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Smart Trolley Using RFID Reader

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Abstract: *This project presents an IoT based smart trolley system for supermarkets that aims to provides customers with an improved shopping experience. The system consists of a smart trolley equipped with sensors and microcontrollers that interact with a cloud- based server and a mobile application. This involves designing the hardware and software components of the smart trolley, including the IoT sensors, RFID reader, microcontroller, display screen, and user interface. The system will communicate with a cloud-based server that stores and processes data from the sensors and provides real- time analytics for store managers. The trolley can detect the items placed in it and display the total cost of the purchase on an LCD screen.*

The mobile application allows customers to view the list of items in their trolley, their prices, and the total cost, search for items, and navigate to their locations in the supermarket. The cloud-based server collects and analyzes data from the trolleys and generates insights for supermarket management, such as popular products, inventory levels, and customer footfall. The proposed system has the potential to enhance the shopping experience for customers and provide valuable insights into supermarket management.

Keywords: RFID Reader, RFID Tags, Ultrasonic Sensors, Display Unit (DWIN HMI LCD Screen), IoT Technology, Automated Billing

I. INTRODUCTION

Mall and market is a big corner for customer to purchasing the daily requirement like branded food items, snacks, cloth materials, electric and electronic devices etc. Nowadays, a maximum numbers of shopping mall are available large as well as small in the world. In holidays and weekend time we can see a huge rush at mall. The public was demand & spending more time in shopping mall. After purchasing a long time, the customers waste of unnecessary time at the billing counter for billing the purchased item. Continuously improvement was compulsion in the common billing system to increase the quality of shopping experience to the customers. To overcome these problems and to change and improve the existing system, we have designed a Smart Shopping Trolley. This can be done by simply attaching using RFID tags to the products and a RFID reader with a LCD display on the shopping trolley. In this system, customer will have to know the price of each and every item that is scanned in with help RFID and LCD, total price of the item will be displayed in LCD and also brief about the product. In this system will save time of customers and manpower required in mall. It is also used to reduce the employee work in the shopping mall.

II. LITERATURE SURVEY

[1] Patel et al.(2019),"IoT-Based Smart Shopping Trolley for Automated Billing":

o Proposed: A smart trolley using RFID tags and an Arduino microcontroller for automatic product identification and billing.

o Strengths: Reduces billing time and eliminates long queues.

o Limitations: No real-time communication with a central server; limited to local processing.

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o Relevance: Motivates us to include cloud-based data storage and synchronizations for improved system connectivity.

[2] Gupta & Sharma (2000), "RFID and Sensor-Based Smart Cart System":
o Proposed: A trolley equipped with RFID reader and load cell to identify products and verify weight.
o Strengths: Prevents billing errors and enhances accuracy.
o Limitations: Higher cost due to multiple sensors; no user interface for customer interaction.
o Relevance: Encourages integration of display screen and mobile app for better user experience.

[3] Kumar et al. (2021), "IoT Enables Smart Trolley Using ESP32":
o Proposed: A smart trolley using ESP32 microcontroller, RFID reader, and Wi-Fi module to connect to cloud server.
o Strengths: Enables real-time data transfer and remote monitoring.
o Limitations: Internet dependency; may face connectivity issues in large supermarkets.
o Relevance: Inspires inclusion of offline data caching and RF communication backup for reliability.

[4] Reddy & Nair (2022), "AI-Integrated Smart Shopping Cart for Retail Automation":
o Proposed: A trolley system combining RFID and computer vision to identify products automatically and suggest items based on shopping efficiency.
o Strengths: Provides personalized suggestions items based on shopping history.
o Limitations: Complex image processing requires high-end hardware, increasing system cost.
o Relevance: Inspires the idea of integrating AI and IoT to create an intelligent, customer-friendly trolley system.

