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RFID BASED CUSTOMER BILLING SYSTEM FOR SUPERMARKET SHOPPING USING IOT

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ABSTRACT-- 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 RFID based customer billing system for supermarket shopping using Internet of Things (IoT) is proposed which consists of Radio Frequency Identification (RFID) sensors, Arduino micro-controller, 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 manages the shopping list-in Mobile application according to preferences. Then shopping information will be sent to the server wirelessly and automatically generates billing. This experimental prototype is designed to eliminate time-consuming shopping process and quality of services issues.

Keywords: RFID, Arduino micro controller, IoT, Mobile Application, Embedded systems….

I. I.INTRODUCTION

Technology has been an enlightening path for innovative new ideas and connecting the world in which Modern world has brought us many possible ways of connecting people with technology such as IoT and industrial automation. Right from the start when innovations started in the world of technology the meaning was to reduce unnecessary hardship and increase the productivity of humans. One of the most important modern world leisure activities is spending time shopping in malls, shopping complexes etc… Thus, an upbringing innovation in the field of shopping and retail stores can be the inclusion of smart shopping trolley systems in which the person has to just register with the help of his/her phone number and enjoy shopping with personalised billing system which helps the customer to view his total amount anytime while shopping which helps to maintain the budget, as well as automatic billing, helps in did you see the hardships required for waiting and standing in long queues in the shopping malls.

Our paper consists of RFID tags which can be attached to the required products, an RFID reader which is used for scanning the products after putting them in the trolley while dropping them in the trolly the product will be scanned which will be used to show the items added in the trolley along with the total. Also, automated the movement of the trolley with the help of ultrasonic sensors, Arduino and motors. Using a GSM module which helps us in connecting the mobile phone of the registered

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customer with the trolley and after the billing is done a message will be sent to the registered customer's mobile number with the total description of the bill.

IOT (INTERNET OF THINGS)

The **Internet of Things** (**IoT**) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human- to-computer interaction.

The definition of the Internet of things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems.[5] Traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), and others all contribute to enabling the Internet of Things. In the consumer market, IoT technology is most synonymous with products pertaining to the concept of the "smart home", covering devices and appliances(such as lighting fixtures, thermostats, home security systems and cameras, and other home appliances) that support one or more common ecosystems, and can be controlled via devices associated with that ecosystem, such as smartphones and smart speakers. There are a number of serious concerns about dangers in the growth of IoT, especially in the areas of privacy and security; and consequently industry and governmental moves to begin to address these.

Security

Security is the biggest concern in adopting Internet of things technology,[180] with concerns that rapid development is happening without appropriate consideration of the profound security challenges involved and the regulatory changes that might be necessary. Most of the technical security concerns are similar to those of conventional servers, workstations and smartphones, and include weak authentication, forgetting to change default credentials, unencrypted messages sent between devices, SQL injections and poor handling of security updates. However, many IoT devices have severe operational limitations on the computational power available to them.

Safety

IoT systems are typically controlled by event-driven smart apps that take as input either sensed data, user inputs, or other external triggers (from the Internet) and command one or more actuators towards providing different forms of automation. Examples of sensors include smoke detectors, motion sensors, and contact sensors. Examples of actuators include smart locks, smart power outlets, and door controls

EMBEDDED SYSTEMS

An Embedded System is a system that has software embedded into computer-hardware, which makes a system dedicated for a variety of application or specific part of an application or product or part of a larger system.

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An embedded system can be a small independent system or a large combinational system. It is a microcontroller-based control system used to perform a specific task of operation.

An embedded system is a combination of three major components

- **Hardware:** Hardware is physically used component that is physically connected with an embedded system. It comprises of microcontroller based integrated circuit, power supply, LCD display etc.
- **Application software:** Application Software allows the user to perform varieties of application to be run on an embedded system by changing the code installed in an embedded system.
- **Real Time Operating System (RTOS):** RTOS supervises the way an embedded system work. It act as an interface between hardware and application software which supervises the application software and provide mechanism to let the processor run on the basis of scheduling for controlling the effect of latencies.

Fig 1: Embedded System

CHARACTERISTICS OF EMBEDDED SYSTEM

1. An embedded system is software embedded into computer hardware that makes a system dedicated to be used for variety of application.
2. Embedded system generally used for doing specific task that provide real-time output on the basis of various characteristics of an embedded system.
3. Embedded system may contain a smaller part within a larger device that used for serving the more specific application to perform variety of task using hardware-software intermixing configuration.
4. It provides high reliability and real-time computation ability.

