



# Advanced Shopping Cart with an Automated Billing System Based on the Internet of Things

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**Abstract:** The IoT-Based Smart Shopping Cart aims to optimize the billing procedure in supermarkets and shorten long lines at the checkout. A NodeMCU microcontroller and an RFID reader work together in this system to read RFID cards or tags and identify products. When you add something to your cart, the details of the item show up on an LCD screen and have been revised as well on an online page that can be reached through the cart's IP address. If you need to, you can use a push button to take things out of the cart. The entire invoice is automatically calculated and can be seen on both the LCD alongside the web interface. This makes shopping quick, easy, and accurate.

## I. INTRODUCTION

The rapid advancement of technology and the increasing demand for convenience have transformed traditional shopping methods in supermarkets and retail stores. One of the major challenges faced by customers and store management is the long waiting time at billing counters, especially during peak hours. Conventional billing systems require manual scanning of products, which is time-consuming, labor-intensive, and prone to human error. These issues reduce customer satisfaction and affect the overall efficiency of retail operations.

To overcome these limitations, the use of Internet of Things (IoT) technology in retail environments has gained significant attention. IoT enables real-time communication between devices, allowing automation and seamless data exchange. Smart shopping systems based on IoT can improve the billing process by reducing manual intervention, speeding up transactions, and providing accurate billing information to customers.

The **Smart Shopping Cart with IoT Based Automated Billing System** is designed to automate

the billing process directly at the shopping cart level. The system utilizes a NodeMCU microcontroller integrated with an RFID reader to identify products using RFID tags or cards. Each time a product is added to the cart, its details such as name and price are instantly detected and displayed on an LCD screen. The system also updates the billing information on a web page that can be accessed using the cart's IP address, allowing customers to view their purchases in real time.

A push button is incorporated to allow customers to remove items from the cart, ensuring flexibility and accuracy in billing. The total bill amount is calculated automatically and displayed both on the LCD and the web interface. This eliminates the need for traditional checkout counters and significantly reduces waiting time.

Overall, the proposed system provides a fast, accurate, and user-friendly shopping experience. By integrating IoT technology with automated billing, the smart shopping cart improves customer convenience, reduces workload on store staff, and enhances operational efficiency, making it a suitable solution for modern retail environments.

## II. RELATED WORK

### "IoT-Based Smart Shopping Trolley for Automated Billing and Inventory Management"

The swift evolution of the Internet of Things (IoT) has revolutionized many industries, and the retail and shopping experience is no exception. This is an overview of the creation of a Smart Shopping Trolley with IoT integration to increase convenience, decrease checkout time, and enhance inventory management. The system under the proposal includes a trolley mounted with RFID sensors, a barcode reader, a microcontroller, and a real-time billing system connected through a mobile application. As



items get added or taken away, the cart total automatically gets updated to reduce the involvement of conventional checkout counters. With an IoT-driven cloud platform, store owners also get to know inventory and the buying habits of customers in real time, facilitating better stock handling and operational efficacy. The smart navigation system integrated with a screen in the trolley also advises the best possible routes based on shopping lists for further convenience for users. This innovation largely minimizes human intervention, avoids billing errors, and provides a hassle-free shopping experience. The use of this system is intended to revolutionize the retail industry by combining IoT, automation, and real-time data processing, which eventually results in enhanced customer satisfaction and efficient business operations.

#### **“IoT-Based Smart Shopping Cart Using Radio Frequency Identification”**

The modern age of technology in which most of the customer needs to wait in the supermarket for shopping because it is a highly time-consuming process. A huge crowd in the supermarket at the time of discount offers or weekends makes trouble to wait in long queues because of a barcode-based billing process. In this regard, the Internet of Things (IoT) based Smart Shopping Cart is proposed which consists of Radio Frequency Identification (RFID) sensors, Arduino microcontroller, Bluetooth module, and Mobile application. RFID sensors depend on wireless communication. One part is the RFID tag attached to each product and the other is RFID reader that reads the product information efficiently. After this, each product information shows in the Mobile application. The customer easily manages the shopping list in Mobile application according to preferences. Then shopping information sends to the server wirelessly and automatically generates billing. This experimental prototype is designed to eliminate time-consuming shopping process and quality of services issues. The proposed system can easily be implemented and tested at a commercial scale under the real scenario in the future. That is why the proposed model is more competitive as compared to others.

