Stochastic Modelling and Computational Sciences

SMART SHOPPING TROLLEY WITH NFC-BASED AUTOMATED BILLING AND AUTONOMOUS MOVEMENT

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ABSTRACT

Shopping in malls has become a daily routine, especially in metro cities where people often experience long queues at billing counters. During festive seasons or promotional events, the rush increases significantly, leading to delays and inconvenience for shoppers. To address this problem, we propose a Smart Shopping Trolley using Near Field Communication (NFC) technology to facilitate a seamless shopping experience. Each product in the mall is embedded with an NFC tag, containing essential information such as product name, price, and unique identification. The trolley is equipped with an NFC reader, allowing users to scan products instantly. Upon scanning, the product details are displayed on an LCD screen and synchronized with the server for automatic bill generation. This eliminates the need for manual barcode scanning at billing counters, reducing wait times and streamlining the checkout process. Additionally, to ensure minimal physical interaction during the COVID-19 pandemic, the trolley incorporates a motor-driven autonomous movement system, controlled by the shopper using an intuitive interface. The movement is assisted by infrared (IR) sensors for obstacle detection, enhancing safety and usability. This system consists of key components including an NFC Reader, NFC Tags, Microcontroller Board, LCD Display, IoT Module, UART (Universal Asynchronous Receiver-Transmitter), IR Sensors, and a Buzzer for notifications. The proposed smart shopping trolley offers a secure, efficient, and contactless shopping experience, contributing to enhanced customer satisfaction.

Keywords: *Smart Shopping Trolley, NFC Technology, Automated Billing, IoT, Autonomous Movement, Contactless Shopping*

INTRODUCTION

The traditional shopping experience in malls involves manually adding products to trolleys and proceeding to billing counters for checkout. Barcode scanning at the billing counters consumes significant time, especially during peak hours. Shoppers often face long waiting times, leading to frustration and reduced satisfaction. Additionally, during festive seasons or sales, the influx of customers further aggravates the situation, resulting in crowded billing counters and inefficient service. In the wake of the COVID-19 pandemic, reducing contact points and ensuring social distancing have become critical. Conventional billing processes that involve direct human interaction pose a health risk. Moreover, customers prefer minimal physical contact with shared surfaces like billing counters and barcode scanners.

To address these challenges, this project proposes the implementation of a smart shopping trolley integrated with NFC technology and autonomous movement capabilities. By incorporating NFC-based product identification and automatic billing, the need for manual barcode scanning is eliminated. Customers can complete their shopping with minimal assistance, ensuring a faster and safer checkout process. Furthermore, the autonomous movement feature assists users by navigating the trolley within the store. Equipped with sensors and controlled by the user, the trolley can avoid obstacles, offering a hands-free and comfortable shopping experience. This solution not only reduces the dependency on store staff but also enhances the overall shopping efficiency.

This innovative approach is designed to meet the evolving needs of consumers, making shopping experiences more enjoyable and stress-free. With the integration of IoT technology, real-time data management is enabled, providing malls with insights into shopping patterns and improving inventory management

SYSTEM DESIGN

Components

NFC Reader and Tags: NFC (Near Field Communication) is a wireless communication technology that allows data exchange between devices within close proximity. In this system, each product is affixed with an NFC tag containing product details such as name, price, and unique identification number. The NFC reader, mounted on the trolley, scans the tags and transmits the data to the microcontroller for processing. This ensures accurate product recognition and real-time price updates.

Microcontroller Board: The microcontroller serves as the central processing unit of the trolley. It receives data from the NFC reader, updates the display screen with the product information, and sends the data to the server via the IoT module. Additionally, it controls the motors, IR sensors, and buzzer based on the user's commands and sensor inputs.

LCD Display: The LCD screen provides users with an interface to view real-time information about the scanned products, including their names, prices, and the cumulative total bill. The clear and concise display ensures transparency and enhances the user experience.

IoT Module: The IoT module connects the trolley to the central server using wireless communication. It transmits product data for automated bill generation and synchronizes the updated bill to the cloud. This enables the server to monitor and manage data efficiently.

IR Sensors: Infrared sensors are installed on the trolley for obstacle detection and navigation assistance. By detecting objects in the trolley's path, the sensors send signals to the microcontroller, which adjusts the trolley's movement accordingly. This feature ensures a safer shopping experience, reducing the likelihood of collisions.

Motors and Motor Driver: The trolley is equipped with DC motors and a motor driver, which facilitate autonomous movement. The motors receive commands from the microcontroller, enabling smooth and controlled movement of the trolley within the mall. Users can operate the trolley using a joystick or a mobile application.

Buzzer: The buzzer serves as an alert mechanism, notifying users of system errors, obstacles detected by IR sensors, or any operational malfunctions. It ensures the user remains informed and can take appropriate actions when necessary.

Working Principle

Product Scanning: Users scan the product using the NFC reader attached to the trolley. Upon scanning, the reader reads the product information stored in the NFC tag, including the product name, price, and identification number.

Data Processing: The microcontroller processes the data received from the NFC reader. The scanned product details are displayed on the LCD screen, providing instant feedback to the user. Simultaneously, the data is transmitted to the server through the IoT module.

Automated Billing: The server generates a dynamic bill in real-time based on the scanned products. Any updates, such as adding or removing items, are reflected immediately. The user can view the bill on the display, allowing them to track their expenses.

Autonomous Navigation: Using IR sensors, the trolley detects obstacles in its path. The microcontroller processes sensor data to adjust the trolley's movement, preventing collisions. Users can manually control the trolley using a mobile app or joystick.

Checkout and Verification: Upon completing the shopping, the user proceeds to the exit where a final verification is performed. The server cross-checks the products in the trolley with the data recorded in its system. After successful verification, the payment is processed automatically, providing a seamless checkout experience.

ADVANTAGES

Reduced Waiting Time: Automated billing eliminates the need for manual barcode scanning at counters, significantly reducing checkout time.

Contactless and Safer Shopping: Minimized physical contact ensures a safer shopping experience, especially during pandemics.

Real-Time Billing Updates: Users can view a running total of their purchases, making budget management easier.

Efficient Inventory Management: Real-time data synchronization helps stores monitor stock levels and optimize inventory.

Enhanced Customer Satisfaction: The faster, more convenient, and safer experience increases customer satisfaction and loyalty.

Reduced Operational Costs: Automation reduces the need for additional staff at billing counters.

CONCLUSION

The proposed NFC-based smart shopping trolley provides a user-friendly, efficient, and hygienic shopping experience. By eliminating the need for manual billing and offering autonomous movement, this solution optimizes mall operations and ensures customer safety. Future advancements could involve AI-driven personalized shopping recommendations, adaptive route optimization for faster in-store navigation, and seamless integration with digital payment gateways for one-click payments. Additionally, predictive analytics could be incorporated to enhance inventory management, and voice-assisted shopping could further elevate user convenience.

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