II.EXISTING SYSTEM

In the existing system, they have used the traditional method of barcode scanning. Using the barcode scanner we need to scan each product and so this method becomes very slow to be scanned. A barcode reader is associate in electronic device for reading with the barcodes. In this process we have no automatic billing system and the customer has to wait for the billing process in the long queues.

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Therefore, using the barcode process billing method is slow. This eventually results in the long queues. To avoid the process, we introduced types of technology is the RFID based billing system.

User can pay the amount through credit/debit cards or by cash. But it is the time consumption process for the billing purpose. So, the waiting time to pay the bill is increased. To overcome the time consumption process the RFID based customer billing system for supermarket shopping is proposed.

Fig 2: Barcode Scanning

Barcode Scanner While the customer keeps the product in the smart trolley, the Radio frequen cy ID reader automatically senses the product by scanning the tag. And its corresponding elec tronic product code number is generated automatically. To store the item price and total billing data, microcontroller memory is used. This electronic product code provides the information of the product its name, price and quantity.

DISADVANTAGES OF EXISTING SYSTEM

- Line-of-sight Scanning. .Manual Handling of Products.
- Dependency on Cashiers . Limited Information Storage.
- Slow Scanning Process . Queue management Challenges
- Limited Integration and Scalability

III.PROPOSED FRAMEWORK

In the proposed system, we are using the RFID reader at the trolley side and every product in the supermarket has its unique RFID tag with unique ID. Once the customer drops a certain product in the trolley, then the tag attached to that product was read by the RFID reader and sent to the controller.

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The controller counts the product value. Like that we can add any number of products of our need and check the total bill on the customer mobile screen. After completion of the shopping, one should scan the pay tag at the trolley side to receive the bill amount by the customer. Finally, customer can pay the bill without standing or waiting in the queue.

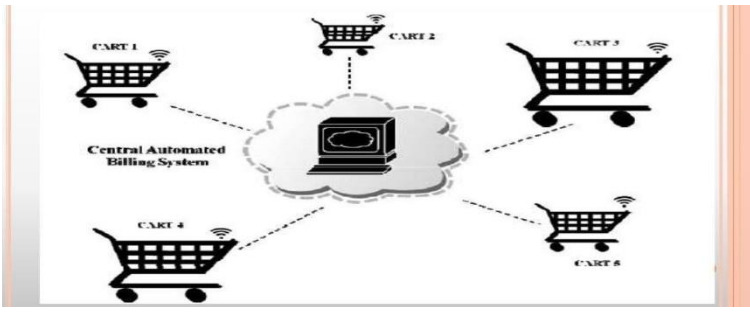

Fig 3: Smart trolley system using RFID

The objective of this paper is to improve the speed of purchase by using RFID. This paper is designed to use the RFID based security system application in the shopping trolley.

This paper is used in shopping complex for purchase the products. In this paper RFID card is used as security access for product.

Advantages of the Proposed System

1. **Speed and Efficiency:** The proposed system offers faster and more efficient operations, enabling quicker processing and task completion.
2. **Increased Data Capacity:** With real-time tracking and inventory management features, the system can handle large volumes of data, enhancing storage and retrieval capabilities.
3. **Real-Time Tracking and Inventory Management:** The system provides real-time tracking of items and efficient inventory management, allowing businesses to monitor their stock levels accurately.
4. **Enhanced Durability and Longevity:** The system is built to withstand rigorous industrial environments, ensuring durability and longevity in operation.
5. **Non-Line-of-Sight Scanning:** Capable of non-line-of-sight scanning, the system can accurately track and manage items even when not directly visible.

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6. **Bulk Scanning:** The system supports bulk scanning capabilities, enabling rapid identification and processing of multiple items simultaneously.

Applications

The proposed system finds applications in various industries and sectors, including:

- Shopping malls
- Industries
- Medical stores
- Marts

Tool: Arduino IDE

The software utilized by the system is the Arduino IDE. Arduino IDE is a user-friendly cross-platform application designed to introduce programming to artists and newcomers unfamiliar with software development. Some key features of Arduino IDE include:

- **Code Editor:** Includes features like syntax highlighting, brace matching, and automatic indentation for easy code writing.
- **Compilation and Uploading:** Capable of compiling and uploading programs to the Arduino board with a single click, eliminating the need for complex command-line interfaces.
- **Wiring Library:** Arduino IDE comes with a C/C++ library called "Wiring," which simplifies common input/output operations.
- **Simple Program Structure:** Arduino programs are written in C/C++, requiring users to define only two functions – **setup()** and **loop()** – making it easy to create runnable programs.