#### **“IoT Based Smart Shopping Cart Integrated with Payment Gateway”**

In the cutting-edge era of technology, customers frequently experience extended waits in supermarkets, specifically throughout top instances inclusive of discount gives or weekends. This inconvenience arises from the time-eating barcode-based total billing process, exacerbated by huge

crowds. An answer is proposed to cope with this trouble: the Internet of Things (IoT) is primarily based on an intelligent shopping cart. This progressive device includes a barcode reader with a cart, a Raspberry Pi, and a Bluetooth module. Barcode readers facilitate wireless communication, with barcodes affixed to every product and barcode readers efficiently extracting product facts. This record is then seamlessly displayed on the LCD, permitting clients to manage their shopping listings based on possibilities. subsequently, the buying statistics are wirelessly transmitted to the server, automating the billing procedure. This experimental prototype aims to streamline the time-consuming shopping experience and enhance service quality. The proposed device's ease of implementation and capacity for real-world checking out make it a competitive choice for addressing the demanding situations of contemporary grocery store operations.

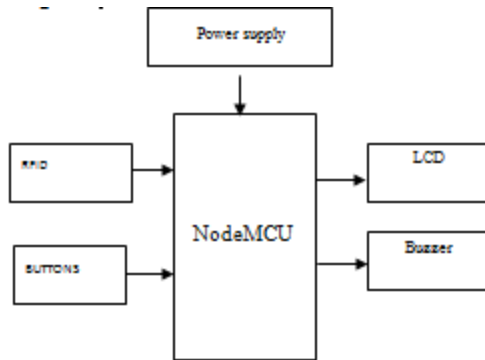
#### **"IoT Based Smart Shopping Cart" – Sharma, R.**

This paper introduces an IoT-enabled shopping cart system that automates billing using RFID technology. The authors highlight the inefficiencies of traditional checkout systems and propose a solution that integrates RFID readers with microcontrollers. The system updates product details in real time and calculates the total bill automatically. The study emphasizes reduced waiting time, improved customer satisfaction, and scalability for large retail environments.

### **III. IMPLEMENTATION**

The proposed IoT shopping cart automates product identification and billing using RFID technology and NodeMCU. Each product is assigned a unique RFID card. When the product is placed in the cart, the RFID reader scans it and updates the product information on an LCD and a web page hosted by NodeMCU using its IP address. A push button allows customers to remove products from the cart, updating the bill instantly. This system reduces checkout time and improves shopping efficiency.

#### **Block diagram:**



### Working

The Smart Shopping Cart system functions by combining IoT technology with automated billing to streamline the shopping experience. A Node MCU microcontroller serves as the core, interfacing with an RFID reader to identify products tagged with RFID cards. Each time an item is added, its details are displayed on the LCD screen and simultaneously updated on a web page linked to the cart's IP address. A push button allows customers to remove items if needed, ensuring flexibility. The system automatically calculates the total bill, which can be viewed both on the LCD and the web interface,

eliminating manual checkout and reducing queues. This integration provides a fast, accurate, and user-friendly solution for modern retail environments.

