RFID BASED SMART TROLLEY USING IOT

A Project Report

Submitted to the FACULTY of ENGINEERING of

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY, KAKINADA

In partial fulfillment of the requirements,

for the award of the Degree of

Bachelor of Technology

In

Electronics and Communication Engineering

By

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Under the Guidance of

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GUDLAVALLERU ENGINEERING COLLEGE

SESHADRI RAO KNOWLEDGE VILLAGE

GUDLAVALLERU – 521356

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CERTIFICATE

This is to certify that the project report entitled **"RFID BASED SMART TROLLEY USING IOT"** is a bonafide record of work carried out by **M.A.A.ANSARI (17481A04C9), M.BHAGYA RAJ (17481A04D1), B.PAWAN KALYAN (18485A0431)** under my guidance and supervision in partial fulfillment of the requirements, for the award of the degree of Bachelor of Technology in **Electronics and Communication Engineering** by **Jawaharlal Nehru Technological University, Kakinada**.

(L.PADMALATHA)

Project Supervisor

(Dr. Y. RAMAKRISHNA)

Head of the Department

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CONTENTS

ABSTRACT

(Keywords: Node MCU, RFID Module, IoT)

Today's world has a fast-growing population with a wide range of demand from a variety of domains. Customers who need to purchase different products in Walmart or supermarkets needs lots of time and patience in coordinating among them self for successful shopping. We need to address this problem by efficiently using our technologies. In the advancement of technologies, the world is getting automated in many aspects. In this system, we depict reasonable and cost-effective Smart Shopping Cart utilizing IoT (Internet of Things) innovations. Such a framework is appropriate for use in areas such as Walmart & supermarkets, where it can help in diminishing the work and in making a superior shopping knowledge for the clients. Rather than influencing the clients to sit tight in a long line for looking at their shopped things, this framework helps in mechanizing the easy and comfortable billing process. The shopping is processed with two aspects, with a predefined list and random shopping.

This idea is to develop a system in shopping malls to overcome the above problems. To achieve this, all products in the mall should be equipped with RFID tags and all trolleys should be equipped with a Device which we have made to accelerate the whole process of shopping. Further, we utilize IoT technology for displaying the items purchased in a HTML page connected through common server. We can easily monitor the items we are purchasing and their price. We can also control our expenditure by removing the items which we don't need in huge quantity. Hence the billing can be done in the trolley itself thereby saving a lot of time to the customers.

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Chapter-1

INTRODUCTION

A RFID based Smart Trolley using IoT is used for auto billing of products purchased within the trolley, so as to reduce the time for conventional billing system. It has a hardware part which is used to scan RFID cards of each product and proceed for billing, and also a software part containing the webserver page linked to Node MCU where the data is published for successful billing activity.

1.1. Aim

The main purpose of this system is to design and implement the RFID based Smart Trolley using IoT and control it with Node MCU which is connected to RFID module for scanning RFID code of items and display the item name and price both on I2C 16*2 LCD Display and also Webserver page.

1.2. Methodology

In shopping malls, we spend lot of time standing in line for billing of our purchased products. Sometimes it takes hours to get our billing done and leave the mall. Therefore, the proposed “RFID BASED SMART TROLLEY USING IOT” is designed to eliminate the time taken for billing activities in malls where customers have to stand in line for long time. This Smart Trolley can perform the billing activity of items within the trolley, which saves lot of time for customer and it is also user friendly to use.

1.2.1 Sub methodology

In this Smart Trolley, we need RFID module to scan the RFID codes of each item and start billing for the item purchased which can be displayed both on the I2C 16*2 LCD Display and also in a webserver page connected to same network to which Node MCU is connected.

1.3. Significance of this work

The system is implemented to make the billing activity quick and user friendly so as to have complete control over purchasing of products by monitoring the budget and taking only necessary items, which can reduce lot of expenditure on shopping. It can be implemented in the following areas:

- It can be utilized in Clothing Stores.
- Grocery stores.
- Wholesale shopping malls.
- Vegetable marts.

1.4. Outline of this project

The report deals with the working and Block diagram of RFID based Smart Trolley using IoT, followed by the hardware part implemented in this system along with the software tools used. Finally, it is concluded with the result and appendix part.

1.5. Conclusion

The main aim of our system is to reduce the time wasted for the billing activities in malls and make the billing activity quick and easier within the trolley.

Chapter-2
EXISTING SYSTEM

The system is already implemented using bar codes on the products. The items are held exactly in line of sight of bar code scanner which is also held in hand. The invent of RFID cards have eliminated the drawbacks of bar codes like Line-of-sight problem, less durability, data capture and security issues, low productivity. RFID comes up with higher durability, higher productivity and data security issues though it is costly than bar codes. The bar codes need to printed on the packing of products for scanning, but these RFID cards can be just tagged with the products or kept near the products which can be scanned when we want to purchase that product. A single RFID card can be used for numerous items of same product with same cost, whereas bar codes need to be printed on every packing of item even though they are of same type and same cost.

There is also another system which used RFID technology for shopping, whereas in this idea, the IoT technology is also used which creates a webserver page displaying the billing interface of customer through which customer can monitor his purchases and reduce over expenditure on shopping. Red and Green LEDs are also used for removing of items the user wants to remove and for purchasing items respectively. A I2C 16*2 LCD Display is also used which displays the item purchased and its price. In this way, by implementing more functionalities than existing systems, this project is implemented which reduces time spent in shopping malls for billing activities for which the customer has to stand in line for long time.

Chapter-3
WORKING TITLE EXPLANATION

3.1 Project Work Organization

The project work corresponding to our system is done in a structured and meticulous manner. We formulated a algorithm of all the steps we need to follow in order to complete the project and meet our objective. The Algorithm is as follows:

- Designing the Circuit
- Writing program to scan the RFID cards in order to note the value of each card and use it for future references in project code.
- Writing program for Node MCU and compiling it.
- Dumping program into Node MCU.
- Connecting components to Node MCU according to Circuit Diagram.
- Supplying power to Node MCU.
- Noting down the IP address of the network which is used to connect both the desktop and Node MCU.
- Entering into the webpage of that IP address.
- Scanning the RFID cards of items, we want to purchase immediately after the Node MCU is connected to network and webpage is connected.
- Pressing the push button and scanning RFID card of item so as to remove any unnecessary item taken.
- Scanning the Master RFID card once we are done with our shopping, so as to generate final grand total bill.
- Pressing Reset button of Node MCU to initialise the trolley to initial position for further usage by another customer.

First of all, we had designed the circuit and had written the program for Node MCU with the help of our project guide and then we had purchased the hardware components required. The tasks of dumping the code in to Node MCU and webserver is shared among us and we completed the tasks. Testing is done in the presence of our project

guide. Thus, the RFID based Smart Trolley is used to reduce the time taken for billing activities.

3.2 Block Diagram

The Block Diagram of the RFID based Smart Trolley consists of Node MCU, EM 18 RFID Block, I2C 16*2 LCD Display Block, Push Button and LEDs which is shown in below figure 3.1

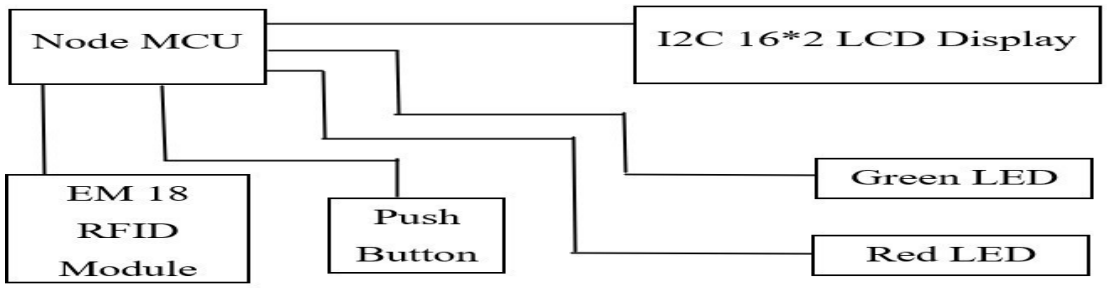


Fig 3.1: Block Diagram of RFID based Smart Trolley using IoT

3.3 Operation

The RFID cards are first scanned to find out the unique codes corresponding to each card. Coding part is implemented using corresponding RFID card values and is uploaded to Node MCU. The corresponding Desktop and Node MCU must be connected to the same network with credentials which is used in the code so as to see the web server page of IoT.

When the customer needs any item, he/she scans the RFID card of item with the RFID module which starts billing of item which can be displayed on the LCD Display and blinking of Green LED, along with the billing page connected to webserver. When the customer wants to replace or remove a product, he/she presses push button and again scans RFID card of product, so that the product is removed from billing which can also be displayed on the LCD and blinking of Red LED along with the billing page connected to webserver. When the customer completes his shopping, he/she scans the master card which displays grand total on the LCD Display and blinking of Green LED along with Grand Total bill displayed on the webserver. The Device is disconnected or reset button is pressed on Node MCU to reset the operation to initial state so that the trolley can be used by another customer. This process saves lots of time for customer, as all the billing is done in the trolley itself.

Chapter-4

HARDWARE IMPLEMENTATION

This chapter includes the components required and explanation of each component. The components discussed here are:

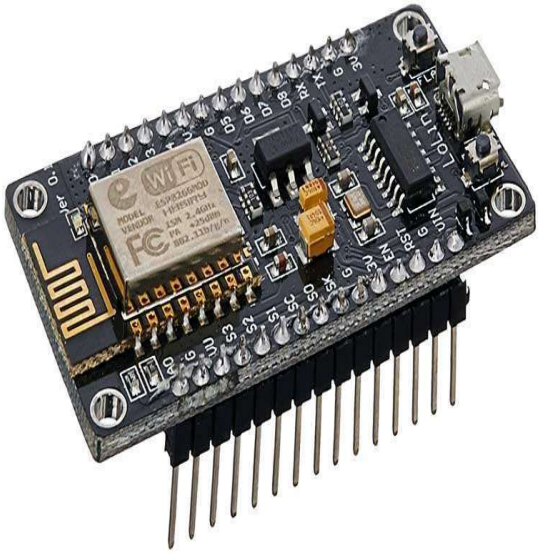
- Node MCU ESP8266
- EM18 - RFID Reader Module
- REES52 I2C Module
- 16*2 LCD Display
- Push Button
- Red LED
- Green LED

4.1 Node MCU ESP8266

Node MCU is an open-source Lua based firmware and development board specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.