Arduino IDE offers a straightforward approach to programming microcontrollers, making it accessible for a wide range of users.

Fig 3: Arduino IDE

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Arduino IDE and Components Overview

Arduino IDE

The Arduino IDE utilizes the GNU toolchain and AVR Libc for compiling programs and avrdude for uploading programs to the board. It offers a user-friendly environment for programming microcontrollers.

Libraries

1. **SPI:** Provides functions and interfaces for Serial Peripheral Interface (SPI) communication.
2. **MFRC522:** Used for RFID (Radio Frequency Identification) communication, facilitating communication with RFID readers.
3. **Software Serial:** Enables serial communication on any digital pins of the Arduino, useful for communication with devices via software-defined serial communication.
4. **ESP8266WiFi:** Enables communication with Wi-Fi networks using the ESP8266 Wi-Fi module, facilitating connections to servers and data exchange.
5. **FirebaseArduino:** Allows communication with the Firebase Realtime Database, enabling reading and writing data to the database.
6. **Wire:** Used for Inter-Integrated Circuit (I2C) communication, providing functions for communication with devices connected via the I2C bus.

Devices

RFID (Radio Frequency Identification System): RFID technology enables the identification of objects through tags attached to them, without requiring line-of-sight communication between the tags and the reader. Key components of an RFID system include:

- **RFID Tag:** Consists of a silicon microchip attached to a small antenna, encapsulated in materials like plastic or glass, and equipped with an adhesive for attachment to objects.

RFID systems offer a convenient and efficient method for object identification and tracking, finding applications in various industries and scenarios.

Fig 4: RFID Tag

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Reader: The reader is a crucial component of the RFID system, comprising a scanner equipped with antennas for transmitting and receiving signals. It facilitates communication with RFID tags and retrieves information stored on the tags. The reader plays a vital role in initiating communication with tags, reading their data, and processing the information received from them.

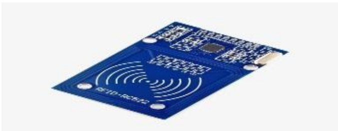

Fig 5: RFID reader

Arduino: Arduino is an open-source electronics platform based on easy-to-use hardware and software. It consists of a microcontroller board and a development environment that simplifies the process of writing and uploading code to the board. Arduino boards are widely used for various projects due to their simplicity and versatility.

NodeMCU: NodeMCU is an open-source IoT (Internet of Things) platform that utilizes the ESP8266 Wi-Fi System-on-Chip (SoC) from Espressif Systems. It comprises firmware that runs on the ESP8266 and hardware based on the ESP-12 module. NodeMCU allows for easy development of IoT projects, leveraging the capabilities of the ESP8266, and supports the Lua scripting language. It is built on the Espressif Non-OS SDK for ESP8266, providing a convenient platform for IoT prototyping and development.

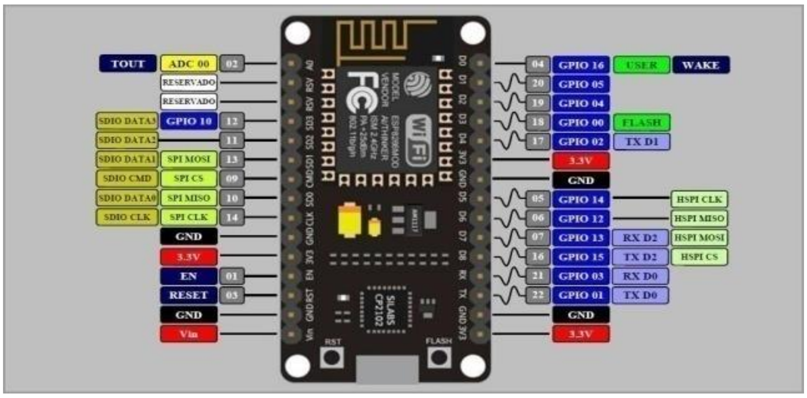

Fig 6: NodeMCU

Microcontroller: The NodeMCU is based on the ESP8266 microcontroller, which features an integrated Wi-Fi module. The ESP8266 has a 32-bit Tensilica processor running at a clock speed of 80MHz.

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RAM (Random Access Memory): The ESP8266 on the NodeMCU board typically has 80KB of available RAM. This should be sufficient for most RFID-based applications, as long as the code and data are optimized.