### HARDWARE REQUIREMENTS

#### Node MCU

Technically speaking NodeMCU is a firmware for ESP8266 developed using C Programming Language, Espressif NON-OS SDK and Lua scripting language. Traditionally, we write code for our Microcontrollers like Arduino, STM32, 8051 etc., either in C or C++ and compile it with a set of tools and generate a binary file. This binary file is then uploaded into the flash memory of the microcontroller and it gets executed. Things are quite different with NodeMCU. You can consider the NodeMCU firmware as an interpreter for Lua Scripts. So, if your ESP8266 is loaded with NodeMCU Firmware, you can simply write your application in Lua and send it to the ESP8266. NodeMCU Firmware will interpret the byte code and executes the commands. There is no compilation, no binary file etc. Just write a script and run it the team which developed NodeMCU Firmware also developed a breakout board for ESP-12E module called the NodeMCU Devkit. So, many of us are actually using the board called NodeMCU and programming it with Arduino IDE and not the Lua Scripts.



**IMPORTANT NOTE:** Only one firmware can exist on the ESP8266. It can be either AT Commands Firmware, NodeMCU Firmware or Arduino based code. Once you upload an Arduino sketch, the NodeMCU firmware gets erased. If you want to work with Lua Scripts and NodeMCU, then you have to flash the NodeMCU Firmware.

**ESP-01 vs. NodeMCU (ESP-12E)** As mentioned earlier, the NodeMCU Devkit is actually a Breakout Board for the ESP-12E Module. The ESP-01 is the vanilla version of the ESP8266 Wi-Fi SoC made by Ai-Thinker, a third part module manufacturer for ESP8266.

#### Brief about NodeMCU ESP8266

The **NodeMCU ESP8266 development board** comes with the ESP-12E module containing the ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency. NodeMCU 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.

NodeMCU can be powered using a Micro USB jack and VIN pin (External Supply Pin). It supports UART, SPI, and I2C interface.

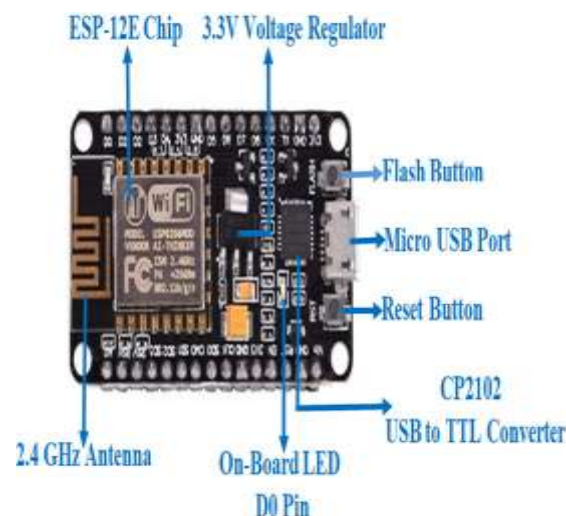
- **ESP8266 Chip:** The core of the NodeMCU module is the ESP8266 chip, which provides Wi-Fi connectivity and microcontroller functionality.
- **GPIO Pins:** The NodeMCU board includes multiple digital and analog pins that can be used



to connect various peripherals such as sensors, LEDs, and motors.

- **Serial Communication Protocols:** It supports UART, SPI, and I2C protocols, enabling communication with other devices and modules.
- **Open-Source Firmware:** The NodeMCU firmware is open-source and based on the Lua scripting language, making it easy to program and customize.

**Compact Design:** The NodeMCU module is small and lightweight, making it suitable for various applications, from hobby projects to professional IoT solutions



## RFID

**Radio Frequency Identification (RFID)** is a form of wireless communication that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum to uniquely identify an object or person. It uses radio frequency to search, identify, track, and communicate with items and people.

RFID (Radio Frequency Identification) is a technology that uses electromagnetic fields to automatically identify and track tags attached to objects. These tags contain electronically stored information that can be read from several meters away, without requiring direct line-of-sight. RFID is commonly used in inventory management, asset tracking, access control, and supply chain logistics due to its efficiency and accuracy in tracking and managing items.

It is a method that is used to track or identify an object by radio transmission over the web. Data is digitally encoded in an RFID tag which might be read by the reader. This device works as a tag or label during which data is read from tags that are stored in the database through the reader as compared to traditional barcodes and QR codes. It is often read outside the road of sight either passive or active RFID.