The Node MCU ESP8266 development board comes with the ESP-12E module containing ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency. Node MCU has 128 KB RAM and 4MB of Flash memory to store data and programs. Its high processing power with in-built Wi-Fi / Bluetooth and Deep Sleep Operating features make it ideal for IoT projects. Node MCU can be powered using Micro USB jack and VIN pin (External Supply Pin). It supports UART, SPI, and I2C interface.

The Node MCU Development Board can be easily programmed with Arduino IDE since it is easy to use. Programming Node MCU with the Arduino IDE will hardly take 5-10 minutes. The Node MCU and its Pinout Configurations are shown in below figure 4.1 and figure 4.2 respectively.



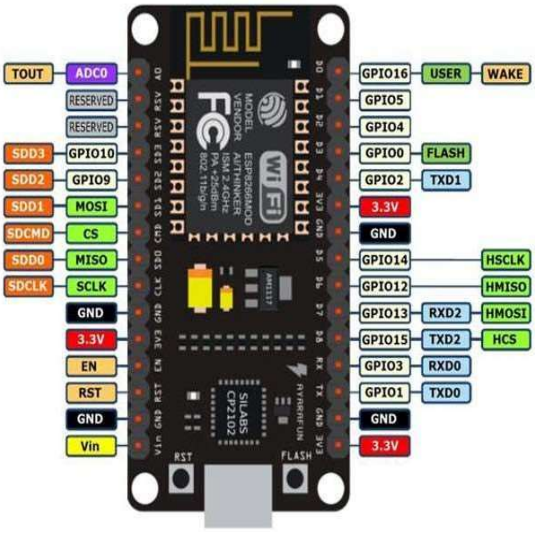


Fig 4.1: Node MCU ESP8266 **Fig 4.2: Node MCU ESP8266 Pinout**

4.1.1 Specifications

- Microcontroller : Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage : 3.3V
- Input Voltage : 7-12V
- Digital I/O Pins (DIO) 16
- Analog Input Pins (ADC) 1
- UARTs 1
- SPIs 1
- I2Cs 1
- Flash Memory : 4 MB
- SRAM : 64 KB
- Clock Speed : 80 MHz

4.1.2 Power

As the operating voltage range of ESP8266 is 3V to 3.6V, the board comes with a LDO voltage regulator to keep the voltage steady at 3.3V. It can reliably supply up to 600mA, which should be more than enough when ESP8266 pulls as much as 80mA during RF transmissions. The output of the regulator is also broken out to one of the sides of the board and labelled as 3V3. This pin can be used to supply power to external

components. Power to the ESP8266 NodeMCU is supplied via the on-board MicroB USB connector. Alternatively, if you have a regulated 5V voltage source, the VIN pin can be used to directly supply the ESP8266 and its peripherals.

4.1.3 Memory

There's also 128 KB RAM and 4MB of Flash memory (for program and data storage) just enough to cope with the large strings that make up web pages, JSON/XML data, and everything we throw at IoT devices nowadays.

4.1.4 Input and Output

Table 4.1 Node MCU Pinout configurations

Pin Category	**Name**	**Description**
Power	Micro-USB, 3.3V, GND, Vin	**Micro-USB:** NodeMCU can be powered through the USB port **3.3V:** Regulated 3.3V can be supplied to this pin to power the board **GND:** Ground pins **Vin:** External Power Supply
Control Pins	EN, RST	The pin and the button reset the microcontroller
Analog Pin	A0	Used to measure analog voltage in the range of 0-3.3V
GPIO Pins	GPIO1 to GPIO16	NodeMCU has 16 general purpose input-output pins on its board
SPI Pins	SD1, CMD, SD0, CLK	NodeMCU has four pins available for SPI communication.
UART Pins	TXD0, RXD0, TXD2, RXD2	NodeMCU has two UART interfaces, UART0 (RXD0 & TXD0) and UART1 (RXD1 & TXD1). UART1 is used to upload the firmware/program.
I2C Pins		NodeMCU has I2C functionality support but due to the internal functionality of these pins, you have to find which pin is I2C.

4.1.5 Communication

Serial communication is a communication process wherein data transfer occurs by transmitting data one bit at a time in sequential order over a computer bus or a communication channel. It is the most widely used approach to transfer information between data processing equipment and peripherals. Binary One represents a logic HIGH or 5 Volts, and zero represents a logic LOW or 0 Volts, used for communicating between the Arduino board and a computer or other devices. All Arduino boards have at least one serial port which is also known as a UART or USART. It communicates on digital pins 0 (RX) and 1 (TX) as well as with the computer via USB. Serial communication on pins TX/RX uses TTL logic levels (5V or 3.3V depending on the board).

The board includes CP2102 USB-to-UART Bridge Controller from Silicon Labs, which converts USB signal to serial and allows your computer to program and communicate with the ESP8266 chip.

4.1.6 Dimensions

The dimensions of Node MCU are shown in figure 4.3 below.

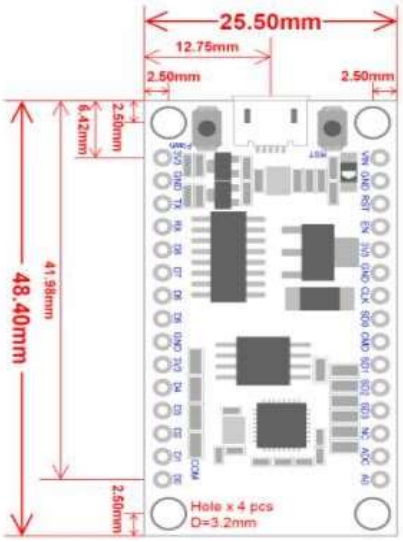


Fig 4.3: Dimensions of Node MCU

4.1.7 Programming

The first thing is having latest Arduino IDE (Arduino 1.6.4 or higher) installed on your PC. To begin, we'll need to update the board manager with a custom URL. Open up Arduino IDE and go to File > Preferences. Then, copy below URL into the Additional Board Manager URLs text box situated on the bottom of the window as shown in figure 4.4 below.

http://arduino.esp8266.com/stable/package_esp8266com_index.json

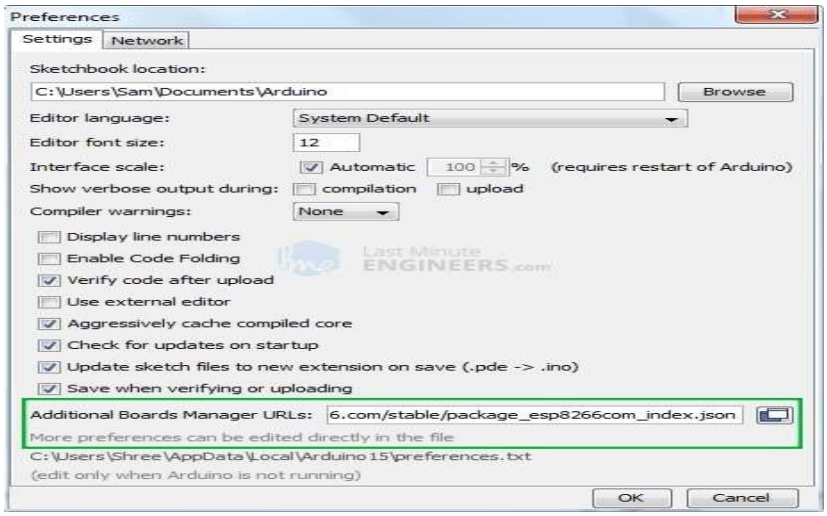


Fig 4.4: Preferences for Arduino IDE

Hit OK. Then navigate to the Board Manager by going to Tools > Boards > Boards Manager. There should be a couple new entries in addition to the standard Arduino boards. Filter your search by typing esp8266. Click on that entry and select Install. It can be observed in the figure 4.5 below.

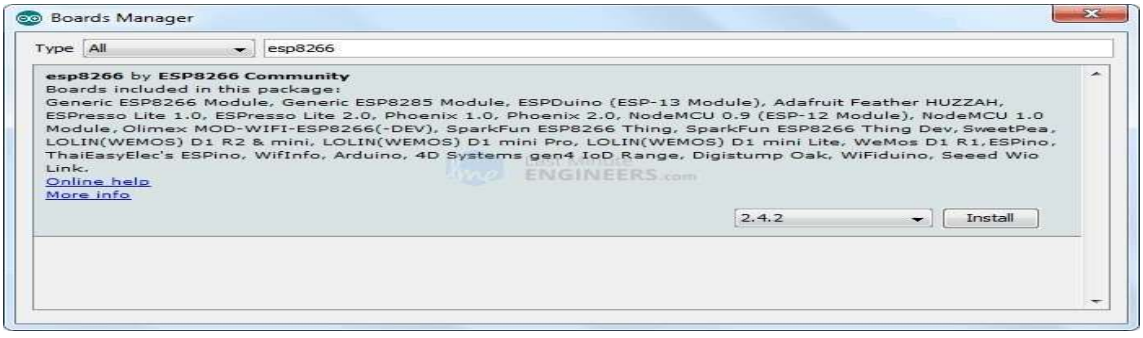


Fig 4.5: Boards Manager

The board definitions and tools for the ESP8266 include a whole new set of gcc, g++, and other reasonably large, compiled binaries, so it may take a few minutes to download and install (the archived file is ~110MB). Once the installation has completed, a small INSTALLED text will appear next to the entry. You can now close the Board Manager.

Before we get to uploading sketch, we need to make sure that the board is selected properly in Arduino IDE. Open Arduino IDE and select Node MCU 0.9 (ESP-12 Module) option under your Arduino IDE > Tools > Board menu. It is shown in figure 4.6 below.