Flash Memory: The NodeMCU board comes with 4MB of flash memory, which is used to store the program code and any additional data.

Communication Interfaces: The NodeMCU board provides various communication interfaces, including UART (serial communication), SPI (Serial Peripheral Interface), and I2C (Inter-Integrated Circuit). These interfaces allow you to communicate with RFID readers, sensors, and other external devices.

Wi-Fi: One of the key features of NodeMCU is its integrated Wi-Fi module. This allows your project to connect to the internet and communicate with other devices or cloud services.

Power Supply: The NodeMCU board can be powered via a USB connection or an external power supply. Make sure to provide a stable power source to ensure reliable operation.

PCB (Printed Circuit Board): A printed circuit board is the base for physically supporting and wiring the surface-mounted and socketed components in most electronics. PCBs are made from fiberglass or glass-reinforced plastics with copper traces, and they come in various configurations depending on the complexity of the hardware they support. Printed circuit boards are essential components of electronic devices, providing a platform for connecting and integrating various electronic components.

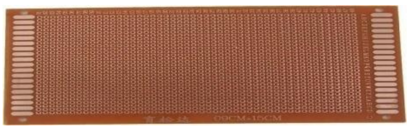
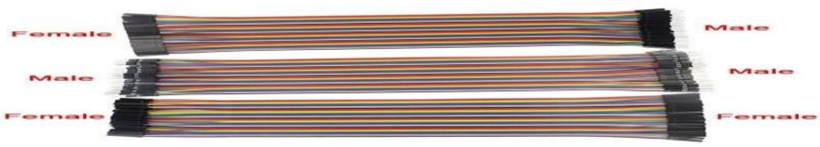


Fig 7: PCB (Printed Circuit Board)

JUMPER WIRES



Jumper Wires:

Jumper wires are electrical wires with connector pins at each end, used to connect two points in a circuit without soldering. They are versatile tools for modifying circuits, diagnosing problems, and bypassing faulty components. Jumper wires come in three versions:

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1. **Male-to-Male Jumper:** Both ends have pins, suitable for connecting two components or points on a breadboard.

2. **Male-to-Female Jumper:** One end has pins, while the other end has receptacles, useful for connecting male pins to components or female headers.

3. **Female-to-Female Jumper:** Both ends have receptacles, allowing connection between female headers or components.

Jumper wires come with different head shapes, including square head and round head. The color of jumper wires serves as an aid for organization and tracking connections but does not affect circuit operation. They are commonly used in electronic prototyping, circuit testing, and troubleshooting.

Buzzer:

A buzzer or beeper is an audio signaling device used in various electronic products for sound notification. It can be mechanical, electromechanical, or piezoelectric and typically consists of electronic transducers and a DC power supply. Buzzers find applications in alarm systems, timers, confirmation signals (e.g., mouse clicks), and notifications in electronic devices such as computers, printers, copiers, telephones, and automotive electronics.

The buzzer emits a distinctive sound when powered, alerting users to specific events or conditions. It is widely used due to its simplicity, reliability, and effectiveness in providing audible alerts and notifications in electronic systems.

Pin Configuration of Passive Buzzer:

The passive buzzer typically has three pins, each serving a specific purpose:

1. **I/O:** This pin is used to provide the input signal that controls the buzzer's sound output. By toggling the voltage on this pin, the buzzer can be turned on or off, or the frequency of the sound produced can be modulated.

2. **Vcc:** This pin is connected to the positive voltage supply, providing the necessary power for the buzzer to operate.

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3. **Gnd:** This pin is connected to the ground or 0V reference, completing the electrical circuit and allowing the current to flow through the buzzer.

RFID Technology:

Introduction: RFID, or Radio Frequency Identification, is a wireless technology that uses radio waves to identify and track objects. It consists of special wireless cards with embedded chips and loop antennas. The embedded chip stores a unique identifier, typically a 12-digit number, which represents the RFID card or tag.

An RFID reader generates a 125kHz magnetic signal, transmitted through the loop antenna. When an RFID card comes within range of the reader, the magnetic signal powers the card, allowing it to transmit its unique identifier. The reader captures this identifier, which can then be used for various purposes such as security access, inventory tracking, or authentication.

Implementation: In the context of security access, each product is assigned an individual RFID card that represents its identity. The RFID reader is interfaced with a microcontroller, typically a reprogrammable flash microcontroller. The microcontroller is pre-programmed with the RFID card numbers corresponding to authorized products.

