WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Hands-Free Smart Shopping Trolley with Human Following Technology: A Review

Gitanjali Jadhav[1], Pooja Nikam[2], Aditi Gharge[3], Prof, Prashant Yadav[4]

[1]Student, Electronics and Telecommunication Engineering, AITRC, Vita, India
[2]Student, Electronics and Telecommunication Engineering, AITRC, Vita, India
[3]Student, Electronics and Telecommunication Engineering, AITRC, Vita, India
[4]Professor, Electronics and Telecommunication Engineering, AITRC, Vita, India

ABSTRACT:

Every supermarket provides shopping baskets to help customers to select and store the products. Develop an innovative human-following smart shopping trolley using Arduino technology, designed to enhance the shopping experience for customers. The trolley will autonomously follow shoppers, providing hands-free assistance while they navigate the store. Key features of the trolley include ultrasonic sensors for accurate navigation and obstacle detection, enabling it to move smoothly through crowded aisles without colliding with obstacles. The system will incorporate a Bluetooth module that allows communication with a dedicated mobile app, enabling users to manage their shopping lists, receive notifications, and issue voice commands for greater control. The integration of real-time data analytics allows for personalized recommendations and seamless checkout via mobile apps or contactless payment methods. Using RFID tags on products, the trolley automatically detects and updates the shopping cart with product details and pricing as items are placed in the trolley. Ultrasonic sensors and LiDAR technology guide the trolley's movement, allowing it to avoid obstacles and maintain a safe distance from the customer. By automating the shopping process, this project not only improves convenience and efficiency for customers but also provides retailers with valuable insights into consumer behavior, helping optimize inventory and store operations.

KEYWORDS: Smart Trolley, RFID Scanner, Human Follower, Arduino Uno, Shopping Malls.

1. INTRODUCTION

The Smart Shopping Trolley Robot is an innovative solution that aims to make shopping easier and more enjoyable by allowing a trolley to follow customers automatically as they move around the store. Shoppers won't need to push or pull a heavy trolley anymore. The trolley will have sensors and tracking technology to stay with the customer, avoiding obstacles and carrying their items without any effort from the shopper. This project aims to improve the way we shop, making it hands-free and more comfortable for everyone. The robot operates using a combination of sensors, cameras to identify and follow a specific customer. Makes Shopping Easier: Carrying or pushing a heavy trolley can be tiring, especially during big shopping trips. A trolley that follows the customer reduces this effort, letting people shop without worrying about their trolley. Saves Time and Energy: Since the trolley follows automatically, shoppers can move more quickly and easily through the store, making the shopping process faster and more efficient. The trolley uses a combination of sensors, including LiDAR and ultrasonic, to navigate through crowded aisles while avoiding obstacles. Customers can seamlessly checkout using mobile apps or contactless payments, enhancing convenience and reducing wait times. This system not only offers an enhanced shopping experience but also provides valuable data for retailers to optimize store operations and customer engagement. By reading RFID tags on products, the trolley updates the shopping list automatically, tracks prices, and ensures accurate billing. The system's AI-powered navigation helps it move efficiently, avoiding obstacles and adapting to the customer's pace. This technology not only enhances convenience for shoppers but also streamlines inventory management and improves in-store operations for retailers.

2. LITERATURE REVIEW

The literature review highlights advancements in retail automation, focusing on RFID, IoT, and computer vision for seamless billing and navigation, along with user tracking for personalization. Privacy and data security remain critical considerations in implementing these technologies.

1. **Quoc Khanh Dang , Young Soo Suh [2012]:** "Human-following robot using infrared camera" The use of an infrared camera in human-following robots enhances detection accuracy and tracking capabilities, especially in low-light conditions. A human-following robot using an infrared camera leverages thermal imaging to detect and track individuals based on their body heat. The robot's key components include

an infrared camera to identify heat signatures, a microcontroller for processing, motors for mobility, and a control algorithm for smooth tracking.

2. **W. W. Tai, B. Ilias, S.A. Abdul Shukor, N. Abdul Rahim and MA Markom [2019]:** A Study of Ultrasonic Sensor Capability in Human Following Robot System The study finds ultrasonic sensors effective for distance measurement and obstacle avoidance in human-following robots, but notes their sensitivity to environmental factors.