## RC522 RFID Reader Module

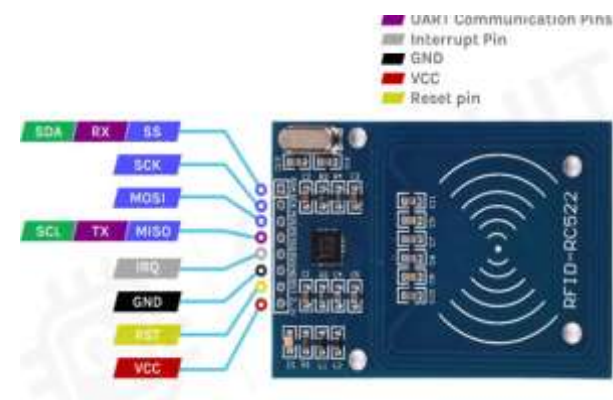
RC522 is a Multi-communication RFID Module for Arduino and Microcontrollers. The RC522 is known as MFRC-522 due to its NFX semiconductor microcontroller. The module allows the developers to interface it with any other SPI, I2C, and UART based microcontrollers. The RC522 module works on 13.56 MHz frequency and it can act as a reader and write for UID/RFID cards. The RFID cards communicate with the module at a short distance with radio frequency due to the mutual induction technique. In most of the security and commercial products, the module is effective because the errors and issues with RFID Tags are detectable by it.

## RC522 Pin Configuration Details

In this module, there are only two kinds of pins. So, the first one is power and the second one is the communication pins. Therefore, the device may have its microcontroller chip on itself but it only makes it to work as an RFID. The on-board microcontroller won't make the module a stand-alone device.

## RC522 Pinout Diagram

All the pins of MFRC/RC522 RFID card Reader are:



## RC522 RFID Reader Features



- RFID RC522 uses mutual induction to activate the cards and 13.56MHz for data transfer.
- The RFID Cards are useable from both sides of the module at max 5cm.
- The only 3.3V is required to activate the device.
- Its auto-sleep mode makes it less power consumption module.
- The module has three kinds of communications (UART, SPI, and I2C). Therefore, it is useable with almost every microcontroller or device in the market.
- The RFID cards and reader (RC522) can transfer data up to 10Mb/s.

### RFID cards

An RFID card is a smart card that integrates **radio frequency identification** (RFID) technology. Each RFID card is embedded with an antenna connected to an RFID IC, so it can receive, store, and transmit data via radio waves. The core function of an RFID card is to automatically identify objects and transmit data in a contactless manner.



Fig: RIFD cards

### PUSH BUTTON

Push Buttons are normally-open tactile switches. Push buttons allow us to power the circuit or make any particular connection only when we press the button. Simply, it makes the circuit connected when pressed and breaks when released. A push button is also used for triggering of the SCR by gate terminal.

A push button switch is a mechanical device to control an electrical circuit by a manual operation to energize the internal switching mechanism. Push button switches are electrical actuators this switch will close or open an electrical circuit by pressing the switch. Push button switches control a wide range of electronic circuits. These switches are in the form of a button or a key. These switches can be either

momentary or maintained. But, the push button is the frequent sort of momentary switch. Generally, A closed push button switch is known as a push-to-break switch. An open push button switch is known as a push-to-make switch. The maintained push button is connected to a mechanism that holds and releases between successive alternate pushes. Push buttons technically consist of two states or more, but, a push button having more than two states is not a common option. These push buttons are available in a variety of shapes, sizes, and configurations, depending on the design requirements.