PROBLEM DEFINITION:
Public shopping in supermarkets usually involves long queues at billing counters, which causes inconvenience to customers and wastes time. The conventional billing method requires manual scanning of every product by a cashier at the checkout counter. This process becomes slow and inefficient during busy hours in large supermarkets. Therefore, there is a need for an automated system that can make shopping faster and more convenient.

System to be simulated by the participants:
A Smart Trolley system using an RFID reader, RFID tags, microcontroller, ultrasonic sensor, and display unit. Each product will have an RFID tag containing unique information. When a customer places an item in the trolley, the RFID reader scans the tag and sends the data to the microcontroller. The microcontroller processes the information and displays the item name and price on the display screen.

Desired Outcome:
The smart trolley system will allow automatic product scanning and display the total bill in real time. This reduces waiting time at billing counters and improves the shopping experience. It also helps store management maintain records of purchased items and improve efficiency.

OBJECTIVE:
• Develop an automated billing system using RFID/barcode sensors for real-time price updates.
• Implement IoT-based connectivity for seamless synchronization with store servers and inventory databases.
• Ensure secure and quick payment processing through integrated digital payment gateways.
• Reduce manpower dependency at billing counters and improve overall operational efficiency.
• Increase customer satisfaction by providing a faster, easier, and more interactive shopping experiences.

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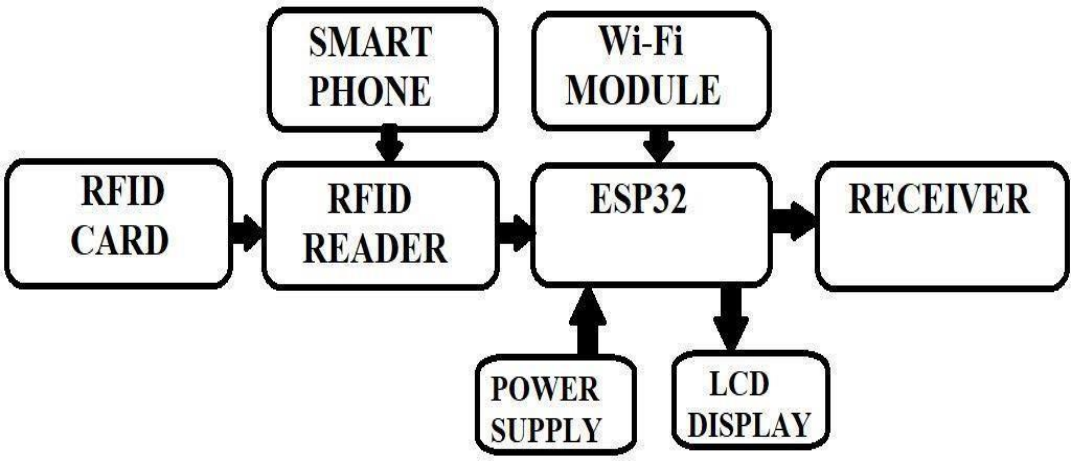
BLOCK DIAGRAM:



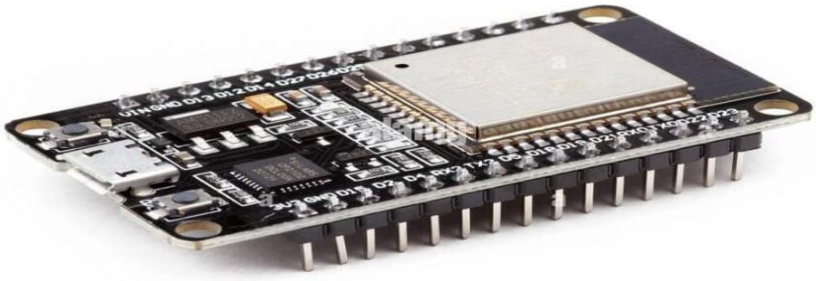
III. PROPOSED METHODOLOGY

The main purpose of this project is to reduce billing time, improve shopping convenience, and maintain accurate records of purchased items. For automatic identification of products, we will use RFID (Radio Frequency Identification) technology. The idea of the project is to use a microcontroller with an RFID reader that can scan RFID tags attached to each product. When a customer places an item in the trolley, the RFID reader detects the tag and sends the information to the controller. The product details and price are then displayed on the display screen, allowing customers to see the total bill while shopping.

