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REVIEW ARTICLE

Internet of Things-based Smart Intelligence Cart

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ABSTRACT

Shopping is easy, but standing in line at the billing counter makes it exhausting and challenging. Long lines are caused by heavy traffic and the time it takes the cashier to prepare the bill using a barcode scanner. An automatic billing system may be installed inside the shopping cart for this creative invention. Therefore, this strategy is suited for usage in settings such as supermarkets since it will reduce the need for staff while improving the shopping experience for customers. The SmartShopping cart is a generally updated version of the other normal smart shopping trolleys. The Smart trolley consists of a Nodemcu ESP32, radio-frequency identification tags, a reader, an LCD display, an Ultrasonic sensor, and other required electronic components.

Key words: Automatic billing system, automatic movement, radio-frequency identification tags/ reader, Wi-Fi module

INTRODUCTION

The Intelli-cart, an evolution of traditional shopping carts, enhances the shopping experience through technology. This Smart shopping cart, also known as an automatic shopping cart, utilizes ultrasonic sensors and Internet of Things (IoT) connectivity to streamline and personalize the shopping journey. Equipped with an ESP32 module, the cart autonomously follows customers, eliminating the need for manual pushing. Ultrasonic sensors detect obstacles and range, ensuring smooth navigation. Prices are dynamically updated from a central server or cloud, eliminating the need for manual tagging. This innovation not only saves time but also enhances accuracy. IoT integration enables the cart to connect to the Internet, facilitating data exchange with other systems. This connectivity empowers the cart to automate the checkout process, which is a significant advantage. The customers can experience a more efficient and enjoyable shopping experience. The use of ultrasonic sensors in robotics has proven effective due to their affordability and reliability. While ultrasonic waves have limitations, the application of obstacle recognition and range detection has revolutionized the capabilities of smart shopping carts. Overall, the Intelli-cart represents a significant advancement in retail technology, offering convenience, efficiency, and customization to enhance the shopping experience.

LITERATURE SURVEY

In a series of journal papers, researchers explore innovations aimed at revolutionizing the shopping experience through technology integration. Research on Smart Shopping carts by Roopa *et al*., 2020[1] proposes a framework to streamline mall shopping by integrating radio-frequency identification (RFID) tags and digital displays into carts. It enables automatic billing as items are added or removed, reducing checkout queues and enhancing efficiency. The Value of Implementing API by Larsson and Åkermark, 2021[2] highlights the significance of API-first methodology in application development. It addresses challenges in accommodating diverse device types and emphasizes the role of Swagger in API specification and documentation.

Smart Shopping Cart Using Machine Vision along with Machine Learning by Shetty *et al*., 2021[3] introduces a system leveraging machine vision and

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object recognition to streamline billing processes in supermarkets. By employing cameras on carts, this technology tracks items and facilitates automatic checkout.

Developing a user-friendly online shopping website by Vaidya, 2018[4] emphasizes the importance of front-end and back-end development in creating a seamless online shopping experience. It employs the Model-View-Controller pattern and emphasizes database interaction for effective website functionality. Collectively, these papers signify a shift toward more efficient, personalized, and user-friendly retail environments. They demonstrate the integration of cutting-edge technologies such as RFID, machine vision, and ultrasonic sensors to automate processes, reduce waiting times, and enhance overall shopping experiences. The research is pivotal in shaping the future of retail, as it strives to make shopping more convenient, enjoyable, and accessible for consumers worldwide.

Smart Trolley System for automated billing using RFID and IoT[5-7] highlights how RFID tags embedded in products can be read by smart carts, automating the billing process and reducing wait times for customers. The smart cart system can also display product expiry dates and identify damaged products. The system allows consumers to do shopping within an adequate time and reduces the waiting time for billing, making it convenient and secure for both consumers and retailers.