3. **Mr Kumar and Mr Gupta,12 December [2013]:** A "Smart Trolley using Arduino", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET). The Smart Trolley using Arduino effectively combines automation and user-friendly features, enhancing the shopping experience through real-time navigation and item tracking.

4. **D.J.S.P.S. Dhavale Shraddha D [2016]**: IOT Based Intelligent Trolley for Shopping Mall An IoT-based intelligent trolley in shopping malls enables real-time item tracking, automated billing, and personalized shopping experiences, enhancing efficiency and customer convenience.

5. **S. M. Kalyani Dawkharet al[2022]:** proposed Using Radio Frequency Identification (RFID) technology, an electronic shopping cart. This cart has a feature to keep track of the contents, like. Viewing the product name, expiration date, and price, they have employed a Liquid Crystal Display (LCD) screen to display the products. The trolley only performs the aforementioned tasks, which is a downside of the system. Since the trolley is electronic, the automatic travelling facility is not covered.

6. **Hanooja T, Raji C.G and Sreelekha M in the year of [2020]**: "Human Friendly Smart Trolley With Automatic Billing System" A Human-Friendly Smart Trolley with Automatic Billing System is an innovative solution designed to enhance the shopping experience by integrating technology into traditional shopping carts. Equipped with sensors, a barcode or RFID scanner, and a display screen, the smart trolley automatically scans items as they are placed into the cart. It calculates the total cost in real-time, eliminating the need for manual billing at checkout counters. Additionally, features like navigation assistance and integration with digital payment systems make it user-friendly.

7. **Mr.P. Chandrasekar and Ms. T. Sangeetha in the year of [2014]:** "Smart Shopping Cart with Automatic Billing System through RFID and ZigBee" A Smart Shopping Cart with Automatic Billing System using RFID and ZigBee is a cutting-edge technology aimed at revolutionizing the retail experience. The cart is equipped with RFID readers to automatically identify and record items as they are placed in or removed from the cart, ensuring accurate real-time billing.

8. **S. K. Shankar, S. Balasubramani, S. A. Basha, S. Ariz Ahamed, and N. S. Kumar Reddy [2021]:** "Smart Trolley for Smart Shopping with an Advance Billing System using IoT," A Smart Trolley for Smart Shopping with an Advanced Billing System using IoT streamlines the shopping experience by automatically detecting items through IoT-enabled sensors and updating the bill in real-time

3. System Architecture

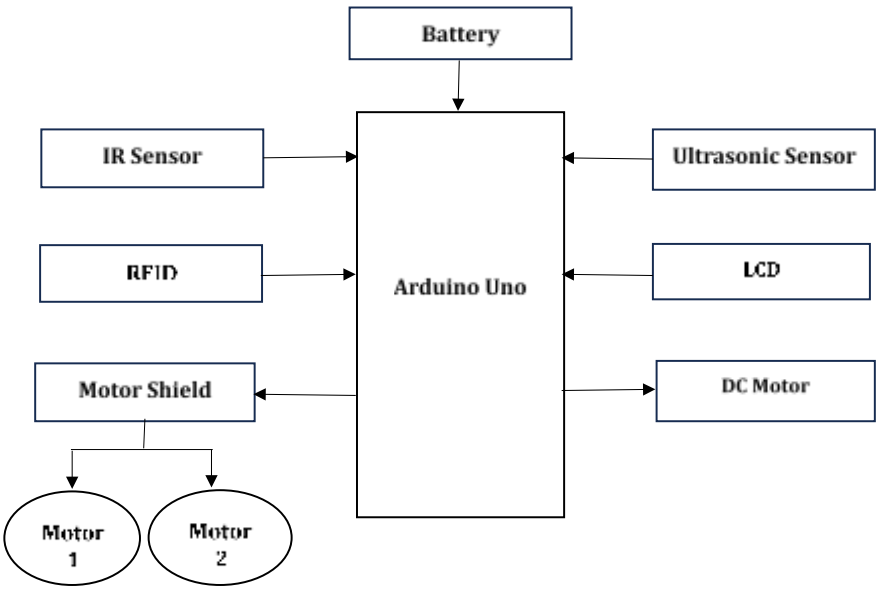

Figure 1. System Architecture

The block diagram for the Smart Shopping Trolley Robot includes tracking system, sensors, microcontroller, motorized wheels, battery, and user interface, all working together to enable the trolley to follow the customer, avoid obstacles, and provide user control.