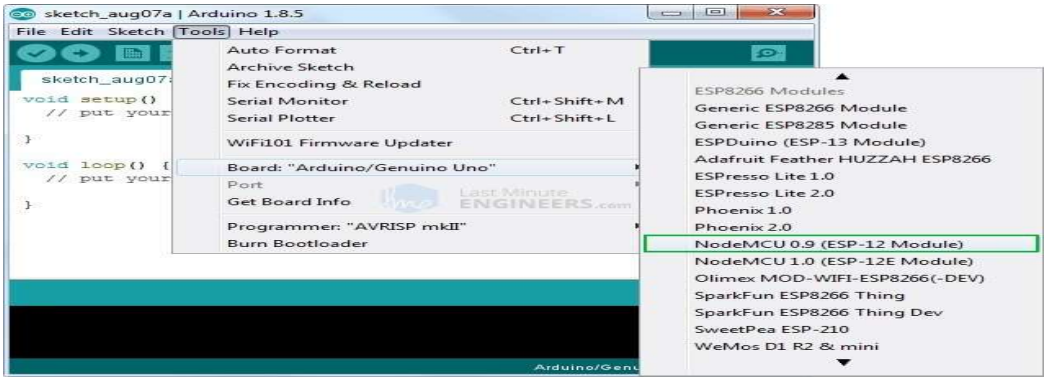


Fig 4.6: Selecting Board

Now, plug your ESP8266 NodeMCU into your computer via micro-B USB cable. Once the board is plugged in, it should be assigned a unique COM port. On Windows machines, this will be something like COM#, and on Mac/Linux computers it will come in the form of /dev/tty.usbserial-XXXXXX. Select this serial port under the Arduino IDE > Tools > Port menu. Also select the Upload Speed: 115200. It is shown in figure 4.7 below.

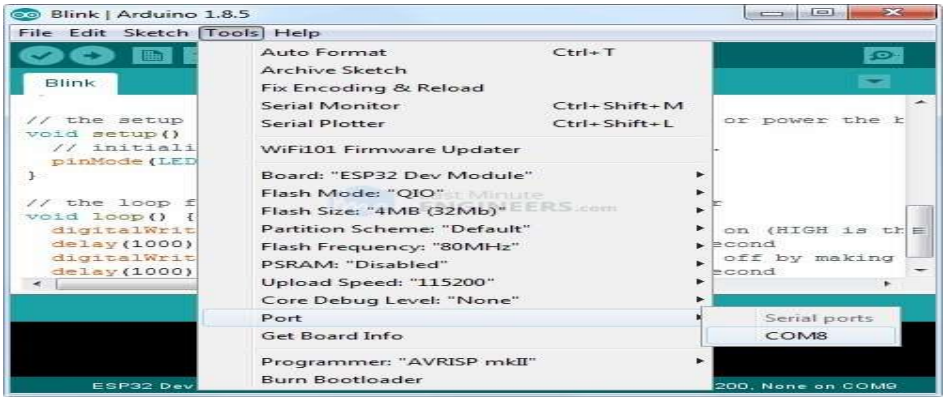


Fig 4.7: Port Selection

Compiling: After writing the whole code there may be some syntax errors or some other errors in the code, so to detect such errors the code should be examined. This process is done by the compiler in the software by pressing the compile button shown in figure 4.8 below.

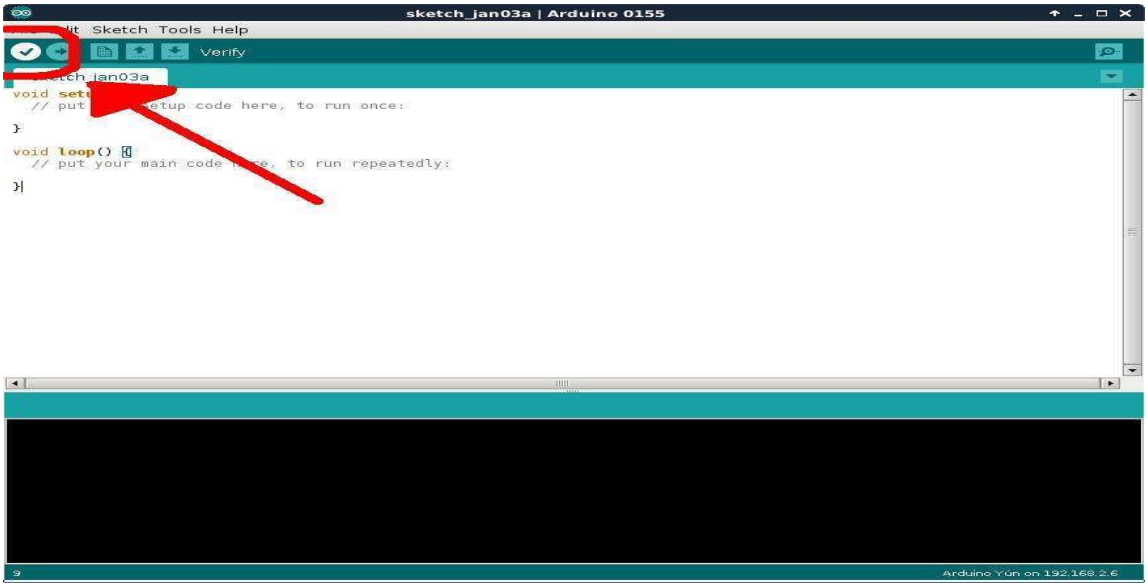


Fig 4.8: Compiling the code

Dumping: After the code is completed and compiled if there are any errors rectify them. Now to implement the code we should dump it in to the Node MCU. To perform this dumping select the dump option shown in figure 4.9 below.

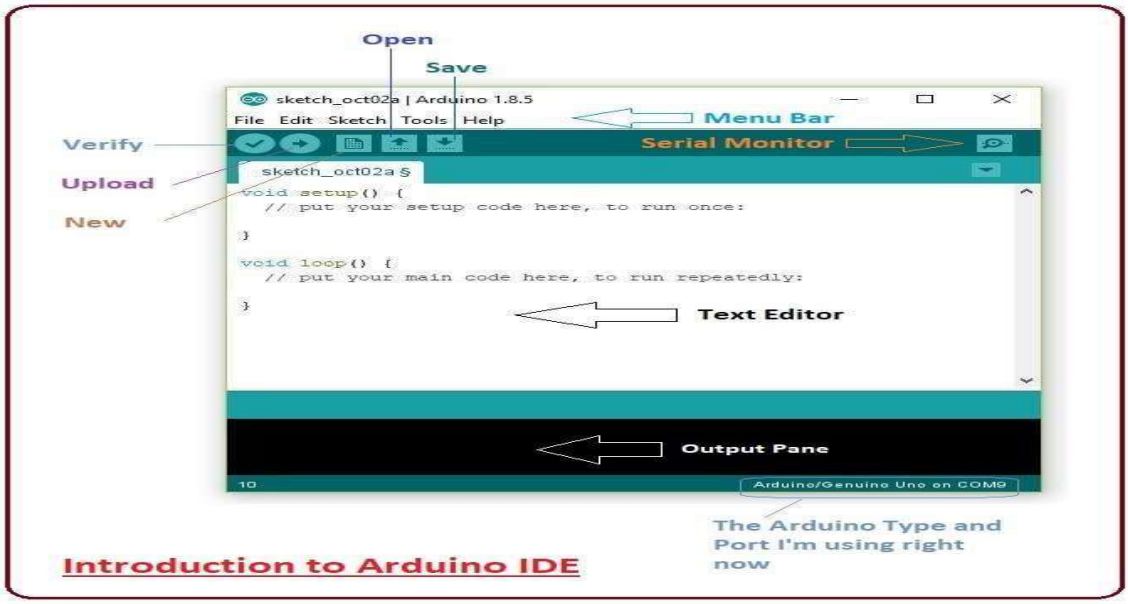


Fig 4.9: Dumping the code

After performing all these operations, Node MCU is able to perform the operations that we had programmed. In this manner the programming of the Node MCU will be done.

4.2 EM18 - RFID Reader Module

RFID is an upcoming innovation which has as of late pulled in light of a legitimate concern for the exploration group in view of the uncommon advantages it offers over the other existing recognizable proof and information detecting advancements. RFID is a specific term utilized for systems which use radio wave to naturally distinguish things. RFID is a technology that permit exchange of information amongst labels and reader without the need of viewable pathway over a separation up to a couple of 10 meters relying upon the sort of label engaged. For this framework the information is being swapped by radio waves and distinct tags can be scrutinized or collected normally. This part is designed to survey the current technology writing and probe the problems in the existing RFID organisation starting from the transformation to yet in its recognition phase. From past the growth of this revolution from 1900's, aside to this expressed reliable perspectives, thus innovation likewise supports a few affairs or points. A planned motivation behind part for look at the writing identified with the above-mentioned technology additionally develops scholarly analysis with giving a deal into a segment of the outstanding and noteworthy cases hindering the growth of this alteration. It ought to confront these cases with a specific end goal to give a more prominent perceivability and an enhanced item speed of the RFID innovation.

EM-18 RFID reader is one of the commonly used RFID reader to read 125KHz tags. It features low cost, low power consumption, small form factor and easy to use. The module radiates 125KHz through its coils and when a 125KHz passive RFID tag is brought into this field it will get energized from this field.

The EM 18 RFID Module and the block diagram is shown in the figure 4.10 and figure 4.11 below.