1. SYSTEM COMPONENTS:

a) Microcontroller (ESP32):

ESP32 is a powerful microcontroller designed for Internet of Things (IoT) applications. It is developed by Espressif Systems and provides built-in Wi-Fi and Bluetooth connectivity, which allows it to communicate with other devices and access the internet. ESP32 offers multiple GPIO pins that can be used to connect sensors, RFID readers, displays, and other electronic components. It has high processing speed and low power consumption, making it suitable for smart and connected systems. Due to its compact size, reliability, and wide range of features, ESP32 is commonly used in IoT projects and automation systems. In this project, the ESP32 microcontroller will be used to control the RFID reader, process the product data, and display the information on the screen.



b) Ultrasonic Sensor:

An Ultrasonic Sensor is a commonly used electronic device that measures distance by using ultrasonic sound waves. It is widely used in obstacle detection, distance measurement, and automation systems. The ultrasonic sensor works by

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transmitting high-frequency sound waves and receiving the reflected waves from nearby objects. By calculating the time taken for the echo to return, the sensor determines the distance between the sensor and the object. Ultrasonic sensors are useful because they provide accurate and contactless distance measurement. When an object is detected within a certain range, the sensor sends a signal to the microcontroller. In smart systems like a smart trolley, the ultrasonic sensor can be used to detect the presence of items placed inside the trolley.

c) RFID Reader:

An RFID Reader is a widely used electronic device that reads data stored in RFID tags using radio frequency signals. It is commonly used in access control systems, inventory management, tracking systems, and automated identification applications. An RFID reader works by transmitting radio waves to detect and communicate with nearby RFID tags. These tags contain a small microchip and antenna that store unique identification information.

RFID readers do not require direct contact or line-of-sight to read the tags, which makes them very efficient and fast in operation. When a tag comes within the range of the reader, it sends the stored information to the reader, which then converts it into an electrical signal and sends it to a microcontroller or computer system. This makes RFID readers important components in systems where automatic identification and data collection are required.

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d) RFID Tags:

An RFID Tag is a small electronic device used for storing and transmitting data through radio frequency signals. It is commonly used in identification systems, inventory tracking, asset management, and automated applications. An RFID tag consists of a microchip and an antenna that stores a unique identification number and communicates with an RFID reader.

RFID tags do not require direct contact or line-of-sight to be detected, which makes them efficient for automatic identification systems. When an RFID tag comes within the range of an RFID reader, it transmits the stored information to the reader through radio waves. This allows the system to quickly identify and track objects. RFID tags are widely used in applications where fast and reliable identification of items is required.

e) Display Unit (DWIN HMI LCD Screen):

An LCD (Liquid Crystal Display) is a widely used electronic display device that is used to show information in the form of text or numbers. It is commonly used in digital clocks, calculators, measuring instruments, and embedded systems. LCD displays work by using liquid crystals that control the passage of light to form characters and symbols on the screen.

LCD displays are popular because they consume very low power and provide clear visibility. They can be easily connected to microcontrollers to display real-time data and system information. When the system processes data, the microcontroller sends signals to the LCD display to show the required output. This makes LCD displays important components in electronic projects where displaying information to the user is necessary.