MATERIALS AND MODULE SPECIFICATION

Hardware Requirement Specification: RFID Module

A device that employs radio waves to wirelessly transfer data between a tag or card and a reader is called an RFID module. A transceiver, a microcontroller, and an antenna make up the module. Radio waves are released by the reader when the tag approaches it, providing the tag with power. Using radio frequency signals, the tag then uses the reader to transmit back its unique identification information. Applications such as tracking, access control, and inventory management are made possible by the reader's processing and capture of this data. Efficiency and automation are improved across a range of industries by RFID technology.

Hardware Requirement Specification: NodeMCU ESP32

A popular microcontroller with a Wi-Fi module for IoT applications is the ESP32. It has many GPIO ports, Wi-Fi and Bluetooth connectivity, dual-core processors, and support for SPI, I2C, and UART, among other communication protocols. It is perfect for projects such as wearable technology, industrial automation, sensor networks, and home automation because of its low power consumption and adaptability. Because of its vast library and interoperability with the Arduino IDE, both novice and expert users can create with it. Overall, because of its performance, versatility, and cost, the ESP32 is a popular option for creating linked devices.

Hardware Requirement Specification: Ultrasonic Sensor

Ultrasonic sensors measure distance using sound waves that have frequencies higher than what the human ear can detect. It produces sound pulses, times the sound waves' return trip after striking an object, and uses this information to calculate the distance using the sound's speed. Ultrasonic sensors are non-contact, dependable, and accurate devices that are frequently utilized in robotics, industrial automation, and automotive applications. It is adaptable for jobs including item identification, proximity sensing, and level measurement in liquids or solids since it can detect a wide range of materials and perform well in a variety of settings.

Hardware Requirement Specification: 12V DC Motor

A 12V DC motor converts electrical energy from a 12-volt direct current power source into mechanical motion. Its specifications include voltage rating, current draw, power output, speed, torque, and efficiency. These motors are commonly used in automotive systems, robotics, and small appliances due to their compact size, reliability, and ease of control. They power a variety of applications, from electric vehicles to DIY projects, with precision and efficiency. Figure 1 shows the block diagram.

WORKING METHODOLOGY

Modern shopping carts have evolved into intelligent companions, employing RFID technology to effortlessly track products as they are added.

- The RFID reader embedded within the cart detects RFID tags on items, transmitting data to the Node MCU ESP32 controller
- The controller serves as the cart's central hub, meticulously tallying the cost of items in real-time as they are placed inside
- The integration of DC motors ensures the cart moves fluidly alongside the user, eliminating the need for manual pushing or steering. It enables the cart to autonomously navigate near customers with the help of Ultrasonic sensors
- This synchronized movement allows users to focus on selecting items without struggling to handle the cart.
- The products are added to the bill once when the RFID tag on the product is scanned using the RFID reader.

