, then output Y equals to $\overline{X}$, not X. In other words, when X=0, Y =1, and vice versa.
- Voltage Regulator(L7805): The voltage regulator is a device which controls the voltage in the electrical equipment’s. These devices are also used as current limiting device.
- Power Supply/SMPS: A 12 volt power adapter is used here which acts as power Supply. It is an important part of a circuit. It provides required supply to different blocks of the circuit from input230VAC.The main blocks include transformer, rectifier circuit, filter circuit, and regulator circuit. Voltage regulator IC LM7805 is used as a voltage regulator. The microcontroller and other devices get power supply from AC to DC adapter through7805, 5V regulator. The adapter output voltage will be 12V DC no

regulated. The7805/7812 voltage regulators are used to convert 12 V to5V/12VDC.

- Diode IN4007: A diode is a device which allows current flow through only one direction. That is the current should always flow from the Anode to cathode. The cathode terminal can be identified by using a grey bar. Diodes are used to convert AC into DC these are used as half wave rectifier or full wave rectifier.
- Buzzer: The buzzer is a sounding device that can convert audio signals into sound signals. It is usually powered by DC voltage. It is widely used in alarms, computers, printers and other electronic products as sound devices. It is mainly divided into piezoelectric buzzer and electromagnetic buzzer, represented by the letter "H" or "HA" in the circuit. According to different designs and uses, the buzzer can emit various sounds such as music, siren, buzzer, alarm, and electric bell.
- Crystal Oscillator: A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency.

IV.SOFTWAREDESCRIPTIONS

ARDUINO(IDE***):*** Arduino IDE[13][14] is an open source program used to write code for the Arduino interfaced boards. It contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. Arduino can be used by amateurs and professionals alike as it is very versatile and user friendly being based on the C, C++ programming language.

Fig3. Automated Billing Module

V.WORKING

RF (Radio Frequency) communication occurs by the transference of data over electromagnetic waves. By generating a specific electromagnetic wave at the source, its effect can be noticed at the receiver far from the source, which then identifies it and thus the information. In an RFID system, the RFID tag which contains the tagged data of the object generates a signal containing the respective information, which is read by the RFID reader [8][9][10], which then may pass this information to a processor for processing the obtained information for that application. Thus, an RFID System can be visualized as the sum of the following three components:

- RFID tag or transponder
- RFID reader or transceiver
- Data processing subsystem

An RFID tag is composed of an antenna, a wireless transducer and an encapsulating material. These tags can be either 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. Thus, passive tags are cheaper but with lower range and more sensitive to regulatory and environmental constraints, as compared to active tags. An RFID reader consists of an antenna, transceiver and decoder, which sends periodic signals to inquire about any tag in vicinity. On receiving any signal from a tag, it passes on that information to the data processor. The data processing subsystem provides the means of processing and storing the data. Different types of RFID systems operate at different radio frequency. Each radio frequency has its own read distance, power requirements and performance. The choice of frequency depends on the application [7]. Mostly four types of frequencies are used in RFID technology:

A. Low frequency (120-140 KHz) - Low frequency RFID tags operate in low frequency range. Low frequency tags are used for depositing and withdraw and controlling following with the assets.

B. High frequency (13.56 MHz) - High frequency RFID tags operate in high frequency range. HF tags are useful for asset-tracking applications, contactless credit cards and ID badges.

C. The ultra-high frequency (869 MHz-928 MHz)-UHF RFID tag operate in 869 MHz - 928MHz.UHFtags are used in supply chain management applications. tags offer the longer reading range and are cheaper to manufacture in bulk.

D. Microwave (2.4 GHz-2.5 GHz) - Microwave system offers higher read rate. Microwave tags are expensive than UHF tags. Microwave tags are used in electronic toll applications. Input is given to motor driver IC and robot will behave as follows.

The communication taking place for reading of tags is done as:

- Host manages Reader(s) and issues Commands
- Reader and tag communicate via RF signal
- Carrier signal generated by the reader
- Carrier signal sent out through the antennas
- Carrier signal hits tag(s) Tag receives and modifies carrier signal – ―sends back‖ modulated signal (Passive Backscatter – also referred to as ―field disturbance device‖).
- Antennas receive the modulated signal and send them to the Reader.
- Reader decodes the data.
- Results returned to the host application.

The use of RFID tags is applied in shopping environment by attaching an RFID tag[7] to every product in the mall and the reader (EM-18) is attached to the trolley. At the time of purchase, the tag attached to the product is scanned by the reader. Each tag has a unique EPC. Based on the EPC received by the Arduino, the information of the product is displayed on the LCD along with the updated bill[12][13].If the customer wants to remove the added product, the product should be scanned again. Then the cost of the corresponding product will be deducted from the bill. The push button is provided at the trolley to indicate the end of the shopping. On pressing of push button, the final bill is displayed on the LCD and the payment can be done at the billing counter.

VI.CONCLUSION

The dynamic evolution of our world is rapidly replacing outdated technologies and inefficient methods with revolutionary advancements, necessitating an ongoing effort to stay abreast of these changes. This paper seeks to facilitate the adaptation to the evolving way of life by advocating for the integration of technology into our daily activities. Embracing technological advancements contributes to the collective growth of society.The idea reflected in this paper can be presented in supermarkets around the world in the coming future. RFID tags have potential to create seamless shopping experience and can also enhance the overall security of the environment. The forthcoming era is undoubtedly poised to be shaped by such technologies seamlessly integrated into our everyday lives.

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