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Semi-Automated Trolley for Supermarkets with Ultrasonic Sensor and RFID

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***Abstract*: Considering shopping mall, we have to wait much time for billing even though you purchase little things and we are not aware of cost of the product that we wanted to purchase. With the help of this project we reduce the billing time and customers can know the exact cost of the products that they purchased before billing so that they can do their shopping within their budget. The objective of this project is to improve the speed of purchase by using RFID. This project is designed to use the RFID based security system application in the shopping trolley. In this project RFID Key fob is used as security access for product. RFID Key fob with 13.6 MHZ is used for accessing the products. So this project improves the security performance and also the speed. each product has the individual RFID fobs which represent the product name. RFID reader is interfaced with micro controller. Here the micro controller is the flash type re-programmable micro controller in which we already programmed with card number. RFID transceivers can only detect with minimum range so ultrasonic sensors are collectively used with RFID in order to improve the security performance at cheap price.**

***Keywords*: RFID, Key fobs, Frequency identification, Object detection, Object counting.**

1. Introduction

Waiting to pay at the checkouts at hypermarkets is very tiresome as people lead very busy lives. Therefore, waiting time should be managed and controlled. Checkout management is the next big technology for retailers in the modern world with less time spent queueing and better customer care. As customers hate long queues which leads to customer dissatisfaction in retailing. This arises whenever a shared facility needs to be accessed for service by a large number of customers. The expectation of short checkout queues is key ways to build customer loyalty and encourage spending. Historical Checkout Management systems were all about getting the customer in and out of your business as quick as possible in an orderly fashion. Today, Checkout Management systems can offer a lot more with the aid of advanced technology and development. This can help to improve business process and the overall customer experience. People are quite sensitive to wait times. There is no doubt that using a modern queue management system will bring improved efficiencies into the organization, through better understanding of customer expectations, greater opportunity to persuade customer to buy more products, better understanding of staff activity and better visibility of the business. The proposed solution for this problem is an intelligent queue management system which serves customer as well as the supermarket with minimum waiting time by managing the related resources such as staff, customers and checkouts efficiently and effectively.

2. Literature review

Intelligent Retail Checkout Management System can be compared with other related products or systems which are available today, such as Nextiva Queue Management [1], Qtech Queueing system [2], EQMS [3], Qmatic [10], Irisys [9] and AQMS-I6 [11]. Irisys basically uses non-instructive infrared sensors at store entrance and above the checkout lanes to monitor customer numbers and queuing behavior. The system is able to automate the capture of accurate data and calculate in real time the average queue length, average wait times, cashier idle times and overall transaction service time. Qmatic [10] helps to organize the queues by providing visitors with virtual and linear queuing solutions, booked appointments or more sophisticated methods like mobile apps and SMS messages. AQMS-I6 [11] is basically a token management system. According to customer tokens and service counters the system manage waiting and reduce rush in counters. AQMS's goal is to reduce real and apparent waiting time, speeds up service delivery, improves service quality and increases customer satisfaction. In Qtech Queueing System [2] a keypad will be placed at the counter to facilitate the calling of the queue number by the counter staff which can be called in a sequential or random manner. Display panel shows both queue numbers and its corresponding counter number either with or without directional arrows. E-QMS is a method of queue management which is characterized by the use of electronic devices to manage the flow of customers or persons waiting in line to be served. A major feature of this type of queue management system is that, there is always an audio and/or flash light alert to let the next person know that he/she is ready to be served. Most of the above mentioned systems are recognized as token management systems where their goal is to manage waiting and reduce rush in counters.

3. Methodology

In the proposed system, after selecting the goods the customer will be requested to place his/her trolley in the trolley volume detection stall, the system calculates the number of goods in the trolley approximately. Mean time system will keep track of the real time rush in each checkout. Then the system will decide the best checkout with minimum waiting time for each trolley and it will display to the relevant customer at the trolley volume detection stall. By analyzing the real time rush in checkout area, system calculates the average waiting time and displays it outside to attract more customers to the supermarket. In the entrance system tracks the number of customers entered and left the supermarket which calculates the current number of people inside the supermarket. In order to manage the staff efficiently, the system will provide predictions for future cashier formations and monthly reports which will be used to predict future sales. There by saving the time and improving the shopping experience of the customers. The Block diagram is mentioned in fig. 1, represents the postulated method.

