

Design of an IoT based Smart Trolley Prototype for Retail Mart

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Abstract - Shopping at big malls has become a regular activity in metro cities, huge rush in shopping mall on holidays and weekends, so customers need to wait in long queue at billing counter. To overcome this problem, design secure and intelligent trolley prototype for retail mart has become a necessary need. This system contains three main component hardware, software and data transmission layer. The hardware system has five component rfid reader, Arduino Nano, LCD display, raspberry pi and weight sensor. Arduino IDE (Integrated development environment) and raspbian used as software part of this project. Raspbian is main and basic software for raspberry pi device and Arduino IDE is readymade software used to write and upload the program. JavaScript language is used for writing the program. This system involved five steps for designing and implementing intelligent trolley. first step is system architecture design, second step is flow chart for smart trolley, third step is design and develop software system, fourth step is develop database and fifth step is integration testing of hardware and software system. The developed rfid based smart shopping system helps to reduce the customer waiting time at billing counter and increases the business efficiency.

Key Words: RFID Reader, RFID tag, Raspberry pi, Arduino Nano, LCD Display, etc.

1. INTRODUCTION

IoT system is interconnected device that are provided with unique identifiers attached to every objects for transferring the data over the network without human intervention or human to computer interaction .When customer comes to the shopping mall and takes smart shopping trolley, the trolley features are described in figure1[1]. Smart shopping trolley shall have an rfid reader, raspberry PI, weight sensor, Arduino Nano and LCD display. When customer put the items into smart cart, the rfid reader will read the product information and send to raspberry pi through Arduino Nano, raspberry pi compares the tag information with database already stored in sdcard, at last display the product information on the LCD display. This process repeated till the client's shopping finishes. Two buttons are provided on trolley, it helps to add or remove the products from the trolley and each product is added to the trolley then move for further shopping. This whole system depends on client

choice. Once finish the shopping, client can directly pay the payment and come out of shopping mart

Figure 2 Block diagram of smart trolley shopping system containing the subsystems of smart trolley. Whole unit formed by subsystem of cart. This smart system consists of a raspberry PI interfaced with RFID Reader, LCD 16x2 display, Arduino Nano, Weight sensor and Relay running text should match with the list of references at the end of the paper.



Fig-1: Smart shopping trolley features

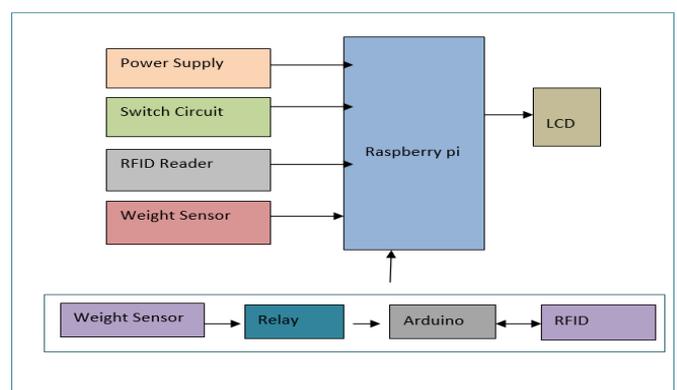


Fig-2: Block Diagram of Smart Trolley prototype for retail mart

1.1 Literature Review

Leena Thomas, Renu Mary George¹, Amalasree Menon, GreeshmaRajan, ReshmaKurian, Discusses an innovative concept of RFID Based intelligent system. The developed

system comprises of a Server unit (SU), a User Interface unit (UIU), an in-built Billing Unit (BU) and Central unit (CU). Billing unit enable the customer pay the bill leave the shopping center, no need to wait in long queue [1].

Purva S. Puranik, Parikshit N. Mahalle, develop the secure and smart shopping system is developed by using IoT. The secure and intelligent trolley is able to read the products information through UHF RFID reader. The developed Prototype is easy to use and economical. They highlighted the importance of a secure, confidential and integrity smart shopping system [2]. **Shallu Dhauta and Shashank Kapoor**, The developed system uses the LiFi technology and TFT screen display to display offers and provide billing. This system is user friendly not required any special training. The proposed system using in super mart by using radio frequency identification technologies it helps to detect items details and automatic billing, etc. This trolley easy to use and provide best customer experience [3] **Zeeshan Ali, Reena Sonkusare**, The main goal of this project is to provide a technology oriented system minimum initial cost. The developed system comprises of trolley location detection unit (CLDU), Server Communication unit (SCU), User Interface and display unit (UIDU) and Billing and Inventory management unit (BIMU). Automatic billing system provided and user friendly [4] **Ankush Yewatkar, Faiz Inamdar, Raj Singh, Ayushya, Amol Bandale**, The proposed system is used to provide a smart and intelligent shopping trolley, This trolley keep tracking the products and online transaction for payment using RFID and ZigBee [5] **P.T.Sivagurunathan. P.Seema, R. Sindhu**, The modern electronic Technology is based on embedded a system, this system consists thousands of transistors which is placed on single silicon chip. This process is very time consuming. This system helps to customers to avoid waiting time at checkout counter. This helps trolley also reduces the man-power and employment cost. This intelligent trolley system is reliable and user friendly [6]