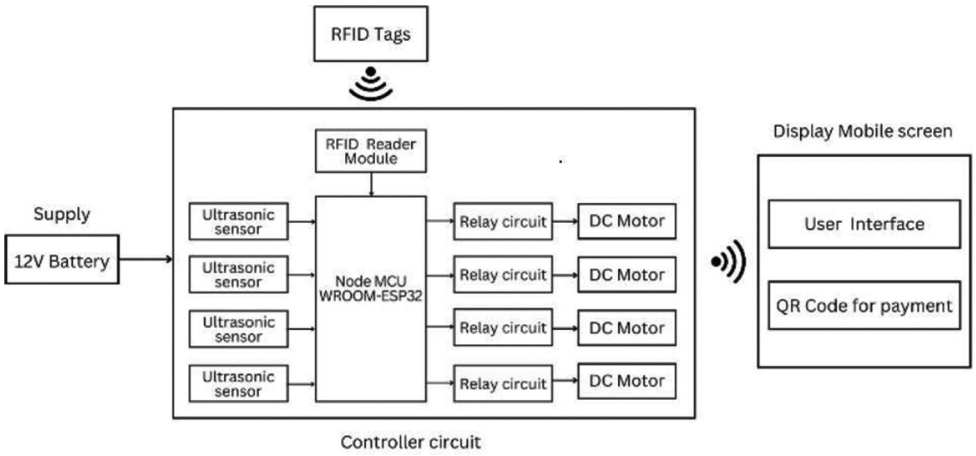

Figure 1: Block diagram

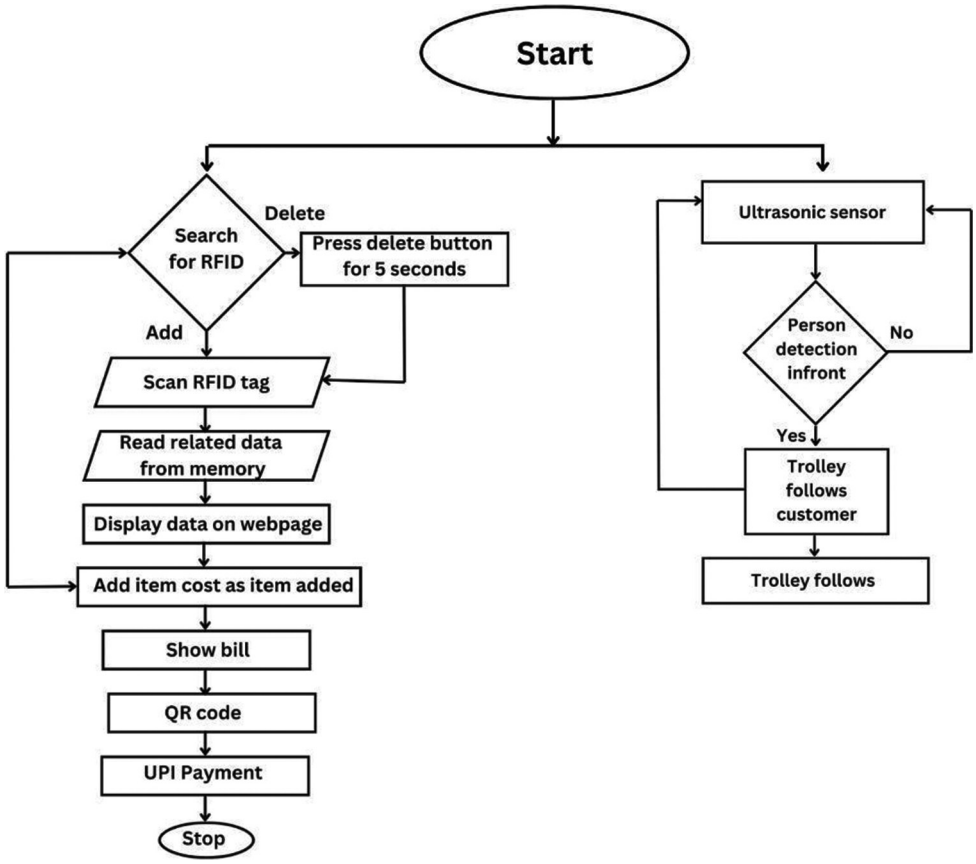

Figure 2: Flowchart

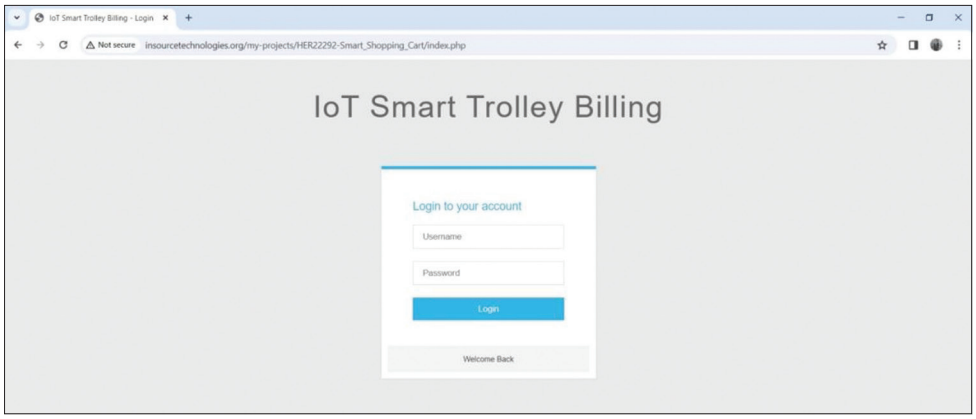

Figure 3: Opening of user interface

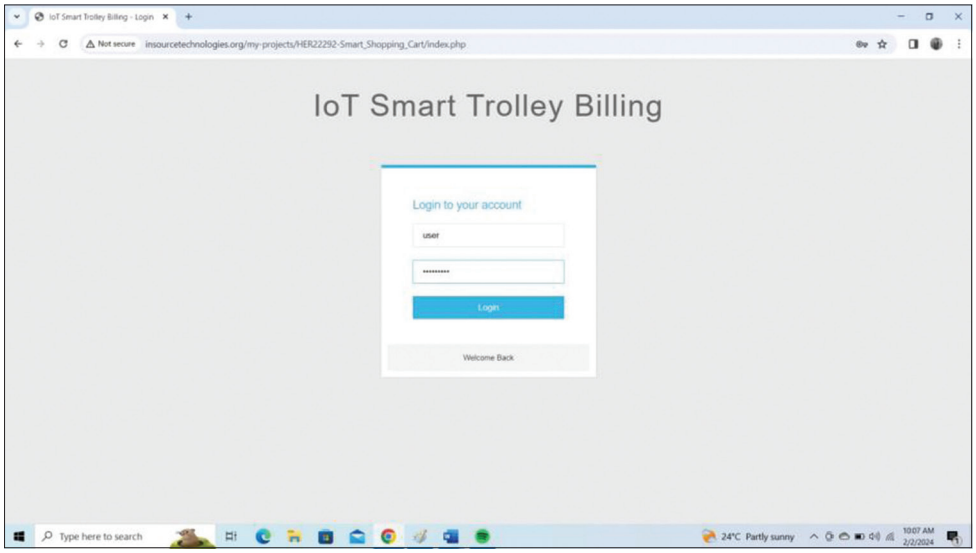

Figure 4: User interface 1

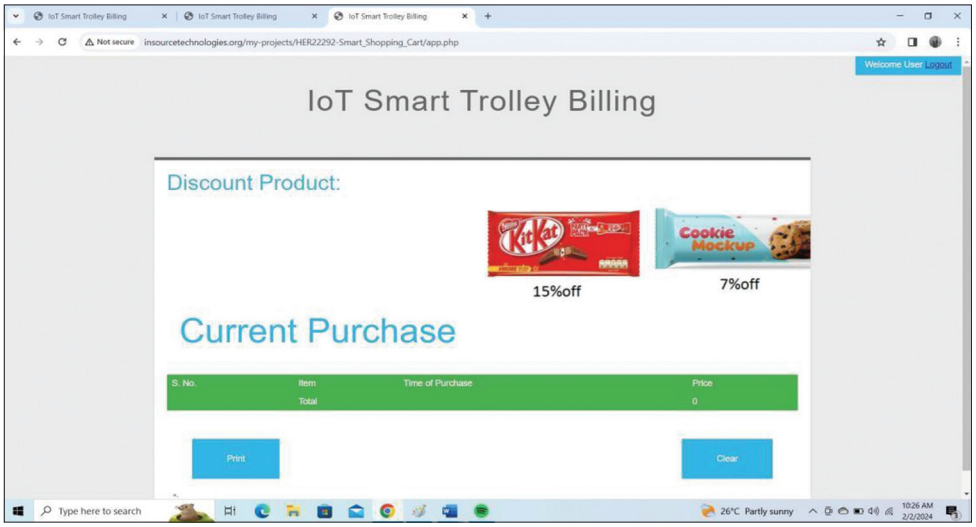

Figure 5: User interface 2

- The products can be easily removed from the billing using the delete button; the product tag has to be just scanned by the RFID reader while pressing the delete button. The price of the product will be reduced from the bill
- Upon reaching the checkout stage, users are greeted with a user login screen displaying the list of their selected items
- Conveniently integrated with a UPI QR code on the screen, enabling secure payments through the smartphone