When an RFID card is presented to the reader, the microcontroller compares its identifier with the authorized list. If the card is recognized as belonging to an authorized product, the microcontroller triggers the desired action, such as granting access or activating a mechanism. Additionally, a keypad may be interfaced with the microcontroller to provide additional authentication or control functionalities.

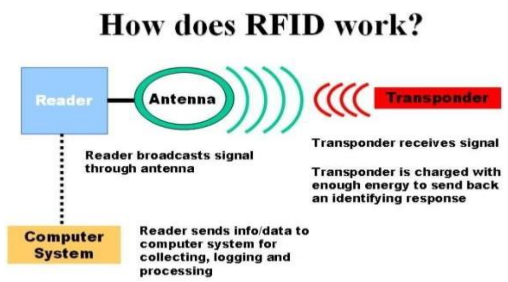

Fig 9: Working of RFID

RFID System Components and Their Effects in Libraries

An RFID system in libraries typically consists of three main components: the tag, the reader, and the application that utilizes the data obtained from the tag.

1. **Tag (Transponder):**

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- The tag, also known as a transponder, comprises an antenna and a silicon chip enclosed in glass or plastic.
- Tags store a small amount of information, ranging from a barcode number and security bit (128 bits) to more extensive data (up to 1,024 bits).
- Tags vary in size, from as small as a grain of rice to larger two-inch squares, depending on their intended application.
- Tags can be passive (powered by the reader's signal), active (containing a battery for power), or semi-active (powered by a battery with additional power from the reader).

2. **Reader:**
   - The reader is responsible for detecting and reading the information stored on the tag.
   - It emits radio frequency signals to power passive tags and receive data from them.
   - Readers are usually connected to a computer system or network to process the data obtained from the tags.

3. **Application:**
   - Once the reader retrieves information from the tag, it is passed on to an application that utilizes this data.
   - Applications in library RFID systems serve various purposes and fall into several categories:
     1. **Access Control (Keyless Entry):** Enables secure access to restricted areas within the library premises.
     2. **Asset Tracking (Self Check-in and Self Check-out):** Allows patrons to check in and check out library materials independently without the need for staff assistance.
     3. **Asset Tagging and Identification (Inventory and Shelving):** Facilitates inventory management and ensures efficient shelving by tracking the location of library items.
     4. **Authentication (Counterfeit Prevention):** Verifies the authenticity of library materials to prevent counterfeiting or theft.
     5. **Point-of-Sale (POS) (FastTrak):** Enables quick and efficient transactions at library counters for borrowing or returning items.

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6. **Supply Chain Management (SCM) (Tracking of Containers, Pallets, or Individual Items):** Manages the movement of library materials from suppliers to library shelves, ensuring efficient logistics and inventory control.

Overall, RFID technology enhances library operations by improving security, efficiency, and accessibility for both patrons and staff.

ARCHITECTURE

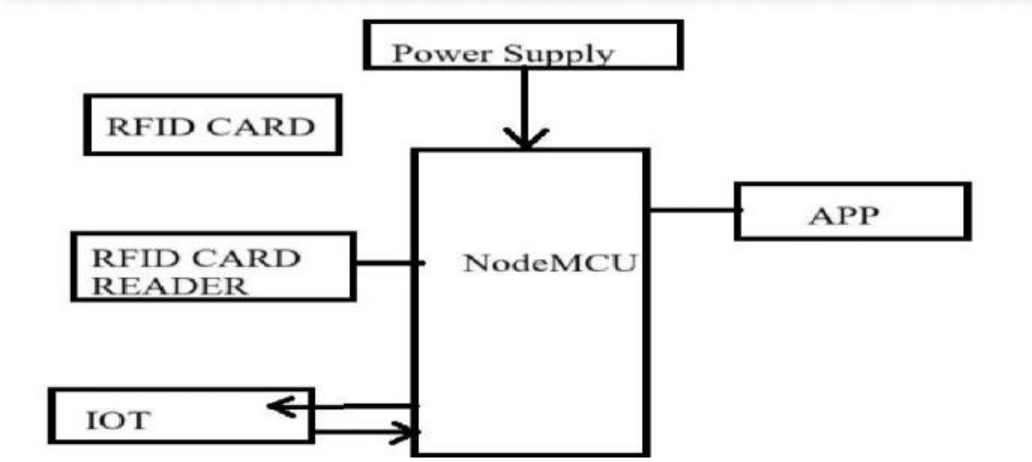

Fig 10: System Architecture

The smart shopping system described consists of various hardware and software components working together to provide an efficient and convenient shopping experience. Here's an overview of how the system operates:

Hardware Components:

1. **RFID Reader:** Reads the RFID tags attached to products in the shopping cart.
2. **NodeMCU:** Acts as the controller, receiving data from the RFID reader and processing it.
3. **Display:** Shows the bill to the customer.
4. **Payment Terminal:** Allows customers to make payments using different methods like credit/debit cards or cash.