4. SYSTEM MODULES

Real-Time Location Tracking: Using technologies like RFID tags, Bluetooth beacons, GPS, or indoor positioning systems, this module tracks the user's location within the store. It helps the trolley to follow the user autonomously or guide them to specific aisles or items.

Automated Item Detection and Billing: This module uses RFID, barcode scanners, or computer vision to automatically detect items placed in or removed from the trolley. The system updates the virtual bill in real time, eliminating the need for manual scanning at checkout.

Navigation and Guidance System: Equipped with sensors and GPS, the trolley can autonomously navigate the store, assisting customers in finding items. Integration with a mobile app or store database ensures personalized recommendations and optimized routes for efficient shopping.

Payment and Checkout Integration: A secure payment gateway allows customers to complete their transactions directly from the trolley. This may include features like contactless payment, mobile wallet integration, or direct bank transfers, reducing waiting times at checkout counters.

User Interface and Connectivity: A touch-enabled screen or mobile app interface provides a seamless interaction point for customers to view their cart, search for items, or apply discounts. Connectivity options like Wi-Fi or Bluetooth enable synchronization with store management systems for real-time inventory updates.

5. METHODOLOGY:

i. Identify Requirements and Plan:

First, outline the trolley's key features like customer following, obstacle avoidance, and ease of use. Understand the specific needs of users, including accessibility for elderly or disabled customers.

ii. **Design System Components:** Create a system plan covering hardware and software:

Hardware: Choose sensors (e.g., ultrasonic for obstacle detection), tracking method (Bluetooth or camera), and motors for trolley movement.

iii. **Software:** Plan the algorithms for customer following, obstacle avoidance, and smooth movement.

- Attach sensors, wheels, battery, and microcontroller
- Ensure all parts are securely integrated and connected to work together.

iv. **Develop and Test Software**: Write code to control the trolley's behavior, and test each feature:

- Test individual parts (e.g., sensors, motors) and how they work together.
- Check if the trolley accurately follows and stops for obstacles in various conditions.

v. **Optimize and Refine:** Improve based on test results, adjusting tracking and obstacle detection as needed. Conduct final tests in a real or simulated store to confirm the trolley's usability and performance

6. PROPOSED SYSTEM

The **Hands-Free Smart Shopping Trolley** introduces an advanced solution to enhance convenience and accessibility in retail environments by autonomously following customers during their shopping journey, thereby eliminating the need for manual pushing. This innovative system employs state-of-the-art technologies such as sensors, cameras, and microcontrollers to deliver a seamless and hands-free shopping experience.

The trolley uses a combination of ultrasonic or infrared sensors and cameras to detect and track the movement of the assigned customer. It is equipped with robust navigation algorithms that enable smooth maneuvering through crowded spaces, ensuring efficient obstacle avoidance for objects such as shelves, other trolleys, and shoppers. A dedicated pairing mechanism, utilizing technologies like Bluetooth or RFID, ensures precise user recognition, allowing the trolley to follow the correct individual without interference.

Powered by a rechargeable battery, the trolley is designed for optimal performance throughout a typical shopping session. Its user-friendly interface simplifies activation and operation, while the design prioritizes accessibility, making it especially beneficial for elderly individuals and those with physical challenges.

This proposed system not only revolutionizes the shopping experience by reducing physical effort but also addresses challenges like store congestion and navigation efficiency. By integrating advanced automation into retail settings, the **Hands-Free Smart Shopping Trolley** sets a new standard for convenience, functionality, and innovation, paving the way for a transformative shopping experience in modern retail spaces.

7. WORKING

7.1 Overview

The **hands-free smart shopping trolley** follows a customer autonomously within a store, using technologies like **autonomous navigation**, **RFID**, **sensor networks**, and **cloud computing**. The trolley follows the customer by using smart algorithms and sensors that help it track their movements. The system tracks the items in the cart, calculates the total cost, and facilitates automated payments. The customer is free to focus on their shopping without worrying about pushing the trolley.