Fig 4.10: EM 18 RFID Reader Module

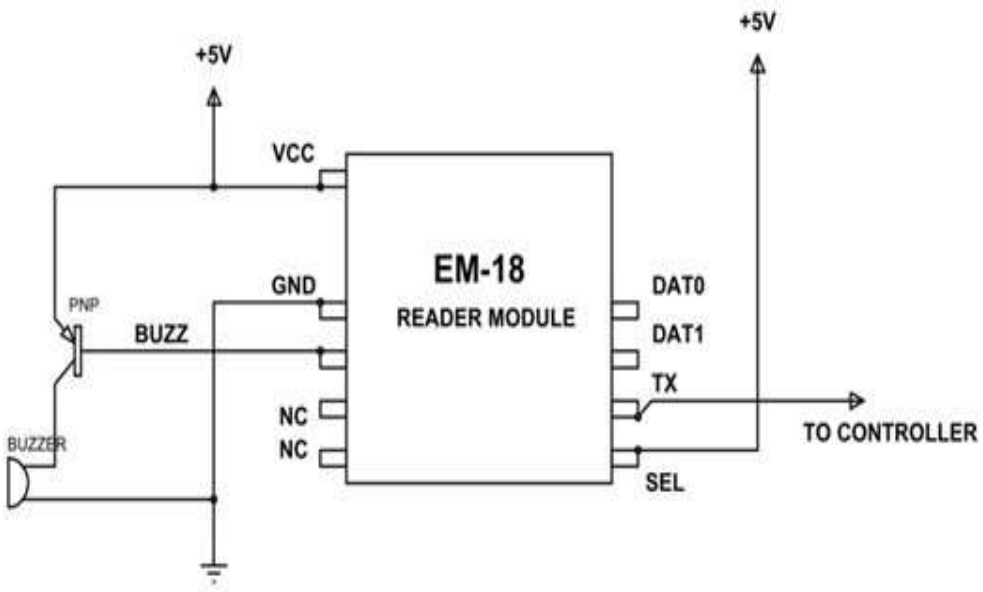


Fig 4.11: Block Diagram of EM 18 Reader Module

4.2.1 Specifications

- Operating voltage of EM-18: +4.5V to +5.5V
- Current consumption:50mA
- Can operate on LOW power
- Operating temperature: 0ºC to +80ºC
- Operating frequency:125KHz
- Communication parameter:9600bps
- Reading distance: 10cm, depending on TAG
- Integrated Antenna

4.2.2 Operation

- **EM-18** is used like any other sensor module. First, we choose the mode of communication between MODULE and CONTROLLER. Next, we will program the controller to receive data from module to display. Next power the system. When a tag is brought near the MODULE it reads the ID and sends the information to controller. The controller receives the information and performs action programmed by us.

- **Step1:** Establishing a mode of communication. EM-18 can provide output through two communication interfaces. One is RS232 and another is WEIGAND. The form of communication is selected by SEL pin. If SEL pin is selected HIGH then form of communication is RS232 and if SEL pin is pulled LOW then form of communication is WEIGAND. Usually, the RS232 is selected because it's popular so SEL pin is pulled HIGH.
- **Step2:** The output of MODULE bit rate is 9600bps (bit per second). The controller should be programmed to receive information from MODULE at this rate. If bit rate of controller mismatches then the system will not work correctly.
- In the circuit Buzzer is not compulsory. When a TAG is read the BUZZER turns ON. As given in circuit, TX is given to CONTROLLER which is to receive DATA.
- Consider a TAG is brought near the MODULE. The MODULE reads the ID and sends the information to controller in 12 ASCII CHARACTERS. In them, 10CHARACTERS represent the TAG ID and 2 CHARACTERS are XOR of previous 10 CHARACTERS.
- So, DATA sent = 10ASCII DATA (tag no.) + 2ASCII DATA (XOR result)
- Once the Information is sent, the MODULES stop sending DATA. This serial DATA received by the controller though RX pin contains TAG information which is ready for processing. We can program the controller to save the DATA or process it to provide response immediately.

4.2.3 Features

RFID reader EM-18 features

1. Serial RS232/TTL output
2. Operating Frequency is 125KHz.
3. Range is 5-8 cm.

4.2.4 Input and Output

Table 4.2 RFID pin configuration

Pin Number	Description
VCC	Should be connected to positive of power source.
GND	Should be connected to ground.
BUZZ	Should be connected to BUZZER
NC	No Connection
NC	No Connection
SEL	SEL=1 then o/p =RS232 SEL=0then o/p=WEIGAND
TX	DATA is given out through TX of RS232
DATA1	WEIGAND interface DATA HIGH pin
DATA0	WEIGAND interface DATA LOW pin

4.3 REES52 I2C Module

This is a I2C Serial LCD Daughter board that can be connected to a standard 16×2 or 20×4 Character Display Module that supports 4-bit mode. All Character Modules sold on our site support 4-bit mode, and nearly all commercially available 16×2 and 20×4-line character modules support it too. This board has a PCF8574 I2C chip that converts I2C serial data to parallel data for the LCD display. There are many examples on the internet for using this board with Arduino. Do a search for "Arduino LCD PCF8574". The I2C address is 0x3F by default, but this can be changed via 3 solder jumpers provided on the board. This allows up to 3 LCD displays to be controlled via a single I2C bus (giving each one its own address).

The REES52 I2C module is shown in figure 4.12 below.

Fig 4.12: I2C module

4.3.1 Specifications

- IC Chip: PCF8574
- Power Supply: 5V

4.3.2 Features

- 16 x 2 Character LCD display is controlled via just two wires
- Up to 8 LCD displays with adapters can be connected and controlled by the same two wire I2C bus
- Easy to control using Arduino board
- Compatible with 16 x 2-character LCD displays
- Adapter includes 16-PIN male header connector for soldering to LCD display
- Contrast is adjusted via onboard potentiometer
- Backlight may be turned on/off via jumper
- Standard 5V voltage supply

4.4 16*2 LCD Display

LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability and programmer friendly. Most of us would have come across these displays in our day-to-day life, either at PCO's or calculators. The appearance and the pinouts have already been visualized above now let us get a bit technical.

16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots.

We know that each character has (5×8=40) 40 Pixels and for 32 Characters we will have (32×40) 1280 Pixels. Further, the LCD should also be instructed about the Position of the Pixels. Hence it will be a hectic task to handle everything with the help of MCU, hence an Interface IC like HD44780is used, which is mounted on the backside of the LCD Module itself. The function of this IC is to get the Commands and Data from the MCU and process them to display meaningful information onto our LCD Screen**.** LCD Module can be observed in figure 4.13. and Pin configuration in figure 4.14 respectively.

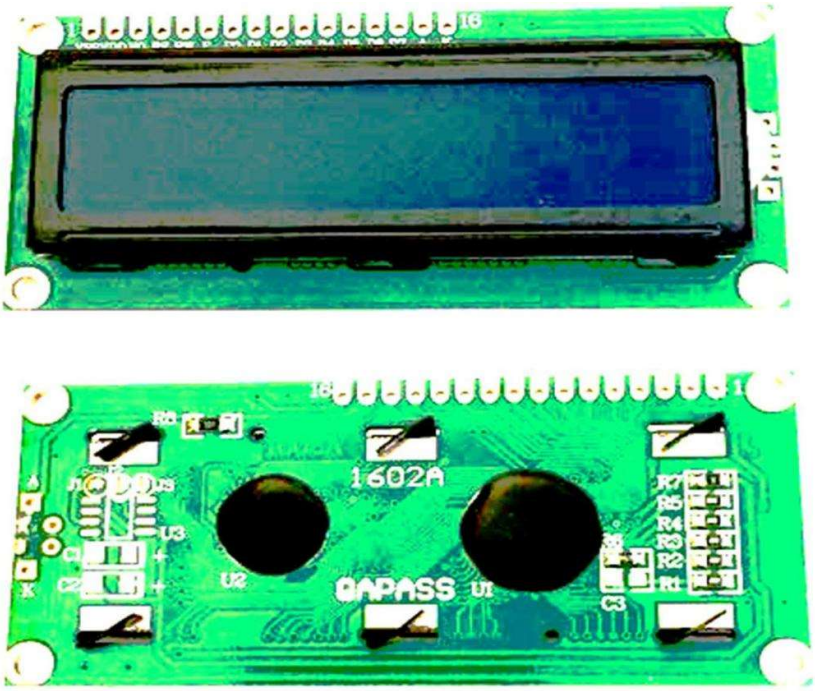


Fig 4.13: 16*2 LCD Module

4.4.1 Features

- Operating Voltage is 4.7V to 5.3V
- Current consumption is 1mA without backlight
- Alphanumeric LCD display module, meaning can display alphabets and numbers
- Consists of two rows and each row can print 16 characters.
- Each character is built by a 5×8-pixel box
- Can work on both 8-bit and 4-bit mode
- It can also display any custom generated characters
- Available in Green and Blue Backlight

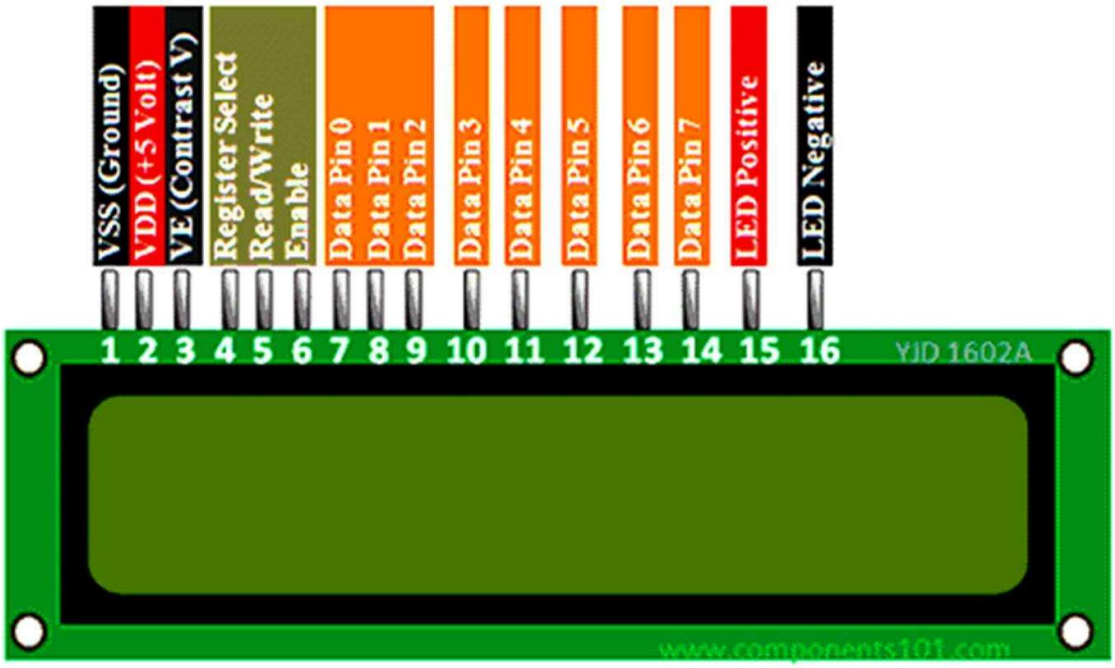


Fig 4.14: 16*2 LCD Pin Configuration

Table 4.3: LCD Pin Configurations

Pin No:	Pin Name:	Description
1	Vss (Ground)	Ground pin connected to system ground
2	Vdd (+5 Volt)	Powers the LCD with +5V (4.7V – 5.3V)
3	VE (Contrast V)	Decides the contrast level of display. Grounded to get maximum contrast.
4	Register Select	Connected to Microcontroller to shift between command/data register
5	Read/Write	Used to read or write data. Normally grounded to write data to LCD
6	Enable	Connected to Microcontroller Pin and toggled between 1 and 0 for data acknowledgement
7	Data Pin 0	Data pin 4,5,6 and 7 will be left free.
8	Data Pin 1	
9	Data Pin 2	
10	Data Pin 3	
11	Data Pin 4	
12	Data Pin 5	
13	Data Pin 6	
14	Data Pin 7	
15	LED Positive	Backlight LED pin positive terminal
16	LED Negative	Backlight LED pin negative terminal

4.5 Push Button

A push-button or simply button is a simple switch mechanism to control some aspect of a machine or a process. Buttons are typically made out of hard material, usually plastic or metal. The surface is usually flat or shaped to accommodate the human finger or hand, so as to be easily depressed or pushed. Buttons are most often biased switches, although many un-biased buttons still require a spring to return to their un-pushed state. Terms for the "pushing" of a button include pressing, depressing, mashing, slapping, hitting, and punching. The "push-button" has been utilized in calculators, push-button telephones, kitchen appliances, and various other mechanical and electronic devices, home and commercial.