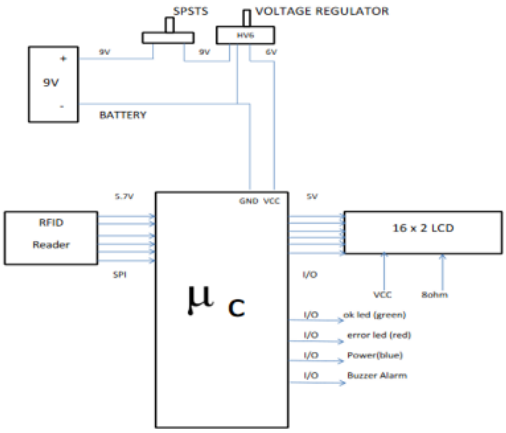

Fig. 1. Trolley system block diagram

A. Components required

1) Arduino 3.0

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.0) or ATmega168 (Arduino Nano 2.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one. The Nano was designed and is being produced by Gravitech.

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Unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source. The FTDI FT232RL chip on the Nano is only powered if the board is being powered over USB. As a result, when running on external (non-USB) power, the 3.3V output (which is supplied by the FTDI chip) is not available and the RX and TX LEDs will flicker if digital pins 0 or 1 are high.

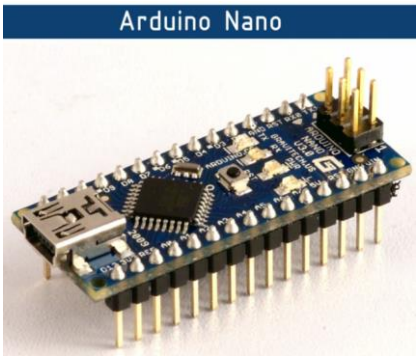


Fig. 2. Arduino Nano

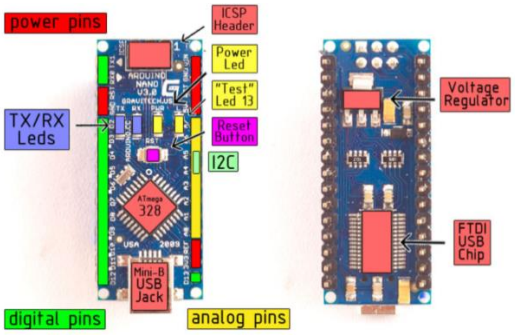


Fig. 3. Arduino Nano 3.0 with AT mega 328 processor

The ATmega168 has 16 KB of flash memory for storing code (of which 2 KB is used for the boot loader); the ATmega328 has 32 KB, (also with 2 KB used for the boot loader). The ATmega168 has 1 KB of SRAM and512 bytes of EEPROM (which can be read and written with the EEPROM library); the ATmega328 has 2 KB of SRAM and 1 KB of EEPROM.

Specialized functions:

- Serial: 0 (RX) and 1 (TX). These are used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip.
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or change in value. See the attach Interrupt () function for details.
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analog Write () function.
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

- LED: 13 - There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is On, when the pin is LOW, it's off.

2) MFRC-522 RFID NFC reader with card and tag

The module is based on RF module RC522 (near field communication module). With the operating frequency of 13.66 MHz you can read and write a tag. This is compatible in all gizDuino/Arduino Microcontroller boards. RFID tags support a larger set of unique IDs than bar codes and can incorporate additional data such as manufacturer, product type and even measure environmental factors such as temperature. Furthermore, RFID systems can discern many different tags located in the same general area without human assistance.

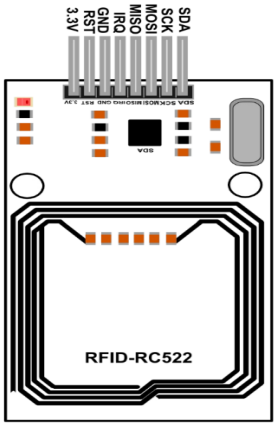


Fig. 4. Sectional view of RFID transceiver

Fig. 5. RFID receiver and tag

The general specifications of the RFID tag:

- Input Supply Voltage: 3.3 VDC
- Working Current: 13 to 26mA
- Part /number: MF522-ED
- Card reading distance: 0 to 60mm
- Interface: SPI communication
- Data Communication speed:10Mbit/s Max.
- Operating Frequency: 13.56Mhz
- Supported card types: Mifare1 S50, Milfare1 S70, Mifare Ultra Ligh, Mifare Pro, Mifare Desfire
- Weight: 8g
- Dimensions: 60mm x 40mm

3) Ultrasonic Sensor

Arduino Ultrasonic Range Detection Sensor with Arduino in order to calculate distances from objects. In this case I'm also altering the output of an LED with PWM according to how close an object is to the sensor. So the nearer you are the brighter the LED. So if we start with the Arduino Ultrasonic Range Detection Sensor, it's an IC that works by sending an ultrasound pulse at around 40Khz with a good ranging frequency.

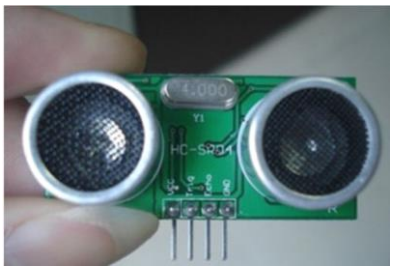


Fig. 6. Ultrasonic sensor

It then waits and listens for the pulse to echo back, calculating the time taken in microseconds (1 microsecond = 1.0 × 10-6 seconds). It can trigger a pulse as fast as 20 times a second and it can determine objects up to 3 meters away and as near as 3cm. It needs a 5V power supply to run. Adding the Arduino Ultrasonic Range Detection Sensor to the Arduino is very easy, only 4 pin to worry about. Power, ground, trigger and echo. Since it needs 5V and Arduino provides 5V.

4) Voltage regulator:

The MC78XX/LM78XX/MC78XXA series of three terminals positive regulators are available in the TO-220/D-PAK package and with several fixed output voltage which will make them useful in a wide range of applications. Each type employs internal current limiting, Thermal shut down and safe operating area protection, making it essentially indestructible.

If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

Fig. 7. Voltage regulator

Features of the regulator are listed as follows,

- Output Current up to 1A
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

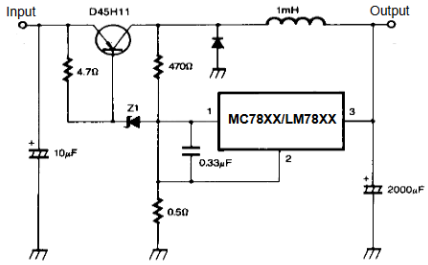


Fig. 8. Voltage Regulator

5) Buzzer

This is an active buzzer so it's easy in use. You just apply voltage to the buzzer and it makes sound. Disadvantage is that you can't determine the frequency of the sounds, for this you need a passive buzzer.

Schematic:

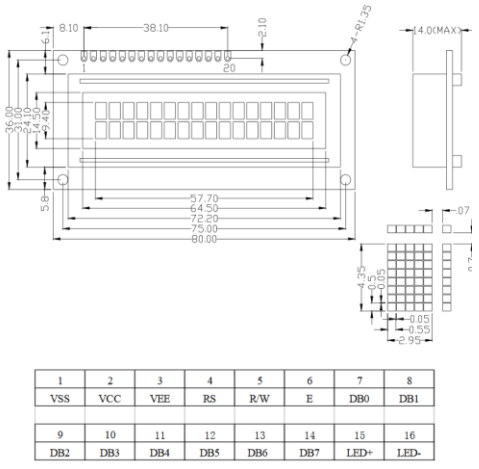
- Module pin - = GND Module pin S = +5V
- Connection to Arduino 0 to digital pin 8 --> Module pin S Arduino GND --> Module pin

Fig. 9. Buzzer

6) LCD

LCD (Liquid Crystal Display a screen is an electronic display module and finds a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs.

The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), an imitations and so on.



1	2	3	4	5	6	7	8
VSS	VCC	VEE	RS	R/W	E	DB0	DB1
9	10	11	12	13	14	15	16
DB2	DB3	DB4	DB5	DB6	DB7	LED+	LED-

Fig. 10. 16x2 LCD pin diagram

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

Fig. 11. 16X2 LCD

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

B. Procedure

1) Object detection

The antenna emits radio signals to activate the tag and read and write data to it. Antennas are the conduits between the tag and the transceiver, which controls the system's data acquisition and communication. Antennas are available in a variety of shapes and sizes; they can be built into a frame to receive tag data from things passing through the transceiver required, a sensor device can activate the field. When an RFID tag Passes through the electromagnetic zone, it detects the reader's activation signal.