7.2. Key Components

To make the system work effectively, several key components are required:

- **Smart Shopping Trolley**: The trolley has integrated sensors, motors, and communication modules to follow the customer autonomously.
- **RFID Reader & Tags**: RFID readers are mounted on the trolley to detect and track RFID tags placed on the products in the store. RFID tags are embedded on items and contain product data like price, name, and category.
- **Ultrasonic Sensors / LiDAR**: These sensors are used to help the trolley navigate and avoid obstacles. They can also be used to detect the customer's position relative to the trolley.
- **GPS & Beacon System**: Inside large stores or malls, GPS or indoor beacon systems can be used to pinpoint the customer's location and help the trolley follow them accurately.
- **Mobile App/Cloud System**: The customer uses an app or interacts with a cloud system that connects to the trolley to manage items in the cart, access promotions, and make payments.
- **Motorized Wheels**: These wheels allow the trolley to move autonomously and follow the customer at a safe distance.
- **Weight Sensors**: Located in the trolley, these sensors monitor the weight of items placed inside, helping to verify the products being added to the cart.
- **Touchscreen/Display**: A display mounted on the trolley provides the customer with information about the cart's contents, price, or any promotional offers available.

7.3. Working Process

The **hands-free shopping trolley** that follows a customer works through several key stages:

Step 1: Initial Setup and Detection

- **Customer Identification**: The system uses **Bluetooth Low Energy (BLE)** or **RFID tags** on the customer to recognize their presence and establish communication. Upon entering the store, the trolley detects the shopper via the **store's beacon system** or by pairing with the customer's app. The system ensures that only authorized customers can use the trolley.
- **Trolley Activation**: Once the customer is identified, the trolley is activated and begins to follow them autonomously.

Step 2: Following the Customer

- **Navigation and Pathfinding**: Using a combination of **Ultrasonic Sensors**, **LiDAR**, and sometimes **GPS or indoor positioning systems**, the trolley tracks the customer's movements. These sensors allow the trolley to avoid obstacles (e.g., other shoppers, shelves) and move towards the customer.
    - **Ultrasonic Sensors**: These help measure the distance between the trolley and nearby objects, ensuring it avoids collisions.
    - **LiDAR**: Provides a more precise 360-degree view of the surroundings, helping the trolley navigate through more complex areas.
    - **Customer Tracking**: The trolley continuously monitors the customer's location and moves to follow them at a predefined safe distance.

Step 3: Product Selection and Tracking

- **RFID-based Item Detection**: As the customer picks up items from the shelves, each product has an **RFID tag**. The trolley's **RFID reader** automatically detects the product by reading its tag and adds the product to the cart in the system.
- **Weight Sensors**: The trolley also has weight sensors to ensure that the correct items are in the cart. This prevents errors, like an item being scanned but not physically placed in the trolley.

- **Real-Time Cart Updates**: The RFID system continuously updates the list of products on the trolley's screen or the customer's app, displaying the total price and other product details.

Step 4: Intelligent Navigation

- **Autonomous Movement**: The trolley's motorized wheels allow it to move autonomously. It adjusts its speed and direction based on the customer's movements, staying close but not too close, and maintaining a safe distance.
- **Obstacle Avoidance**: If the trolley encounters an obstacle (e.g., another shopper), it will stop and navigate around it. The trolley uses **algorithms** to ensure smooth navigation even in crowded environments.
- **Customizable Following Distance**: The customer can set the preferred following distance or speed via the app or the display on the trolley. The system adjusts based on the customer's pace.

Step 5: Checkout and Payment

- **Real-Time Price Calculation**: The system continuously tracks the items in the cart, updating the total price in real-time as items are added or removed.
- **Autonomous Checkout**: When the customer is finished shopping, they can proceed to an automatic checkout zone or use the **mobile app** to check out directly.
- **Payment Processing**: The system supports **contactless payments**, such as **mobile wallets** (e.g., Apple Pay, Google Pay) or **QR code scanning**. The customer can simply pay through the app or a dedicated terminal associated with the trolley.
- **Instant Receipt Generation**: After payment, the customer receives a receipt on their mobile app or via email, and they can exit the store.

Step 6: Exit Verification

• **Exit Gate with RFID**: Before exiting, the customer may pass through an **exit gate** where RFID readers perform a final check to ensure that all items in the trolley have been paid for. If an item hasn't been registered, the system will alert the store staff.