In industrial and commercial applications, push buttons can be connected together by a mechanical linkage so that the act of pushing one button causes the other button to be released. In this way, a stop button can "force" a start button to be released. This method of linkage is used in simple manual operations in which the machine or process has no electrical circuits for control.

Red push-buttons can also have large heads (called mushroom heads) for easy operation and to facilitate the stopping of a machine. These push-buttons are called emergency stop buttons and for increased safety are mandated by the electrical code in many jurisdictions. This large mushroom shape can also be found in buttons for use with operators who need to wear gloves for their work and could not actuate a regular flush-mounted push button.

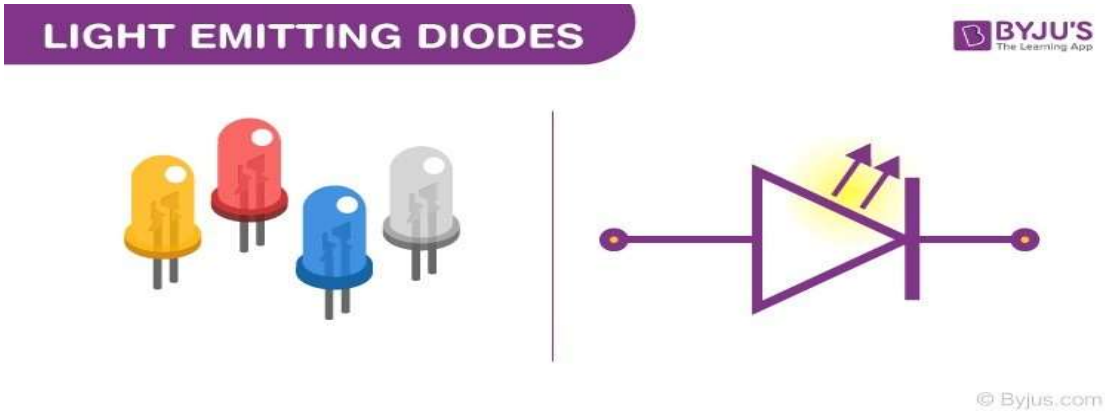
To avoid an operator from pushing the wrong button in error, pushbuttons are often color-coded to associate them with their function. Commonly used colours are red for stopping the machine or process and green for starting the machine or process. The phrase "the button" refers to a button that a military or government leader could press to launch nuclear weapons. Figure 4.15 shows an example of push-buttons.

Fig 4.15 Push Button

4.6 LED

Light-emitting diodes, or LEDs, are widely used as a standard source of light in electrical equipment. It has a wide array of applications ranging from your mobile phone to large advertising billboards. They find applications in devices for showing what the time is and for displaying different types of data. In this post, the main focus would be on learning a lot about LEDs, such as its operations and functions.

A light releasing diode is an electric component that emits light when the electric current flows through it. It is a light source based on semiconductors. When current passes through the LED, the electrons recombine with holes emitting light in the process. It is a specific type of diode having similar characteristics as the p-n junction diode. This means that an LED allows the flow of current in its forward direction while it blocks the flow in the reverse direction. Light-emitting diodes are built using a weak layer of heavily doped semiconductor material. Based on the semiconductor material used and the amount of doping, an LED will emit a coloured light at a particular spectral wavelength when forward biased. The LED representation and LED symbol is displayed in figure 4.16.



4.16 LED

Chapter-5

RESULTS

5.1 Circuit Diagram

RFID based Smart Trolley using IoT is designed using Node MCU, I2C 16*2 LCD Display, RFID EM 18 Module, Push Button and LEDs along with Webserver page designed using IoT. The circuit diagram is represented in the figure 5.1 and hardware model in figure **5.2** below.

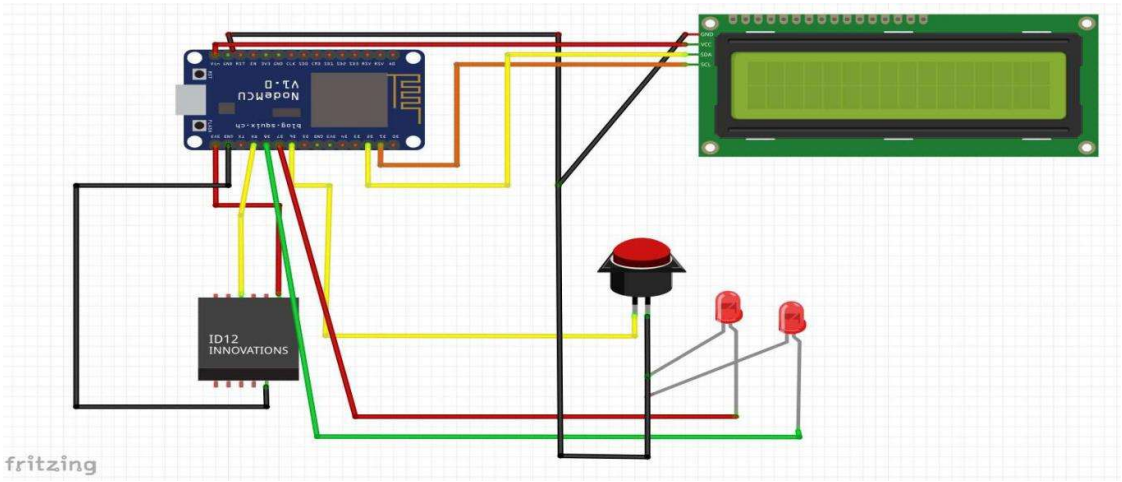


Fig 5.1: Circuit Diagram of RFID based Smart Trolley using IoT

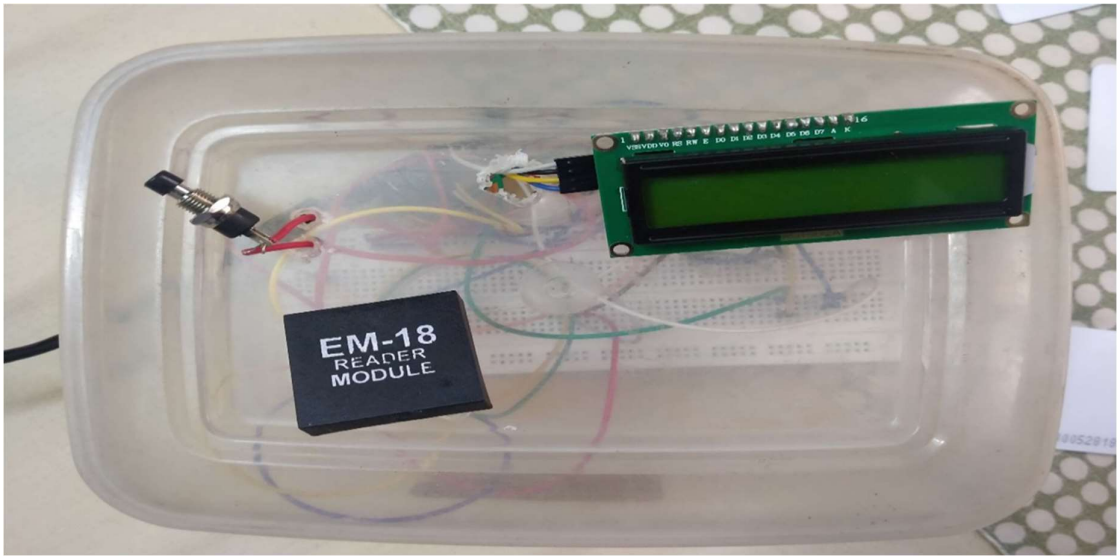


Fig 5.2: Hardware Model of RFID based Smart Trolley using IoT

5.2 RFID Card Values

The RFID cards are first scanned using RFID module which is interfaced with Node MCU and the Node MCU dumped with corresponding code so that the unique RFID card values are displayed in the serial monitor which are to be noted for future references.

The RFID card values are displayed in serial monitor as shown in figure 5.3.

