

Autonomous Smart shopping Trolley

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ABSTRACT

The Autonomous Smart Shopping Trolley is an intelligent retail automation system designed to improve customer convenience and reduce billing time in supermarkets and shopping malls. The system uses technologies such as RFID, IoT, sensors, embedded systems, and wireless communication to automate product detection, billing, and trolley navigation. It consists of Arduino Uno, RFID reader, ultrasonic sensors, IR sensors, LCD display, Bluetooth/Wi-Fi module, L298 motor driver, DC motors, rechargeable battery, and buzzer for efficient operation. When a product with an RFID tag is placed inside the trolley, the RFID reader automatically scans the item and updates the bill on the LCD display in real time. The ultrasonic and IR sensors help the trolley detect obstacles and follow the customer safely through autonomous navigation. Wireless communication modules allow billing data transfer to mobile applications or billing servers for real-time monitoring and checkout. The system reduces human effort, minimizes billing queues, improves shopping efficiency, and provides a smart retail solution. Future enhancements may include AI-based object recognition, mobile app integration, cloud-

based inventory management, and online payment systems.

1. INTRODUCTION

The rapid advancement of technology and increasing demand for automation have transformed the retail industry toward smart and intelligent shopping systems. Traditional shopping methods involve manual billing, long waiting queues, and increased human effort, which reduce shopping efficiency and customer convenience. To overcome these limitations, the Autonomous Smart Shopping Trolley has been developed using RFID technology, embedded systems, IoT, sensors, and wireless communication. The trolley automatically scans products placed inside it using RFID readers and updates the billing information instantly on the LCD display. Arduino Uno acts as the central controller and manages all system operations including product detection, obstacle detection, motor control, and wireless communication. Ultrasonic and IR sensors help the trolley navigate autonomously and avoid obstacles while following the customer. Bluetooth or Wi-Fi modules provide real-time data transfer to billing servers or mobile applications.

The system reduces billing time, minimizes manual errors, improves customer experience, and supports smart retail automation for future

1. PROBLEM STATEMENT

In modern supermarkets and shopping malls, customers spend a significant amount of time waiting in long billing queues during peak hours. Existing manual checkout systems require high manpower, are time-consuming, and are prone to billing and inventory management errors. Although barcode systems and self-checkout counters are available, they still require customer effort and do not completely eliminate delays or inefficiencies. Traditional shopping trolleys also lack autonomous movement and intelligent billing features. Therefore, there is a need to develop an Autonomous Smart Shopping Trolley that can automatically detect products, generate bills in real time, assist customers through autonomous navigation, and reduce manual effort while improving overall shopping efficiency and customer convenience.

2. OBJECTIVES

The main objective of the Autonomous Smart Shopping Trolley project is to develop an intelligent shopping assistance system that automates product detection, billing, and trolley movement using RFID technology and embedded systems. The project aims to reduce customer waiting time at checkout counters and improve shopping convenience through real-time billing updates and autonomous navigation. Another objective is to integrate hardware components such as Arduino Uno, RFID readers, ultrasonic sensors, IR sensors, motor drivers, Bluetooth/Wi-Fi modules, LCD display, rechargeable battery,

and DC motors into a compact and efficient trolley system. The system also aims to reduce manual billing errors, minimize human effort, improve shopping efficiency, and provide a low-cost smart retail solution suitable for supermarkets and shopping malls.

1. The main objectives of the proposed system are:

- To implement RFID-based automatic product detection and billing system.
- To reduce customer waiting time at billing counters through real-time bill generation.
- To develop autonomous trolley navigation using ultrasonic and IR sensors.
- To integrate Arduino Uno, RFID reader, LCD display, motor driver, Bluetooth/Wi-Fi module, and DC motors into a compact smart trolley system.
- To provide real-time product and billing information using LCD display.

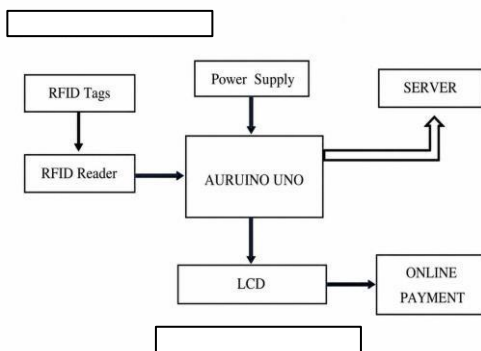
3. METHODOLOGY

The methodology of the Autonomous Smart Shopping Trolley involves integrating RFID technology, embedded systems, sensors, and wireless communication modules to automate shopping operations. Arduino Uno acts as the central controller and receives data from RFID readers, ultrasonic sensors, and IR sensors. When a product with an RFID tag is placed inside the trolley, the RFID reader scans the product and sends its information to the Arduino, which processes the data and updates the total bill on the LCD display in real time.

Ultrasonic and IR sensors are used for obstacle detection and autonomous navigation, allowing

the trolley to follow customers safely. The L298 motor driver controls the DC motors for trolley movement based on sensor inputs. Bluetooth or Wi-Fi modules are used for transmitting billing information to mobile devices or central billing servers for real-time monitoring and checkout processing. Rechargeable batteries provide power to the entire system, while buzzers and LEDs provide alert indications for successful scanning, obstacles, invalid products, and low battery.