7.4. Technologies Involved

The **hands-free smart shopping trolley system** utilizes various advanced technologies:

- **RFID**: For product tracking and updating the shopping cart automatically.
- **Ultrasonic Sensors and LiDAR**: For obstacle detection and navigation.
- **GPS / Indoor Positioning Systems**: For tracking the location of the trolley and the customer within the store.
- **Bluetooth / BLE**: To identify and connect with the customer's mobile app for personalization.
- **Cloud Computing**: For managing inventory, processing payments, and analyzing customer data.
- **Autonomous Navigation Algorithms**: For guiding the trolley to follow the customer safely and efficiently.

8. EXPECTED RESULTS

Autonomous Following: The trolley will successfully follow the shopper at a safe and adjustable distance without requiring manual intervention. The system will track and adapt to the shopper's speed and direction in real time.

Obstacle Detection and Avoidance: The trolley will detect obstacles such as other shoppers, shelves, or objects and navigate around them smoothly without collisions.

Hands-Free Convenience: Shoppers will experience reduced physical strain, as they won't need to push or pull the trolley during their shopping trip.

Real-Time Responsiveness: The trolley will respond quickly to changes in the shopper's movements and environmental conditions, ensuring seamless navigation even in busy or crowded stores.

Enhanced User Experience: The trolley will offer personalized assistance, such as locating products or suggesting promotions.

9. CONCLUSION

In conclusion, the Smart Shopping Trolley Robot addresses key challenges in the shopping process and offers a future-forward approach to improving both the customer experience and retail operations. The Smart Shopping Trolley Robot is an innovative solution aimed at transforming the traditional shopping experience by providing customers with a hands-free, convenient, and accessible way to shop. Additionally, the integration of sensors and AI

enables the trolley to avoid obstacles and adapt to store layouts, making it a versatile tool for various retail environments. As this technology continues to evolve, it has the potential to reshape the shopping landscape, improving customer satisfaction and streamlining operations for retailers. Ultimately, the smart shopping trolley robot not only enhances the shopping experience but also paves the way for a more automated and intelligent retail future.

10. REFERENCES

1. Thangakumar J, Sainath S, Surender K, Vikram Arvind V, "Automated Shopping Trolley for Super Market Billing System." International Conference on Communication, Computer and Information Technology, 2014.
2. Shankar,S. K., Balasubramani, S., Basha, S. A., Ariz Ahamed S., Kumar Reddy, N. S. 2021. Smart Trolley for Smart Shopping with an Advance Billing System using IoT, 5th International Conference on Computing Methodologies and Communication (ICCMC), pp. 390-394
3. Mr Kumar and Mr Gupta. A "Smart Trolley using Arduino", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET),12 December 2013.
4. ManikandanThiyagarajan, M.A Mohammed Aejaz, N.M Nithin Krishna, A.P Mohan Kumar and R. Manigandan, "RFID based Advanced Shopping Trolley for Super Market", Journal of Chemical and Pharmaceutical Sciences, Special Issue 8, pp 225-230, 2017.
5. D.J.S.P.S. Dhavale ShraddhaD.," IOT Based Intelligent Trolley for Shopping Mall,"(online)available https//www.ijedr.org/papers/IJEDR1602225.pdf, International Journal of Engineering Development and Research,vol. 4,no. 2,pp. 1283- 1285, 2016. penetrated July- 2016)
6. Mr P. Chandrasekar and Ms T. Sangeetha "Smart shopping cart with automatic billing system through RFID and transmitter and receiver", IEEE, 2014
7. Leena Thomas, Renu Mary George "Smart Trolley with Advanced Billing System" International Journal of Advanced Research in Electrical, 3, March 2017.
8. Vishwanadha V, Pavan Kumar P and Chiranjeevi Reddy S, "Smart Shopping Cart", International Conference on Circuits and Systems in Digital Enterprise Technology, 2018.
9. Thangakumar J, Sainath S, Surender K, Vikram Arvind V, "Automated Shopping Trolley for Super Market Billing System." International Conference on Communication, Computer and Information Technology, 2014.
10. Galande Jayashree, Rutuja Gholap, Priti Yadav on "RFID based Automatic billing trolley" IJETAE, 2015.