Fig: push button

### How to use a push button?

When connecting in between of supply and the circuit we should only connect the wires with both the legs of the Push-Button as shown in the circuit below:

A Push-Button can also be used for the triggering purpose like of SCR. An SCR is a gate controlled Switch which needs a triggering pulse. So, for this we can add a Push button in the circuit to give a triggering pulse

### LCD

LCD is a flat display technology, stands for "Liquid Crystal Display," which is generally used in computer monitors, instrument panels, cell phones, digital cameras, TVs, laptops, tablets, and calculators. It is a thin display device that offers support for large resolutions and better picture quality. The older CRT display technology has replaced by LCDs, and new display technologies like OLEDs have started to replace LCDs. An LCD display is most commonly found with Dell laptop computers and is available as an active-matrix, passive-matrix, or dual-scan display. The picture is an example of an LCD computer monitor.

The Liquid Crystal library allows you to control LCD displays that are compatible with the Hitachi HD44780 driver. There are many of them out there,



and you can usually tell them by the 16-pin interface.



Output of the sketch on a 16x2 LCD

The LCDs have a parallel interface, meaning that the microcontroller has to manipulate several interface pins at once to control the display. The interface consists of the following pins:

- A **register select (RS)** pin that controls where in the LCD's memory you're writing data to. You can select either the data register, which holds what goes on the screen, or an instruction register, which is where the LCD's controller looks for instructions on what to do next.
- A **Read/Write (R/W)** pin that selects reading mode or writing mode
- An **Enable** pin that enables writing to the registers
- **8 data pins (D0 -D7)**. The states of these pins (high or low) are the bits that you're writing to a register when you write, or the values you're reading when you read.

There's also a **display contrast pin (Vo)**, **power supply pins (+5V and GND)** and **LED Backlight (Bklt+ and Bklt-)** pins that you can use to power the LCD, control the display contrast, and turn on and off the LED backlight, respectively.

The process of controlling the display involves putting the data that form the image of what you want to display into the data registers, then putting instructions in the instruction register. The Liquid Crystal Library simplifies this for you so you don't need to know the low-level instructions.

The Hitachi-compatible LCDs can be controlled in two modes: 4-bit or 8-bit. The 4-bit mode requires seven I/O pins from the Arduino, while the 8-bit mode requires 11 pins. For displaying text on the screen, you can do most everything in 4-bit mode,

so example shows how to control a 16x2 LCD in 4-bit mode.**BUZZER**

An audio signalling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.



Buzzer Pin Configuration

The **pin configuration of the buzzer** is shown below. It includes two pins namely positive and negative. The positive terminal of this is represented with the '+' symbol or a longer terminal. This terminal is powered through 6Volts whereas the negative terminal is represented with the '-' symbol or short terminal and it is connected to the GND terminal.

#### IV. RESULT ANALYSIS



Fig 1: project image



Fig 2: added 1 item to cart



Fig 3: displaying count and price of the product



Fig 4: web page view

## V. CONCLUSION

The **Smart Shopping Cart with IoT Based Automated Billing System** offers an efficient and reliable solution to the challenges faced in traditional supermarket billing processes. By automating product identification and bill generation, the system significantly reduces customer waiting time at checkout counters and minimizes manual intervention. This improves overall shopping convenience and enhances customer satisfaction.

The integration of the NodeMCU microcontroller with an RFID reader enables accurate and real-time detection of products added to or removed from the cart. Displaying product details and the total bill on an LCD provides instant feedback to the user, while the web-based interface allows customers to monitor their purchases remotely through the cart's IP address. The inclusion of a push button for item removal ensures flexibility and correctness in billing.

Automatic bill calculation reduces human errors commonly associated with manual scanning and billing. The system also improves store efficiency by lowering the workload on staff and enabling faster transaction processing. Overall, the proposed smart shopping cart demonstrates how IoT technology can modernize retail systems by offering a fast, accurate, and user-friendly shopping experience.

In conclusion, the IoT-based automated billing system is a practical and scalable solution for smart retail environments. With further enhancements such as mobile payment integration, inventory management, and customer authentication, the system can play a significant role in the future of intelligent and automated shopping systems.

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