Fig 5.3: RFID Card Values in Serial Monitor

5.3 Operation of Model

The Node MCU is supplied with power supply from laptop by micro-USB, and the model starts the operation. First, it displays a welcome message for the customer as shown in figure 5.4

Fig 5.4: Welcome Screen

In the serial monitor, the IP address of the network to which the laptop and Node MCU is connected is displayed as shown in figure 5.5

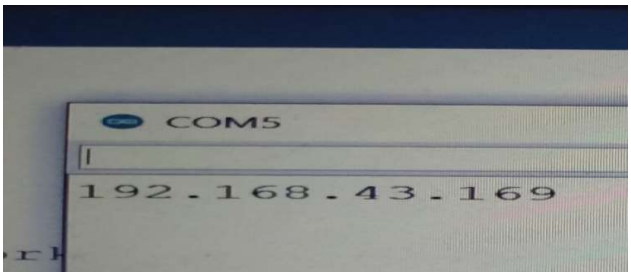


Fig 5.5: IP Address

After couple of seconds, the webserver page is also connected and that message is displayed as shown in figure 5.6

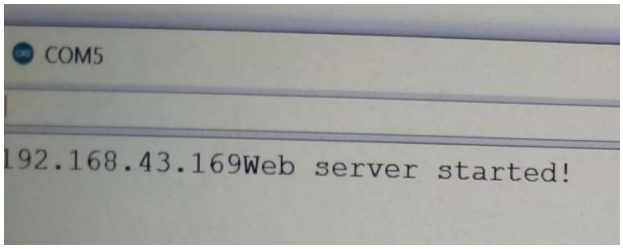


Fig 5.6: Webserver Page

On the other side, the same functionality is also displayed on the LCD Display as shown in figure 5.7

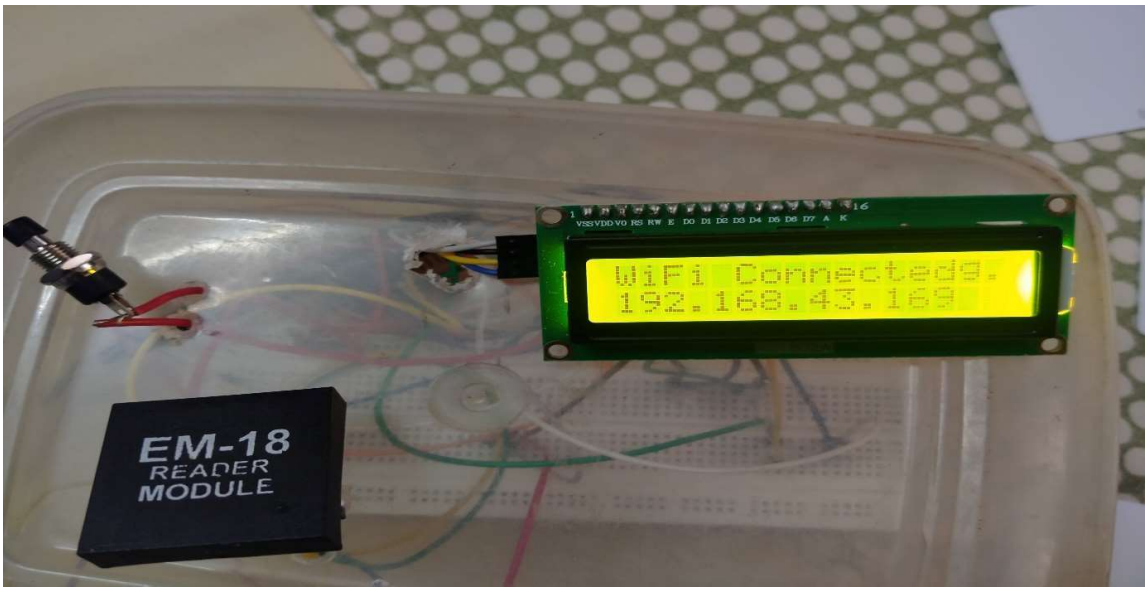


Fig 5.7: WiFi Connecting

The system is now ready to add items in the trolley as shown in figure 5.8.

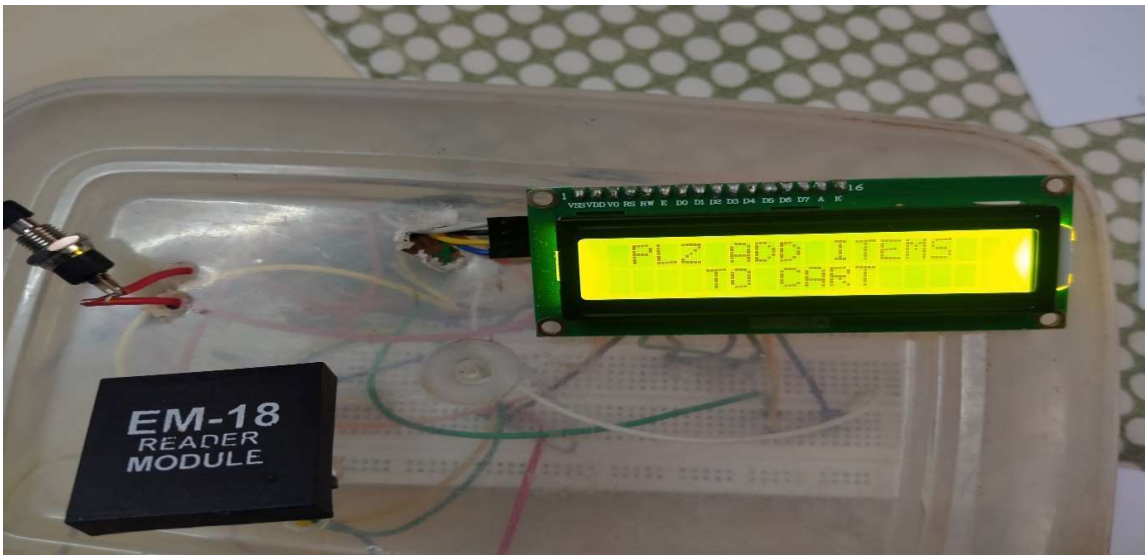


Fig 5.8: Add items

The Web page connected to the IP address is also displayed as shown in figure 5.9

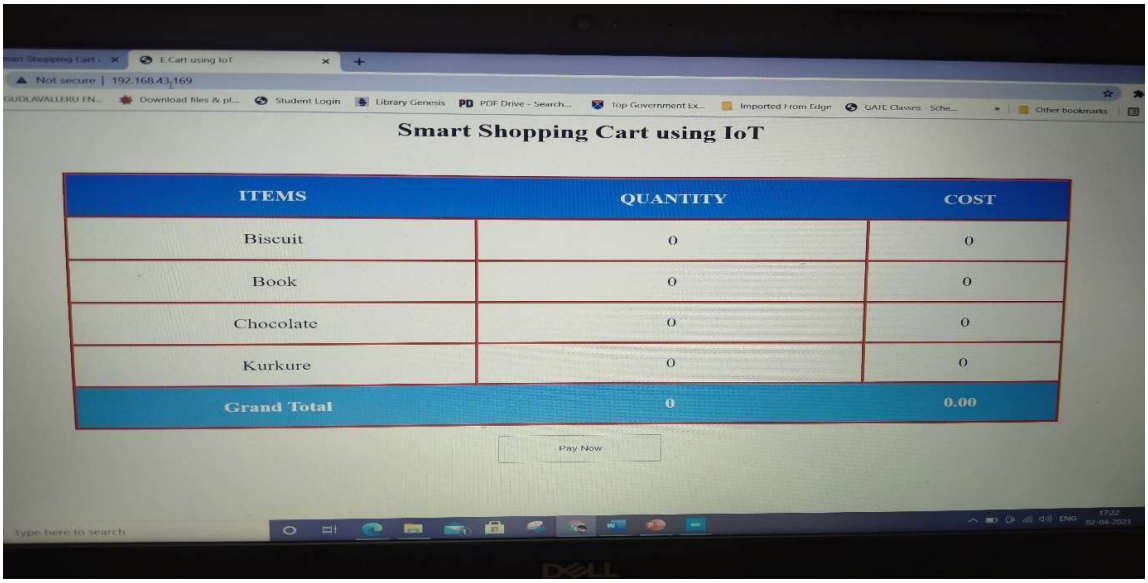


Fig 5.9: Initial Webpage

5.3.1 Adding item to trolley

The customer takes the RFID card of the item he wants to purchase and scans it with RFID module which sends data to Node MCU and it starts billing and publishes data to web page. When the customer scans RFID card of item, the green LED blinks and data is displayed on LCD Display about the name of item and price of item as shown in figure 5.10

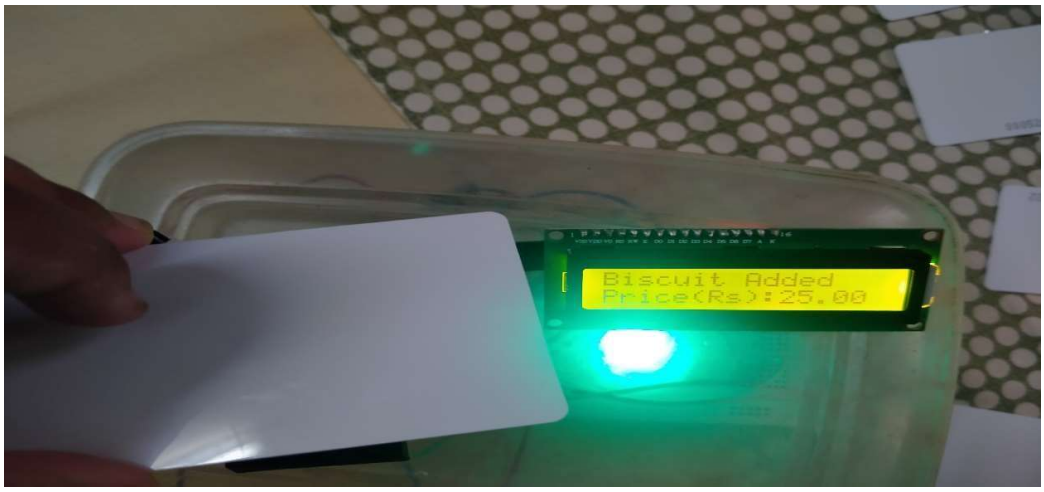


Fig 5.10: Item Added

5.3.2 Removing item from trolley

If the customer takes an item but thinks it is unnecessary, then the customer can scan the RFID card of item and also pressing the push button, so that the item is removed from billing and price is deducted. This operation is done with red LED blinking and data displaying on LCD Display as shown in figure 5.11