Vishwas, Apoorva, Swati R Rsidurga Anand Rao Pawar, in this system, Billing can be generated from the shopping cart. The idea is to save customers time by providing digital billing system which you get through the registered mail of our website [7]

Purva S. Purani, Parikshit N. Mahalle, A secure and intelligent shopping trolley system developed using IoT, Gossamer protocol can be actualized which will guarantee a much more protected framework. Having such a framework gives two advantages. Initially, it keeps clients from holding up in a long line at checkout. Also, by making the item retires

brilliant stock administration turns out to be simple and productive [8]

D. Mohanapriya, R. Mohamed Anas, P. Nandhini, N.M. Deepika, This system provides on spot scanning of the products and shows its product details on LED. This system allows clients to compare the total price with the budget in the pocket before billing [9]

Manan Rao, The aim here is to create a system that combines the convenience of RFID tags and wireless sensing with a simple and easy tracking system that allows customers to purchase products without the hassle of waiting in queues [10].

1.2 Methodology

The methodology of the project is explained in detail to understand the smart shopping trolley prototype for retail marts. In the present scenario, all retail mart uses a barcode reader which takes more time to check the all items and also increase the manpower as well as customer waiting time at billing counter. To overcome this problem a smart shopping trolley prototype has been developed. This system helps to reduce the customer waiting time at checkout, increase the business efficiency by providing good service to customer. So follow the five steps for designing secure and smart trolley

1] System architecture design - Design the block diagram of IoT based smart trolley prototype for retail mart described in figure 3. The block diagram consists of two sections, the transmit section and the receive section. Transmit section is provided with rfid reader, weight sensor and Arduino Nano. Receive section is provided with raspberry pi and LCD display. In transmit section, rfid reader read the tag information and send to the Arduino Nano. The function of Arduino Nano is send the received information to raspberry pi. In receive section, raspberry receives the information from Arduino Nano, once information is received, it starts to compare that information with database already stored in sdcard. If any mismatch occurs in related to weight or amount, then trolley detect it as wrong and customer cannot go for further process. If all items are correct, then it shows valid for billing process. Customer can pay the payment and leave the shopping mall.

2] Flow chart of smart trolley prototype in figure 4, shows the process of smart shopping system and depicts the step by step process. Initially the cart components are deactivated, once supply the power, all cart components are activate and place the product into cart, rfid card have a unique ID number, rfid tags are used to identify products

information. If the client decides to drop a chose item, it should be finished by choosing the suitable catch ("Add/Remove") on the LCD board. RFID reader read the tag information and send that information to raspberry pi. Once raspberry pi receives the information then it starts to compare with database. If there is any mismatch, then LCD display will shows invalid for payment. If all items details are correct, then LCD display will shows valid for billing process. Customers can straight away pay the bill.