2) RFID transceiver

The reader decodes the data encoded in the tag's integrated circuit (silicon chip) and the data is passed to the host computer for processing. The majority of RFID tags contain at least an integrated circuit for modulating and demodulating radio frequency and an antenna for transmitting and receiving signals. Frequency ranges vary from low frequencies of 125 to 134 kHz and 140 to 148.5 kHz, and high frequencies of 850 to 950 MHz and 2.4 to 2.5 GHz. Wavelengths in the 2.4 GHz range are limited because they can be absorbed by water.

3) Tag reader

RFID reader is used to read the data present in the RFID tag. RFID readers or receivers are composed of a radio frequency module, a control unit and an antenna to interrogate electronic tags via radio frequency (RF) communication. Many also include an interface that communicates with an application. Readers can be hand held or mounted in strategic locations so as to ensure they are able to read the tags as the tags pass through an "interrogation zone." RFID systems can be classified by the type of tag and reader. A Passive Reader Active Tag (PRAT) system has a passive reader which only receives radio signals from active tags (battery operated, transmit only).

4) Power supply

Power supply is used to give the 5V to the controller. 5V can be received from IC voltage regulator. Inside supply rectifier, filter is present.

5) Data reading

This library makes it easy to use a Graphical LCD with Arduino this is an extensive modification of the ks0108 library that has higher performance, more features, supports more Arduino boards and is easier to integrate with different panels. Sketches written for the old library should work with little or no modification. The configuration mechanism has been changed to facilitate use with a broad and ATmega Controllers, See the section on sketch migration for details on modifications for the new library

4. Purpose of the project

The objective of this project is to improve the speed of purchase by using RFID. This project is designed to use the RFID based security system application in the shopping trolley. This project is used in shopping complex shows the amount and also the total amount. But in this project RFID card is used for accessing the products. So this project improves the security performance and also the speed. The trolley developed will also have the provision to take out the printout the bill of the purchased materials which will be designed using .net graphical user interface with Access database. It will overcome the Barcode technology which gets lots of problems that will recover in this technology such as the barcode method is so slow and some time it will creating error at the reading the barcode if in case of damaged the barcode it won't be recognized the barcode tag by barcode reader. Since RFID has only a minimum frequency range an ultrasonic sensor can be used within the circumference area of the trolley. If not detected by the RFID the ultrasonic sensor senses the object within the area and buzzer a red light. Indicating that the customer or buyer is trying to steal the product.

5. Conclusion

The intended objectives were successfully achieved in the prototype model developed. The developed product is easy to use, low-cost and does not need any special training. This project report reviews and exploits the existing developments and Different types of radio frequency identification technologies which are used for product identification, billing, etc. We have also learned the architecture of the system that can be used in the shopping systems for intelligent and easy shopping in the malls to save time, energy and money of the consumers. Present trends point towards the fast growth of RFID in the next decade. With around 600 million RFID tags sold in the year 2005 alone, value of market including systems, services and hardware is likely to grow by factor of 10 between years 2006 -2016. It is expected that total number of RFID tags delivered in the year 2016 will be around 450 times as compared to the ones delivered in the year 2006. This project reviews and exploits the existing developments and Different types of radio frequency identification technologies which are used for product identification, billing, etc. Thus the survey paper studies and evaluates research insight in Radio Frequency Identification systems from a big picture first. We have studied in detail about the business model, technological model and all related work and applications in the domain of RFID

Abbreviations and Acronyms

RFID: - Radio Frequency Identification
DoD: - Department of Defense
EAS: - Electronic Article Surveillance
EPC: - Electronic Product Code
ISO: - Indian Standard of Organization
[ARPT: - Active Reader Passive Tag
LCD: - Liquid Crystal Display
PCB: - Printed Circuit Board
BAP: - Battery Assisted Passive
PRAT: - Passive Reader Active Tag
IDE: - Integrated Development Environment

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