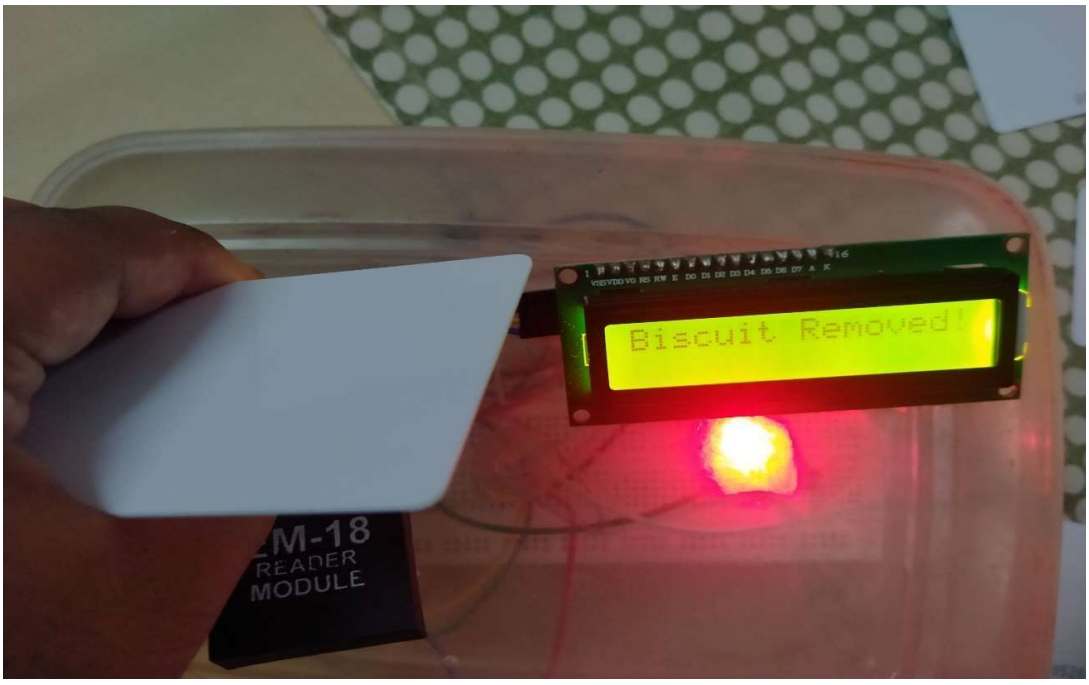


Fig 5.11: Item Removed

5.3.3 Master Card Scanning

Once the customer finishes shopping his products, the master RFID card is swiped so that the total bill is displayed on LCD Display and green LED is blinked as shown in figure 5.12

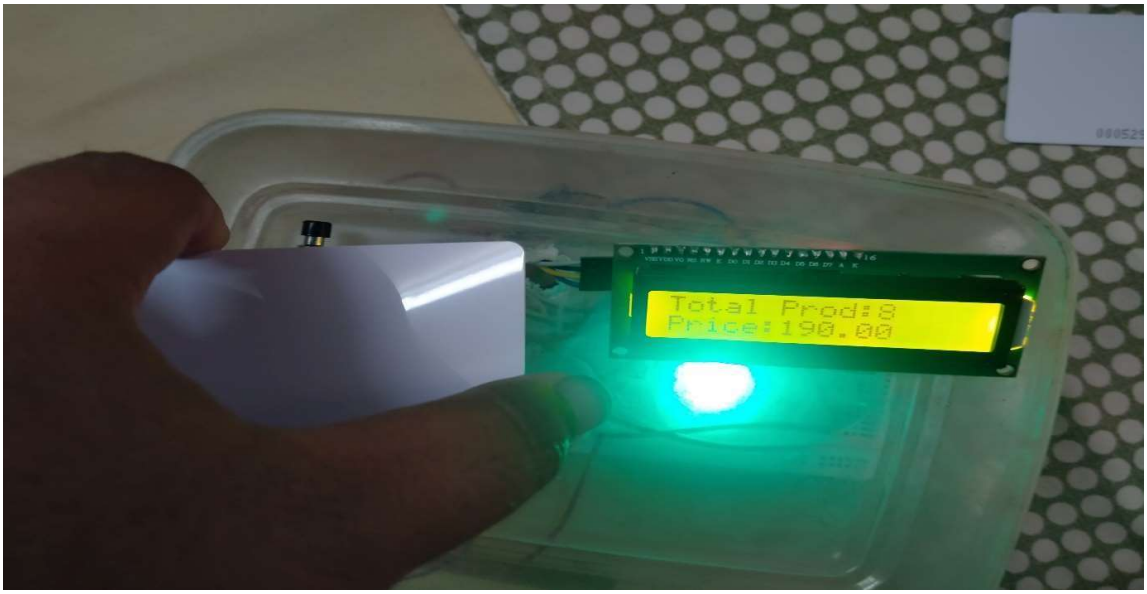


Fig 5.12: Master Card Scan

The corresponding data is simultaneously published to webserver as shown in figure 5.13.

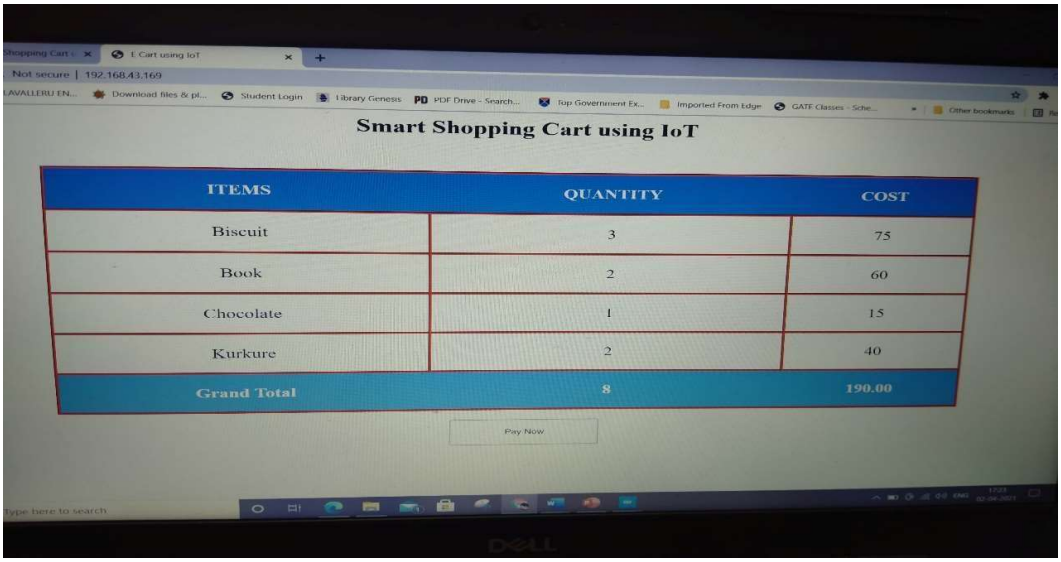


Fig 5.13: Final Webpage

A Thank you message is also displayed on the LCD Display as shown in figure 5.14

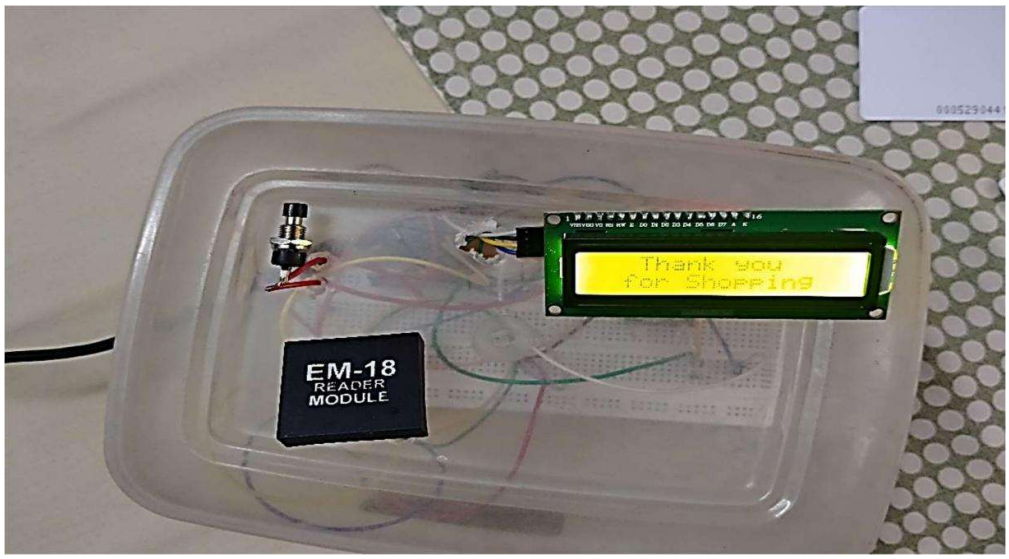


Fig 5.14: Thank You Message

5.3.4 Prototype of RFID Smart Trolley

The intended prototype for the system "RFID based Smart Trolley using IoT" is designed and implemented with respect to corresponding circuit diagram and components attached to Node MCU which has the Arduino IDE code corresponding to the intended functionality uploaded in to it containing the scanning operation of RFID module, displaying data on LCD Display, Blinking of LEDs for adding and removing items from the trolley and simultaneously publishing the data to a web page server which is designed using HTML code integrated with the Arduino IDE code for Node MCU which is connected to the same network to which both the Node MCU and the laptop is connected.

The RFID based Smart Trolley is designed and is attached to the trolley so that the customer who wants to avail this RFID based Smart Trolley uses this and saves lot of time in billing activities. The prototype model can be designed as shown in figure 5.15 below.

Fig 5.15: Prototype

5.4 Advantages

- Reduces time spent at billing counter and increases customer satisfaction.
- Users can be aware of the total bill amount during the time of purchase which prevent them from over shopping.
- Increases overall efficiency.
- Allows quick checkout and eliminates waiting in long queues.

5.5 Disadvantages

- There should be minimal knowledge to use the device which forces people with illiteracy to switch back to conventional shopping system.
- Customers should be alert and must check the webpage by refreshing it for every RFID scan to ensure that only required quantity of items are purchased or removed.

5.6 Applications

It can be utilized in:

- Clothing Stores.
- Grocery stores.
- Wholesale shopping malls.
- Vegetable marts
- Libraries

Chapter-6

CONCLUSION

This application is used in shopping malls for assisting customers by saving a lot of time in buying commodities. In this project RFID is used as safety access for the item which thereby enhances the surveillance performance. This implementation initiates for an automated central billing system in shopping malls and supermarkets. With this, customers no longer have to wait near counters for payment of bills because of their purchased item information getting transferred to central billing unit. By this billing process speed increases and becomes much simpler. In addition to this capability, the mechanism also assures recognition of cases of theft induced by fraudulent consumers which makes the system more reliable and fascinating to both customers as well as sellers. This will enhance the shopping experience to a new level.

Different variables like item cost, item name etc are continuously displayed on LCD attached to the trolley. Thus, we can say that automatic billing of products by using RFID technique will be a more feasible choice in the upcoming days and thereby operation becomes more concise and systematic.