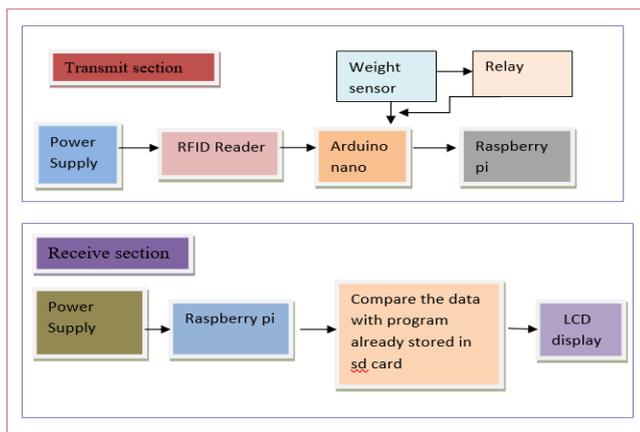


Fig-3: Block diagram of transmit and receive section

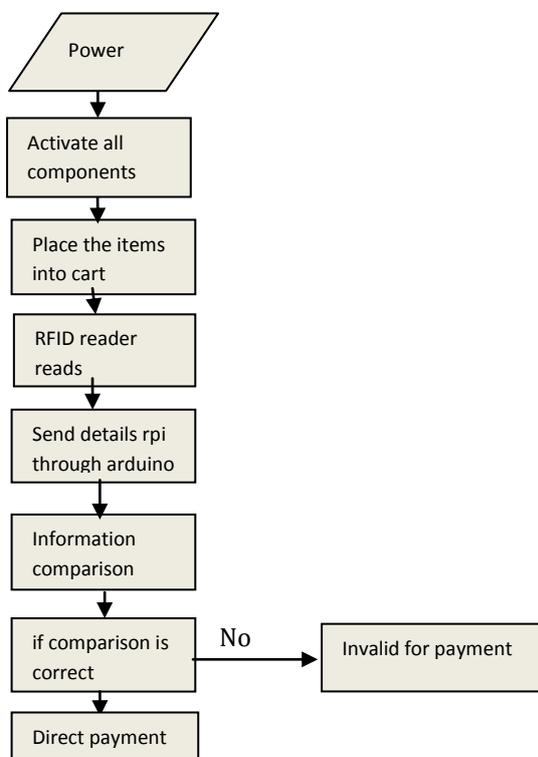


Fig-4: flow chart for smart shopping trolley

2. Design and develop software system

An Arduino IDE and raspbian software are used to develop the software system for the smart shopping trolley. Arduino IDE is a readymade software. (Integrated development environment) set of prewritten codes are available (LED Blink, Sensor interfacing). By using these codes write the program. This software is used for writing and uploading new code to physical board and which supports C language and C++ language. In this IoT system, database is used to organize the collected data and server is a computer program or software used to manage the resources via Internet. SD card present in the raspberry pi, this sdcard stored program for raspberry pi communication.

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Fig-4: Program written to read and write data into Database.

Install the bitwise SSH app and create the IP number for sdcard. Through IP address login to sdcard, this card present in the raspberry pi and Connect this bitwise app to internet through wifi. Once open the bitwise app mention the IP number, username and password it connects to sdcard. Sdcard stores the database written in programming language (JavaScript). Once raspberry pi receive the information it starts to compare with database already stored in sdcard. After comparison all product details are

correct then directly go for payment. If any wrong product information occurs, it shows as invalid for payment at that time this database helps to retailers for cross verification

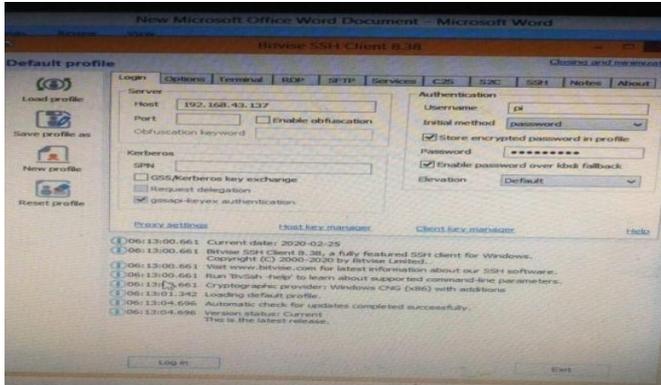


Fig-6: Login to SSH for connecting SD card installed in RPi

2.1 Design Database

Design the database for retailer point of view, database contains the information of all items present in the mart. This database consist detailed information of the products. Once raspberry pi receive the product information from Arduino Nano, it starts to compare with database stored in sdcard. Here database is used to organize the collected data and Server is a computer program or software used to manage the resources via Internet. Database include detail information of the product (product name productID, product price and weight). This database is compared with collected data. Database helps to finding the mismatching of product and it helps the retailers to easily find out the mismatching of product, so all retail mart design the database for easily maintain the inventory and find out the mismatching of product

Table 1 - Product Database

Sl. No.	ID	Product Name	Price (Rs.)	Weight (g)
1	0009793427	Product1	10	140-290
2	0009788262	Product2	20	450-580
3	0010442530	Product3	30	750-900
4	0010441825	Product4	40	1020-1200
5	0010442029	Product5	50	1300-1500

2.2 Integration of hardware and software

This system contains three main component hardware, software and data transmission layer. The hardware system has five component rfid reader, Arduino Nano, LCD display, raspberry pi and weight sensor. RFID reader read the item details and send that details to raspberry pi through Arduino Nano. Raspberry pi is microprocessor it compares the collected data with data base already stored in sdcard and display the result on LCD board. The software part is an application that helps the user to access the information of the hardware system. In this project, Raspbian and Arduino IDE (Integrated development environment) software used. Raspbian is main and basic software for Raspberry pi device and Arduino IDE consider as cross platform application for windows, Linux, macOS. Java language is used.