- This seamless transition from browsing to payment epitomizes the efficiency and convenience offered by smart shopping carts
- In essence, the convergence of RFID technology, NodeMCU ESP32 controllers, DC motors, and UPI QR codes redefines the shopping experience
- It simplifies and accelerates every step of the process, from product selection to payment, providing consumers with a modern and hassle-free shopping journey.

Figure 2 shows the flowchart.

RESULTS AND DISCUSSION

Hardware Results

STEP 1: Open Google Chrome and search for User Interface (UI) 1 using the given link. Below Figure 3 shows the appearance of the UI.
STEP 2: The UI page asks for a username and password after entering that username as the user and password as the password. If the login button is pressed, it takes the customer to UI 2. Figure 4 shows the UI 1.
STEP 3: After the UI 1 page login, it takes you to UI 2. It shows the discounted products scrolling on the top of the page. Figure 5 shows the UI 2 and the discounted products scrolling.
STEP 4: Scan the RFID tag across the RFID reader to add the item to the UI for the automatic billing feature. Figure 6 shows the scanning of an RFID tag with an RFID reader.
STEP 5: After scanning the products, the items were added to the UI, and it showed the total cost and quantity of the products. Figure 7 shows the items added to the UI.
STEP 6: After an end-of-purchase print button is pressed, it takes the customer to the billing invoice page. Figure 8 shows the invoice for the purchase.
STEP 7: After that process, it generates a QR code for automatic cashless payment. Figure 9 shows the QR code generation.
STEP 8: After the payment process, it takes you again to UI 2; if needed, start the purchase again; if not, log out of the UI. Click the logout option on the top right corner of the page. Figure 10 shows the overall hardware.

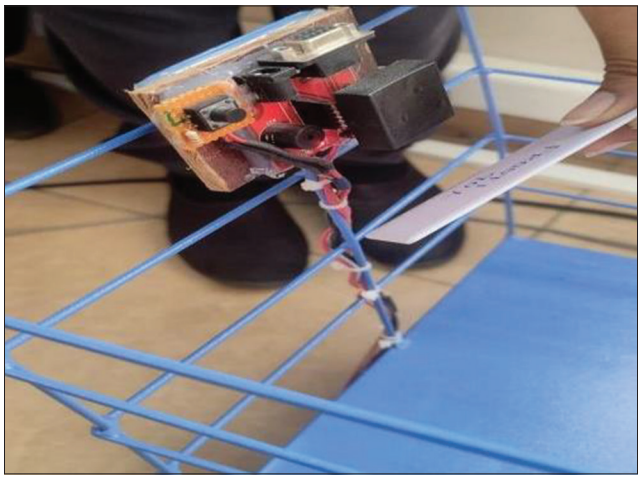

Figure 6: Scanning of radio-frequency identification (RFID) tag to RFID reader

ADVANTAGES

Customers can experience faster and more efficient checkout times, which will improve their shopping experience. Giving clients advance access to the bill details can also assist them in better