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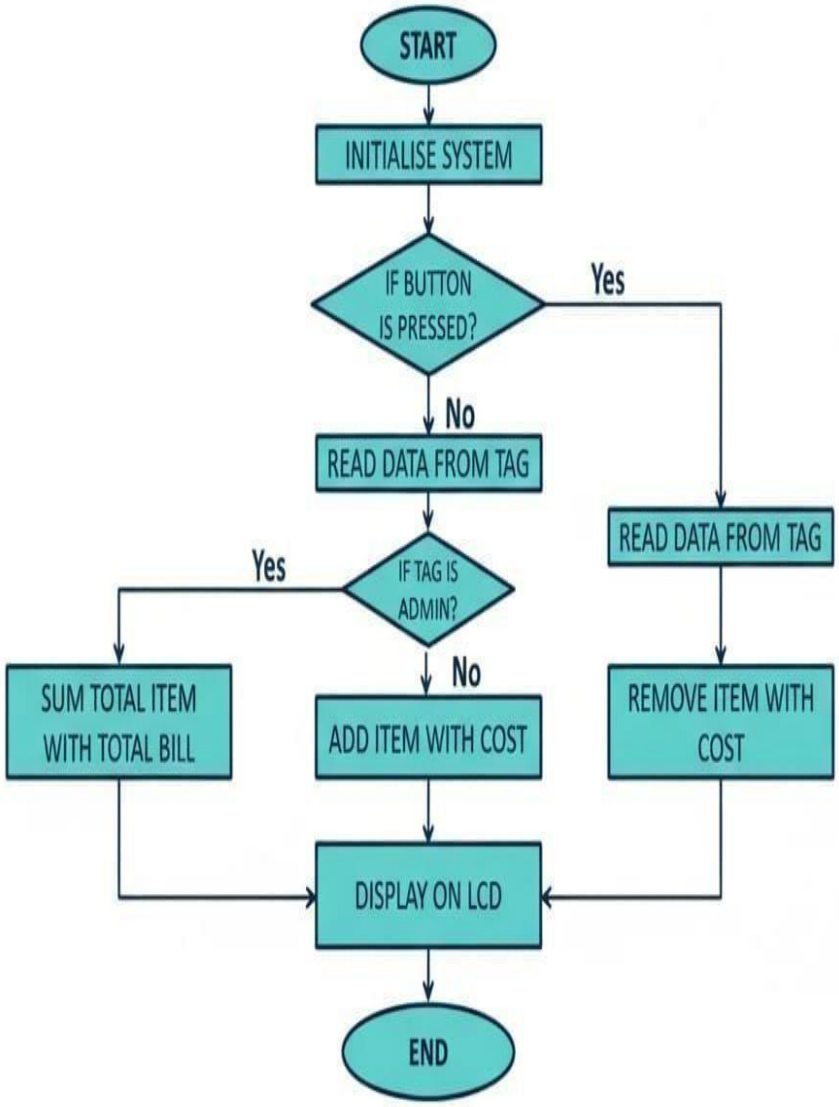
IV. DESIGN AND DEVELOPMENT



BENIFITS:

- Reduces waiting time at billing counters.
- Provides automatic billing of products.
- Improves shopping convenience for customers.
- Saves time and manpower.
- Displays total cost in real time on the LCD screen.
- Reduces billing errors.
- Helps in better inventory management.
- Enhances overall supermarket efficiency.

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ADVANTAGES

1. Reduces waiting time at billing counters.
2. Provides automatic and faster billing.
3. Displays total cost in real time.
4. Improves customer shopping experience.
5. Reduces manual work and billing errors.

DISADVANTAGES

1. High initial installation cost.
2. Requires regular maintenance of electronic components.
3. RFID tags and readers may sometimes cause reading errors.
4. System depends on power supply and internet connection.
5. Technical issues may affect the billing process.

V. CONCLUSION

Our smart trolley system, powered by RFID technology and IoT, offers an efficient and intelligent solution for improving the shopping experience in supermarkets. By integrating an ESP32 microcontroller, RFID reader, RFID tags, ultrasonic sensor, and LCD display, we have created a system that automatically detects products placed in the trolley and displays their price in real time. This system reduces waiting time at billing counters, minimizes manual work, and provides a faster and more convenient shopping experience for customers while improving store management efficiency.

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