2.3 IMPLEMENTATION

Raspberry pi3 is used as the main microprocessor for various functions. The complete system is made up of raspberry pi, rfid reader, Arduino Nano and weight sensor. The Arduino Nano is an open-source. Microcontroller, MicrochipATmega328Pmicrocontroller present in this board. The board consists sets of digital and analog input/output (I/O) pins that may be connected to various expansion boards (shields) and other circuits. The board has 8 analog pins (A0 to A7) here A4 is SDA and A5 is SCA these both pins are used for TWI communication(Two way communication), 14 digital pins (D0 to D13) here D0 is RX(data receiver) and D1 is TX(data transmission) D10 is SS(slave select line for the master to select which slave to send data to) D11 is MOSI(master out slave in- line for the master to send data to the slave -) D12 is MISO(master in slave out line for the slave to send data to the master) D13 is SCK(Clock- line for the clock signal), 4 serial peripheral interface(SS-slave select, MOSI-master out slave in, MISO-master in slave out, SCK- Clock) 2 I2C pin(A4-SDA and A5SCL) and Arduino IDE (Integrated Development Environment). Arduino Nano charged by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts.

The below circuit diagram explain the connection between devices, Weight sensor four lines(Red, Black, White, Green) connected to enable and analog pins of relay (E+,E-,A+,A-) these pins connected to Arduino (analog pin, digital pin, ground pin) these pins connected to RFID(MOIS SDA RST,RX)

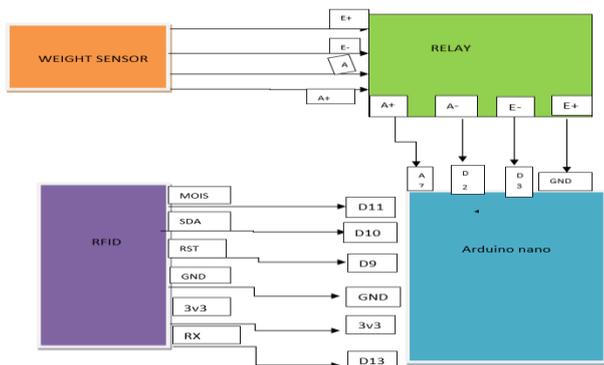


Fig-7: Interfacing weight sensor to relay and Arduino Nano to rfid

Table 2 - Connection from rfid to Arduino Nano

Sr.no	RFID	Arduino Nano
1	MOSI	D11
2	SDA	D10
3	RST	D9
4	GND	GND
5	3V3	3V3
6	RX	D13

Table 3 - Connection from relay to Arduino Nano

Sr.no	Relay	Arduino Nano
1	E+	GND
2	E-	D3
3	A+	A7
4	A-	D2

Table Error! No text of specified style in document. – Pin Description of Sensor to Relay and Arduino to RFID

Pin	Description
MOIS	Master Out Slave In
SDA	Serial pin
RST	Reset
GND	Ground
RX	Receive data
A0 to A7	Analogpins



Fig-8: Shopping basket

The developed intelligent trolley prototype is user friendly, no special training is required

2.4 RESULTS

The smart trolley prototype for retail Mart is an easy to use and not required special training. This intelligent trolley helps customer to reduce the waiting time at the billing counter, automatically check the all products and generate the total bill for payment. So, customer does not waste their time at billing counter, billing done in to trolley itself. By using smart shopping system, to achieve the security in the malls and monitor the theft among the customers and employees.

- To automatically check the shopping carts, which decreases the manpower and the employment cost invested at the billing counter.
- To increase the business efficiency by providing good service to the customer.
- To establish a communication between client and server, so as to supervise each section continuously.

As the power supply is turned on, the components start functioning and a welcome message is displayed on the LCD display before the shopping as shown in figure 9.