4. BLOCK DIAGRAM



5. WORKING OF THE PROPOSED SYSTEM

The Autonomous Smart Shopping Trolley works using RFID technology, embedded systems, sensors, and wireless communication modules to automate shopping and billing operations. Initially, when the system is powered ON, all components such as Arduino Uno, RFID reader, ultrasonic sensors, IR sensors, LCD display, motor driver, Bluetooth/Wi-Fi module, buzzer, and DC motors are initialized. The RFID reader continuously scans for RFID tags attached to products. When a customer places an item inside the trolley, the RFID reader detects the tag and sends the product information to the

Arduino Uno. The Arduino processes the received data, verifies the product details, and automatically updates the item name, quantity,

and total bill on the LCD display in real time. If an invalid product or error is detected, the buzzer gives an alert indication. The ultrasonic and IR sensors continuously monitor the surroundings for obstacle detection and customer tracking. Based on sensor inputs, the Arduino controls the DC motors through the L298 motor driver to ensure smooth autonomous navigation, obstacle avoidance, forward movement, stopping, and turning operations. The Bluetooth or Wi-Fi communication module transfers billing data to a mobile application or central billing server for real-time monitoring and checkout processing. The rechargeable battery supplies power to all electronic and mechanical components, ensuring stable and continuous system operation. Thus, the proposed system reduces manual effort, minimizes billing queues, improves shopping efficiency, and provides a smart and automated retail shopping ESP32 connection

Working

1. System Initialization
2. RFID-Based Product Detection
3. Automatic Billing and Display
4. Autonomous Navigation and Obstacle Detection
5. Wireless Communication and Data Transfer

6. HARDWARE IMPLEMENTATION

The performance and reliability of the project largely depend on the correct

selection and integration of hardware components. Each element in the system plays an important role in achieving accurate

microplastic detection and stable operation.

Hardware components required for the proposed system:

- Arduino Uno
- RFID Reader and RFID Tags
- Ultrasonic Sensors and IR Sensors
- L298 Motor Driver
- BO Motors and Wheels
- LCD Display with I2C Module
- Bluetooth Module HC-05 / Wi-Fi Module
- Rechargeable Battery and Power Supply
- Buzzer and LED Indicators
- Connecting Wires and Supporting Components

7. SOFTWARE IMPLEMENTATION

The software implementation of the Autonomous Smart Shopping Trolley is carried out using Arduino IDE with Embedded C/C++ programming language. Arduino Uno acts as the main control unit and controls all system operations such as RFID scanning, automatic billing, sensor monitoring, motor control, and wireless communication. The program continuously reads inputs from RFID readers, ultrasonic sensors, and IR sensors. When a product is placed inside the trolley, the RFID reader detects the RFID tag and sends the product information to the Arduino Uno. The software processes the data, verifies the product details, and updates the total bill on the LCD display in real time. The program also controls the L298 motor driver and DC motors for autonomous movement and obstacle avoidance. Bluetooth or Wi-Fi modules are programmed to transfer billing information to mobile applications or billing servers for real-time monitoring. The software also manages buzzer alerts, display updates, and battery

monitoring to ensure smooth, reliable, and efficient operation of the smart shopping trolley system.

8. RESULTS AND DISCUSSION

The Autonomous Smart Shopping Trolley was successfully designed, implemented, and tested for automatic product detection, billing, wireless communication, and autonomous movement. The RFID reader accurately detected products and updated the item details and total bill on the LCD display in real time. The ultrasonic and IR sensors effectively detected obstacles and enabled smooth trolley navigation without collisions. Bluetooth and Wi-Fi modules successfully transferred billing data to mobile applications and billing servers for real-time monitoring and checkout operations. The system reduced billing time, minimized manual effort, improved shopping convenience, and provided efficient shopping assistance. The prototype demonstrated reliable performance, stable communication, accurate billing, and efficient power management, making it suitable for smart retail and automated supermarket applications.

The prototype successfully demonstrated the following features:

- Automatic RFID-based product detection
- Real-time billing and LCD display update
- Autonomous trolley movement and navigation
- Obstacle detection and avoidance using sensors
- Wireless communication through Bluetooth/Wi-Fi

- Reduced billing time and manual effort
- Accurate item tracking and billing system
- Efficient motor control and smooth trolley movement
- Audio alerts using buzzer indications
- Reliable and stable system performance

9. APPLICATIONS

- Smart Supermarkets and Shopping Malls
- Automatic Billing Systems
- Retail Inventory Management
- Cashier-less Checkout Systems
- IoT-Based Smart Retail Applications
- Autonomous Robotic Trolley Systems
- Customer Assistance and Navigation Systems
- Smart City Retail Automation
- Elderly and Disabled Customer Assistance

10. FUTURE SCOPE

- Integration of AI-Based Object Recognition System
- Mobile Application for Live Billing and Navigation
- Cloud-Based Inventory Management System
- Online and Cashless Payment Integration
- Advanced Autonomous Navigation Using AI and Machine Learning
- Voice Command and Customer Assistance Features

- GPS/Indoor Navigation for Product Location Guidance

- Improved Battery Backup and Power Management

- IoT-Based Smart Retail Monitoring System

- Fully Automated Smart Shopping and Checkout System

11. CONCLUSION

The Autonomous Smart Shopping Trolley successfully demonstrates the integration of RFID technology, embedded systems, IoT, sensors, and wireless communication for smart retail automation. The system automates product detection, billing, obstacle detection, and trolley navigation, thereby reducing customer waiting time and minimizing manual effort in supermarkets and shopping malls. The integration of Arduino Uno, RFID reader, ultrasonic sensors, IR sensors, LCD display, motor driver, Bluetooth/Wi-Fi module, and rechargeable battery ensures reliable and efficient system performance. The proposed system improves shopping convenience, provides real-time billing updates, and enhances overall shopping efficiency. Thus, the project offers a low-cost, user-friendly, and effective solution for future smart retail and automated shopping applications.

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