Software Components:

1. **Firmware:** Running on the NodeMCU board, it handles communication with the RFID reader, processes data, and controls the display.
2. **Mobile App (Customer):** Allows customers to scan a payment tag and view the total bill on their mobile devices.

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3. **Web App (Owner):** Enables the supermarket owner or staff to monitor transactions, view sales reports, and manage the product database.

Communication:

- **Wireless Communication:** The NodeMCU communicates wirelessly with the mobile app and web app to exchange data.

Backend Services:

1. **Database:** Stores and manages product information, customer details, and transaction data.
2. **Payment Gateway:** Integrates with online payment methods to securely process transactions.

Integration:

- The system integrates all components, including the RFID reader, NodeMCU board, mobile app, web app, database, and payment gateway, to offer a seamless and automated customer billing experience.

Working:

1. **Product Setup:** Shop management adds products to their app.
2. **Customer Shopping:** Users scan products using the smart trolley, which reads RFID tags on items. Customers can also make payments directly through the smart trolley.
3. **Data Processing:** RFID card data is transmitted to the microcontroller, which processes it according to the programmed logic.
4. **Data Update:** The microcontroller updates data in the cloud using IoT technology, ensuring that inventory and transaction records are accurately maintained.

Benefits:

- **Reduced Queue Lines:** The system minimizes queue lines in supermarkets by streamlining the checkout process.
- **Efficient Inventory Management:** Real-time data updates help in managing inventory levels and restocking efficiently.
- **Convenient Shopping Experience:** Customers enjoy a hassle-free and convenient shopping experience with quick checkout and payment options.

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CIRCUIT DIAGRAM

WORKING PRINCIPLE

RFID DETAILS

Radio frequency identification (commonly abbreviated to RFID) is so-named because it relates to the identification of objects using EM radiation at radio frequencies.Once again, RFID systems may be categorized based on the band of the EM spectrum that they operate in. RFID systems in the same band will generally display similar characteristics; those in other bands may well operate very differently and therefore be more or less suitable for a given application. An RFID system comprises two components – an RFID reader and an RFID tag. Despite its name, the RFID reader is really the transmitter in an RFID system. The electronics in the reader uses an external power source to generate the signal that drives the reader's antenna and which in turn creates the appropriate radio wave. This radio wave may be received by an RFID tag, which in turn 'reflects' some of the energy it receives in a particular way (based on the identity of the tag).

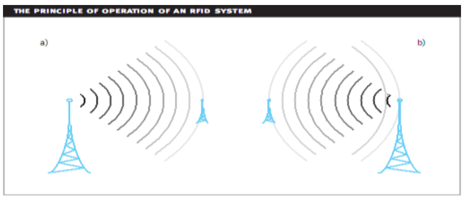
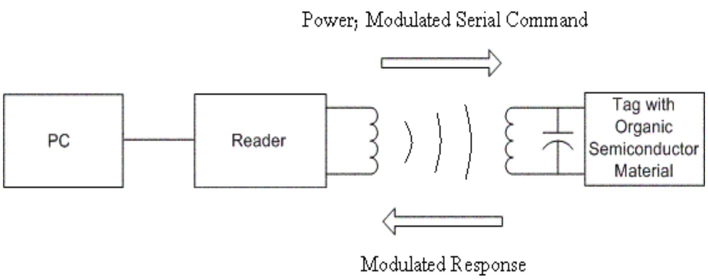


Fig 12: Operation of RFID



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An RFID system is specifically designed to be asymmetric – the reader is big, expensive and power hungry compared to the RFID tag. There are a number of different types of RFID system, but one basic categorization is based on the power source used by the tag

- Passive tag RFID systems require no power source at the tag – there is no battery. Instead, the tag uses the energy of the radio wave to power its operation, much like a crystal radio. This results in the lowest tag cost, but at the expense of performance.
- Semi-passive tag RFID systems rely on a battery built into the tag in order to achieve better performance (typically in terms of operating range). The battery powers the internal circuitry of the tag during communication, but is not used to generate radio waves.
- Active tag systems use batteries for their entire operation, and can therefore generate radio waves proactively, even in the absence of an RFID reader.