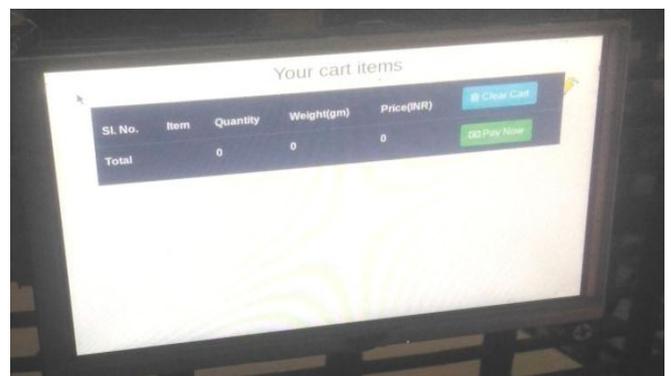


Fig-9: LCD Display - Before Shopping

After showing passive RFID tag, The RFID reader read the tag information and send to raspberry pi through Arduino Nano. If all items are correct, then product details displayed on LCD as shown in figure 10

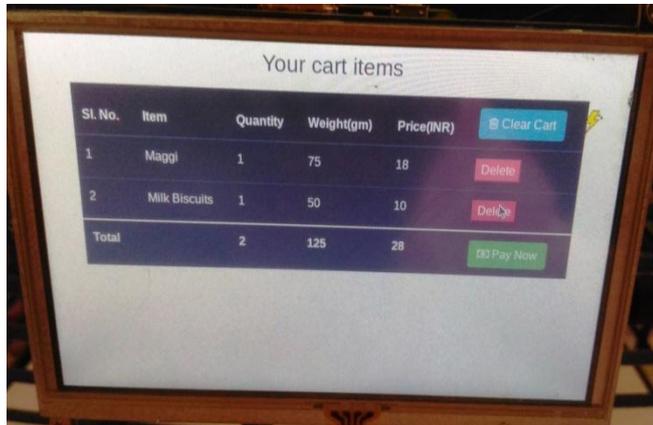


Fig-10: LCD Display- After shopping (Product details)

When same product added three times into the cart, RFID reader read the item three time and displayed on LCD as shown in figure 11

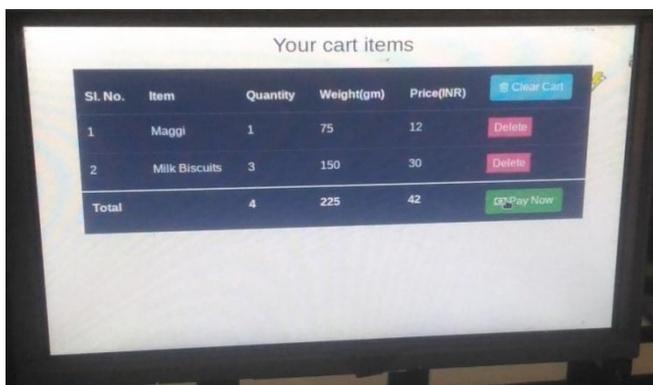


Fig-11: Same product added three times

If there is any mismatch in the cart, such as weight of the product does not match to weight of the product in database, then cart detect it as wrong weight, and it shows invalid for further process as shown in figure 12

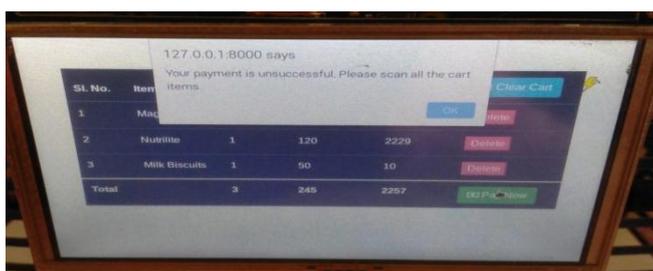


Fig-12: Wrong weight added

If all items are correct after comparing the data present in the database, then customer can straight away pay the bill and leave the shopping center as shown in figure 13



Fig-13: All product details are correct-Directly go for payment

3. CONCLUSIONS

This project is used in shopping malls to reduce customer waiting time at billing counter. In the current work an rfid tag is used as a security card for items. This system develops the safety in shops and also speed the process. The proposed intelligent shopping trolley is easy to use, inexpensive and not required any special training. As the whole system is becoming smart, the requirement of manpower will reduce, employment cost reduce, reduce the customer waiting time. By using this smart shopping system users can control the theft in the mall. The proposed smart system will eliminate the waiting queues so time efficiency will increase. Number of customer can be served at a time thus benefiting the retailers and customers as well.

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