The objective is effectively attained in the prototype model developed. The developed product is of low cost, amiable to use and does not require any specific practice. The ability to take a decision can be done in the cart itself which can be used in the shopping complexes for effortless and clever way of items to save vitality, time and money of the customers.

Future Scope

The RFID based Smart Trolley using IoT can be extended for implementing many other functionalities like:

- Transfer the bill to mobile without printing we can use the GSM module.
- Robotics arm also include in it for the picking and dropping of the product.
- We can also include voice assistance.

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APPENDIX

Arduino IDE code for scanning unique values of RFID cards

```
int count = 0;

char card_no[12];

void setup()

{

  Serial.begin(9600);

}


void loop()

{

  if(Serial.available())

  {

    count = 0;

    while(Serial.available() && count < 12)

    {

      card_no[count] = Serial.read();

      count++;

      delay(5);

    }

    Serial.print(card_no);

  }

}
```

Arduino IDE code for RFID based Smart Trolley using IoT

```
#include<ESP8266WiFi.h>
#include<WiFiClient.h>
#include<ESP8266WebServer.h>
#include<LiquidCrystal_I2C.h>
#include<Wire.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);
const char* ssid = "Ansari";//Replace with your network SSID
const char* password = "333666999@a";//Replace with your network password
ESP8266WebServer server(80);
String page = "";
char input[12];
int count = 0;
int a;
int p1=0,p2=0,p3=0,p4=0;
int  c1=0,c2=0,c3=0,c4=0;
double total = 0;
int count_prod = 0;
void setup()
{
  pinMode(12,INPUT_PULLUP); //push_button
  pinMode(13,OUTPUT);         //Red_led
  pinMode(15,OUTPUT);         //Green_led
  Serial.begin(9600);
  WiFi.begin(ssid, password);
```

```
 Wire.begin(4, 5);
 lcd.begin(16, 2);
 lcd.init();
 lcd.backlight();
 lcd.setCursor(0, 0);
 lcd.print("   WELCOME TO       ");
 lcd.setCursor(0, 1);
 lcd.print("   GEC MART       ");
 delay(2000);
 lcd.clear();
 while (WiFi.status() != WL_CONNECTED)
 {
   delay(500);
 lcd.setCursor(0, 0);
 lcd.print("WiFi Connecting... ");
 }
 Serial.print(WiFi.localIP());
 lcd.setCursor(0, 0);
 lcd.print("WiFi Connected");
 lcd.setCursor(0, 1);
 lcd.print(WiFi.localIP());
 delay(1000);
 lcd.setCursor(0, 0);
 lcd.print(" PLZ ADD ITEMS     ");
 lcd.setCursor(0, 1);
```

```
 lcd.print("    TO CART          ");
server.on("/", []()
 {
   page = "<html><head><title>E Cart using IoT</title></head><style type=\"text/css\">";
   page+="table{border-collapse: collapse;}th {background-color: #3498db ;color: white;}table,td {border: 4px solid black;font-size: x-large;";
   page+="text-align:center;border-style:groove;border-color: rgb(255,0,0);}</style><body><center>";
   page += "<h1>Smart Shopping Cart using IoT</h1><br><br><table style=\"width: 1200px;height: 450px;\"><tr>";
   page += "<th>ITEMS</th><th>QUANTITY</th><th>COST</th></tr><tr><td>Biscuit</td><td>"+String(p1)+"</td><td>"+String(c1)+"</td></tr>";
   page += "<tr><td>Book</td><td>"+String(p2)+"</td><td>"+String(c2)+"</td></tr><tr><td>Chocolate</td><td>"+String(p3)+"</td><td>"+String(c3)+"</td>";
   page += "</tr><tr><td>Kurkure</td><td>"+String(p4)+"</td><td>"+String(c4)+"</td></tr><tr><th>Grand Total</th><th>"+String(count_prod)+"</th><th>"+String(total)+"</th>";
   page += "</tr></table><br><input type=\"button\" name=\"Pay Now\" value=\"Pay Now\" style=\"width: 200px;height: 50px\"></center></body></html>";
   server.send(200, "text/html", page);
 });
 server.begin();
 Serial.println("Web server started!");
}
void loop()
```

```
{
 int a=digitalRead(12);
 if (Serial.available())
 {
  count = 0;
  while (Serial.available() && count < 12)
  {
   input[count] = Serial.read();
   count++;
   delay(5);
  }
  if (count == 12)
  {
   if ((strncmp(input, "300050A3A360", 12) == 0) && (a == 1))
   {
    lcd.setCursor(0, 0);
    lcd.print("Biscuit Added       ");
    lcd.setCursor(0, 1);
    lcd.print("Price(Rs):25.00      ");
    p1++;
    digitalWrite(15,HIGH);
    delay(2000);
    total = total + 25.00;
    count_prod++;
    digitalWrite(15,LOW);
```

```
  lcd.clear();
 }
 else if ((strncmp(input, "300050A3A360", 12) == 0) && (a == 0))
 {
  if(p1>0)
  {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Biscuit Removed!!!        ");
  digitalWrite(13,HIGH);
  delay(2000);
  p1--;
  total = total - 25.00;
  count_prod--;
  lcd.clear();
  digitalWrite(13,LOW);
  }
  else
  {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Not in cart!!!        ");
  digitalWrite(13,HIGH);
  delay(2000);
  digitalWrite(13,LOW);
```

```
  lcd.clear();
  }
}
else if ((strncmp(input, "30004F9F3ADA", 12) == 0) && (a == 1))
{
  lcd.setCursor(0, 0);
  lcd.print("Book Added          ");
  lcd.setCursor(0, 1);
  lcd.print("Price(Rs):30.00         ");
  total = total + 30.00;
  digitalWrite(15,HIGH);
  delay(2000);
  p2++;
  count_prod++;
  digitalWrite(15,LOW);
  lcd.clear();
}
else if ((strncmp(input, "30004F9F3ADA", 12) == 0) && (a == 0))
{
   if(p2>0)
  {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Book Removed!!!        ");
  digitalWrite(13,HIGH);
```

```
    delay(2000);
    p2--;
    total = total - 30.00;
    count_prod--;
    lcd.clear();
    digitalWrite(13,LOW);
    } else {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Not in cart!!!        ");
    digitalWrite(13,HIGH);
    delay(2000);
    lcd.clear();
    digitalWrite(13,LOW);
    }
  }
  else if ((strncmp(input, "300050B9C910", 12) == 0) && (a == 1))
  {
    lcd.setCursor(0, 0);
    lcd.print("Chocolate Added       ");
    lcd.setCursor(0, 1);
    lcd.print("Price(Rs):15.00      ");
    total = total + 15.00;
    digitalWrite(15,HIGH);
    delay(2000);
```

```
  count_prod++;
  p3++;
  lcd.clear();
  digitalWrite(15,LOW);
 }
 else if ((strncmp(input, "300050B9C910", 12) == 0) && (a==0))
 {
  if(p3>0)
  {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Chocolate Removed!!!        ");
  digitalWrite(13,HIGH);
  delay(2000);
  total = total - 15.00;
  p3--;
  count_prod--;
  lcd.clear();
  digitalWrite(13,LOW);
  }
  else
  {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Not in cart!!!        ");
```

```
  digitalWrite(13,HIGH);
  delay(2000);
  lcd.clear();
  digitalWrite(13,LOW);
  }
 }
 else if ((strncmp(input, "30004F899660", 12) == 0) && (a == 1))
 {
  lcd.setCursor(0, 0);
  lcd.print("Kurkure Added          ");
  lcd.setCursor(0, 1);
  lcd.print("Price(Rs):20.00        ");
  total = total + 20.00;
  count_prod++;
  digitalWrite(15,HIGH);
  p4++;
  delay(2000);
  lcd.clear();
  digitalWrite(15,LOW);
 }
 else if ((strncmp(input, "30004F899660", 12) == 0) && (a == 0))
 {
  if(p4>0)
  {
  lcd.clear();
```

```
    total = total - 20.00;
    lcd.setCursor(0,  0);
    count_prod--;
    p4--;
    lcd.print("Kurkure Removed!!!        ");
    digitalWrite(13,HIGH);
    delay(2000);
    lcd.clear();
    digitalWrite(13,LOW);
    }
    else
    {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Not in cart!!!        ");
    digitalWrite(13,HIGH);
    delay(2000);
    lcd.clear();
    digitalWrite(13,LOW);
    }
  }
  else if (strncmp(input, "300050984EB6", 12) == 0)
  {
    lcd.clear();
    lcd.setCursor(0, 0);
```

```
        lcd.print("Total Prod:");
        lcd.setCursor(11, 0);
        lcd.print(count_prod);
        lcd.setCursor(0, 1);
        lcd.print("Price:");
        lcd.setCursor(6, 1);
        lcd.print(total);
        digitalWrite(15,HIGH);
        delay(2000);
        lcd.clear();
        digitalWrite(15,LOW);
        lcd.setCursor(0, 0);
        lcd.print("   Thank you        ");
        lcd.setCursor(0, 1);
        lcd.print("  for Shopping        ");
        digitalWrite(15,LOW);
      }
    }
    c1=p1*25.00;
    c2=p2*30.00;
    c3=p3*15.00;
    c4=p4*20.00;
  }
server.handleClient();
}
```

PROJECT OUTCOMES MAPPED WITH PROGRAMME SPECIFIC OUTCOMES (PSOs) AND PROGRAMME OUTCOMES (POs)

Classification of Project	Application	Product	Research	Review
	✓			

Project Outcomes

Implemented a model of RFID based smart trolley using IoT to reduce the time for billing activities.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

The ECE Graduates will be able to

PSO1: Designing electronics and communication systems in the domain of VLSI, embedded systems, signal processing and RF communications and applying modern tools.

PSO2: Applying the conceptual knowledge of Electronics and Communication Engineering to design, develop, analyze and test systems containing hardware and software components taking into societal, environmental, health, safety, legal, cultural, ethical and economical considerations.

PROGRAMME OUTCOMES (POs)

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12.Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Mapping Table

Project Outcomes	**Program Outcomes (POs)**												**PSOs**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	3	3	3	1	2	3	3	3	3	3	3

1-Slightly (Low)mapped 2-Moderately (Medium)mapped 3-Substantially (High)mapped