Passive tag RFID systems are the most common type, and are often referred to simply as 'RFID systems'.

Implementation

We all have waited in a queue for payment in shopping malls and other places, its very tiring and wastes a lot of time in the billing process. Today we will build a **RFID based customer billing system for supermarket shopping** that not only reduces the waiting time but also makes the process very smooth and easy.

Here we use **RFID cards and RFID readers with NodeMCU** to build the **Smart Shopping Cart** project. The cart information and total value will be displayed on the webpage as well as on LCD. Each RFID card is associated with a certain product and an RFID reader is installed in the cart, which reads the product details like Price and Product details and sends them to NodeMCU ESP8266. Then NodeMCU process the available items and total value in the cart and send them to ESP8266 Webserver, which can be monitored on a web browser from anywhere in the world.

I2C Protocol

What is I2C Bus?

Transmitting and receiving the information between two or more than two devices require a communication path called as a bus system. A I2C bus is a bidirectional two-wired serial bus which is used to transport the data between integrated circuits. The I2C stands for "Inter Integrated Circuit". It was first introduced by the Philips semiconductors in 1982. The I2C bus consists of three data transfer speeds such as standard, fast-mode and high-speed-mode. The I2C bus supports 7-bit and 10-bit address space device and its operation differ with low voltages.

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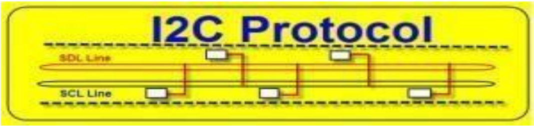

Fig 13:I2c Bus Protocol

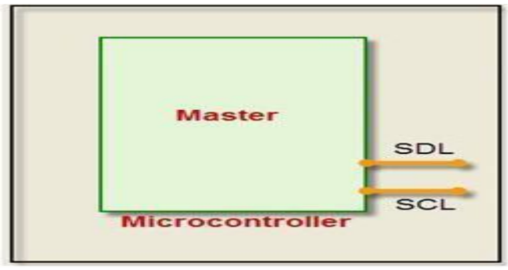

Fig 14: I2C Signal Lines

The I2C is a serial bus protocol consisting of two signal lines such as SCL and SDL lines which are used to communicate with the devices. The SCL stands for a 'serial clock line' and this signal is always driven by the 'master device'. The SDL stands for the 'serial data line', and this signal is driven by either the master or the I2C peripherals. Both these SCL and SDL lines are in open-drain state when there is no transfer between I2C peripherals.

Open-Drain Outputs

The open-drain is the concept for FET transistor wherein the drain terminal of the transistor is open state. The SDL and SCL pins of the master device are designed with the transistors in open state, so data transfer is possible only when these transistors are conducted. Hence, these lines or drain terminals are connected thorough pull-up resistors to VCC for conduction mode.

I2C Interfaces

Many slave devices are interfaced to the microcontroller with the help of the I2C bus through I2C level shifter IC for transferring the information between them. The I2C protocol used to connect a maximum of 128 devices that are all connected to communicate with the SCL and SDL lines of the master unit as well as the slave devices. It supports Multimaster communication, which means two masters are used to communicate the external devices.

I2C Data Transfer Rates

The I2C protocol operates three modes such as: fast mode, high-speed mode and standard mode wherein the standard mode data speed ranges 0Hz to 100Hz, and the fast mode data can transfer with 0Hz to 400 KHz speed and the high speed mode with 10 KHz to 100KHz. The 9-bit data is sent for each transfer wherein 8-bits are sent by the transmitter MSB to LSB, and the 9th bit is an acknowledgement bit sent by the receiver.

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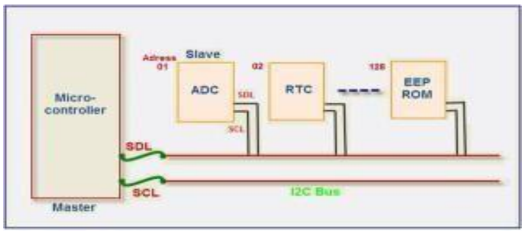

Fig 15: I2C Data Transfer Rates

I2C Communication

The I2C bus protocol is most commonly used in master and slave communication wherein the master is called "microcontroller", and the slave is called other devices such as ADC, EEPROM, DAC and similar devices in the embedded system. The number of slave devices is connected to the master device with the help of the I2C bus, wherein each slave consists of a unique address to communicate it. The following steps are used to communicate the master device to the slave:

Step1: First, the master device issues a start condition to inform all the slave devices so that they listen on the serial data line.