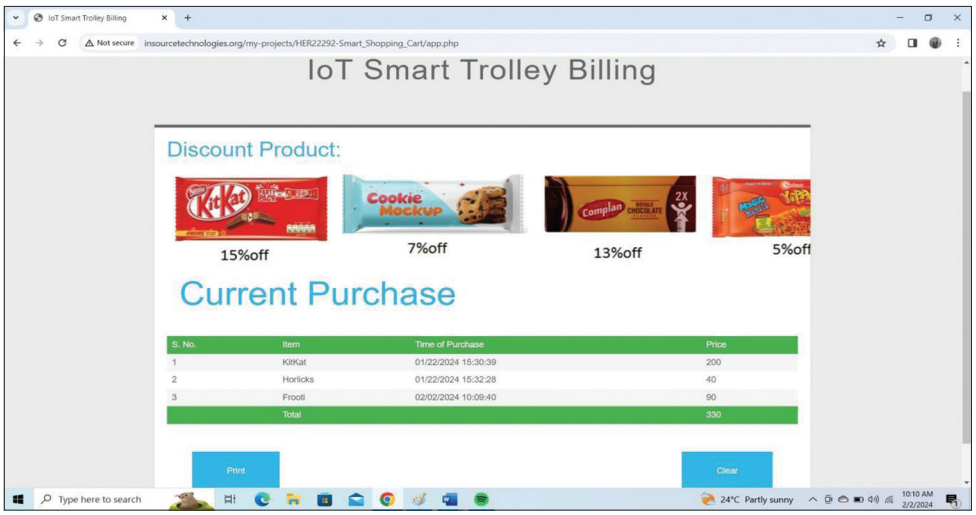

Figure 7: Items added to the user interface

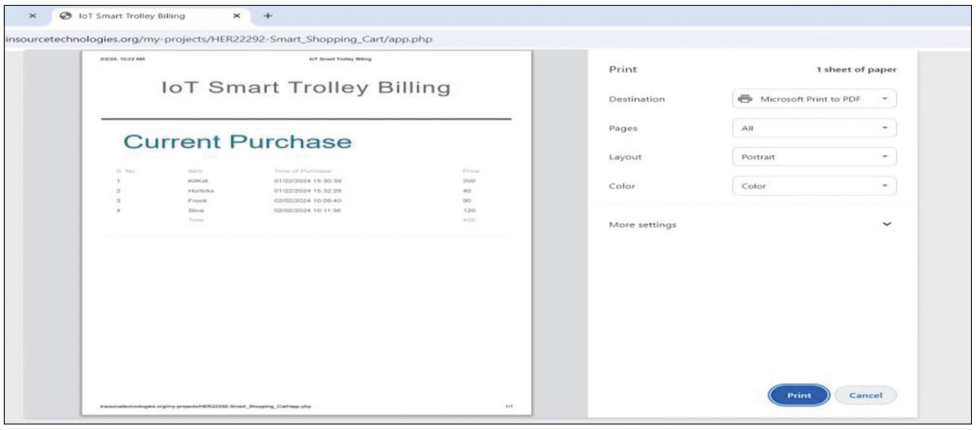

Figure 8: User interface 3

Figure 9: Payment interface

Figure 10: Overall hardware

managing their finances and helping them make more educated purchases. Quicker checkout time scans benefit businesses by improving customer satisfaction, which can attract more devoted clients and boost sales. Artificial intelligence has the potential to enhance inventory management, boost overall productivity, and increase profitability for businesses. All in all, clients and companies stand to gain from an automated billing system based on RFID.

CONCLUSION AND FUTURE SCOPE

The Smart Shopping Cart revolutionizes retail, integrating RFID and Ultrasonic sensors for real-time tracking. Its intuitive interface simplifies item scanning and checkout, offering QR code UPI payments and robust security. This innovation aligns with consumer demands and propels retailers into the tech forefront. It epitomizes the fusion of hardware and software, hinting at a future where automation enriches shopping. Its success pledges efficiency gains and heightened customer contentment, marking a pivotal step in retail evolution.

Technological developments in RFID have greatly improved its robustness and dependability, creating new prospects for its application in the retail industry. It is imperative to recognize the current limitations, such as interference problems and range restrictions. The convenience of shopping can be increased by integrating wireless technologies into smart carts and using mobile payment options to speed up transactions and cut down on wait times. Adding automatic scanning and real-time updates on product availability can improve the shopping experience even more. Using image processing techniques can also improve security and prevent theft more effectively. The combination of these emerging technologies has

the potential to enhance operational effectiveness and customer satisfaction in the retail sector.

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