Step2: The master device sends the address of the target slave device which is compared with all the slave devices' addresses as connected to the SCL and SDL lines. If anyone address matches, that device is selected, and the remaining all devices are disconnected from the SCL and SDL lines.

Step3: The slave device with a matched address received from the master, responds with an acknowledgement to the master thereafter communication is established between both the master and slave devices on the data bus.

Step4: Both the master and slave receive and transmit the data depending on whether the communication is read or write.

Step5: Then, the master can transmit 8-bit of data to the receiver which replies with a 1-bit acknowledgement.

I2C Tutorial: Transmitting and receiving the information step by step serially with respect to the clock pulses is called I2C protocol. It is an inter-system and short-distance protocol, which means, it is used within the circuit board to communicate the master and slave devices.

I2C Protocol Basics: In general, the I2C bus system consists of two wires that are used easily to expand the input and output peripheral features such as ADC, EEROM and RTC, and other basic components to make a system whose complexity is very less.

Terminology Used in I2C Protocols

Transmitter: The device that sends data to the bus is called transmitter.

Receiver: The device that receives data from the bus is called a receiver.

Master: The device that initiates transfers to generate a clock signals and terminate a transfer is called a master.

Slave: The device addressed by a master is called a slave.

Multimaster: More than one master can attempt to control the bus at the same time without corrupting the message is called a Multimaster.

Arbitration: Procedure to ensure that, if more than one master simultaneously tries to control the bus – only one is allowed to do so; the winning message is not corrupted.

Synchronization: Procedure to synchronize the clock singles of two or more devices is called synchronization.

The basic I2C (Inter-Integrated Circuit) communication protocol involves the following sequence of commands:

1. **Start Bit Condition:**
   - The master device initiates communication by pulling the SDA (Serial Data Line) low while SCL (Serial Clock Line) remains high. This signifies the start of a communication sequence.
2. **Write Operation:**
   - The master device sends the address of the slave device it wants to communicate with, along with the read/write bit indicating whether it intends to write data to or read data from the slave.
   - If the slave acknowledges the address, the master proceeds to write data to the slave.
3. **Read Operation:**
   - If the master intends to read data from the slave, it sends a read command after the write operation.
   - The slave then responds by sending the requested data to the master.
4. **Acknowledgement Condition:**
   - After each byte of data sent (either by the master or the slave), the receiving device (master or slave) sends an acknowledge bit (ACK) to indicate successful receipt of the data.

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- If the receiving device cannot process or accept the data, it sends a NACK (Not Acknowledge) bit instead.
- The acknowledgment or non-acknowledgment is typically generated after each byte transfer, allowing for reliable data transmission.

5. **Stop Bit Condition:**
    - Once the communication sequence is complete, the master device generates a stop condition by releasing the SDA line from low to high while SCL remains high. This signifies the end of the communication sequence.

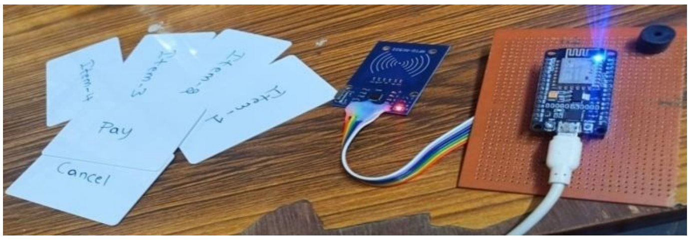

Fig 16: Hardware Implementation of Smart Trolley System

IV.CONCLUSIONS

The progress in science & technology is a non-stop process. New things and new technology are being invented. As the technology grows day by day, we can imagine about the future in which thing we may occupy every place. This paper is used in shopping complex for purchase the products. In this paper RFID card is used as security access for product. If the product is put in to the trolley means it will shows the amount and also the total amount. But in this project RFID card is used for accessing the products. So we shall look forward to a bright & sophisticated world.

V.FUTURE SCOPE

In the Future Enhancement, we can add the indoor navigation system which can locate the required product from the customer place of location. Here we have used a very low range RFID reader, which can be further enhanced with a high range reader when it comes for real enactment of this prototype. Although many new developments have been made in this area, supporting such application is still a major challenge.

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