IoT-Based Smart Shopping Cart(Go Kart) Using RFID Module

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***Abstract*— Supermarkets aim to avoid lengthy queues at the checkout as it can lead to dissatisfied customers and a decrease in customer loyalty. To address this issue, an efficient checkout process is necessary to save customers' time and enable them to engage in other activities. This research proposes a system that includes Go-Kart, a web portal interface, and RFID detectors that allow customers to perform RFID scanning of goods, while the cashier only has to complete the transaction. The development of this system utilized the different methodology and involved several tools such as Node MCU ESP 8266, RFID RC522 Reader, Ultrasonic Distance Sensor - HC-SR04, IR Sensor, Arduino IDE, VS Code, Node.js, and REST. The experimental prototype aims to improve service quality and shopping operations. It can be used commercially and evaluated in real-world settings in the future. Due to its simplicity in implementation and testing, this model is more competitive than others.**

Keywords*— *(Go-kart , RFID code system, Node MCU ESP8266, IR Coupling, HC-SR04)

I. INTRODUCTION

Shopping carts have become an integral part of urban society in India. Unfortunately, the same cannot be said for rural areas. There is a need to create intelligent systems that can improve access to goods in rural areas and help make these areas technologically advanced. Traditional manual methods of placing and storing goods have become burdensome, and there is a need to eliminate them. One promising technology that can revolutionize the supply chain and logistics industry is Radiofrequency Identification (RFID). Although RFID is not a brand-new technology, recent advancements in chip manufacturing technology are making it more practical for identifying consumer goods. This technology can improve inventory control, logistics, and supply chain management. RFID tags are small transponders attached to physical items that respond to wireless interrogation by RFID transceivers or readers with relevant data. Programmers develop software applications to enhance productivity and efficiency. A system is an organised way of carrying out one or more tasks in accordance with a predetermined plan, program, or set of instructions. One of the most important components of embedded systems is computer hardware that has software embedded in it. They are typically created with a single 8- or 16-bit microcontroller and can function independently or as a component of a bigger system. They can even run on batteries and have little hardware and software issues. When creating embedded software for these systems, editors, assemblers, and cross-assemblers tailored to the microcontroller or processor utilised are the primary tools.

These embedded systems can be designed to automate various tasks, such as monitoring and controlling industrial processes, managing household appliances, and even controlling vehicles. They have become essential in many industries, including aerospace, automotive, medical, and consumer electronics.

To address the challenges faced by rural areas in India, we propose developing an intelligent shopping cart system using RFID technology. The system will consist of smart shopping carts equipped with RFID sensors, a web portal as an interface, and a cashier station for transaction processing. Customers will be able to perform self-scanning of goods using RFID sensors, and the cashier will only have to process the transaction. This will eliminate the need for long queues and tedious manual scanning, making the checkout process more efficient and faster.

To develop this system, we will use the Waterfall methodology, which involves a sequential approach to software development. The system will be built using tools such as Node MCU ESP 8266, RFID RC522 Reader, Ultrasonic Distance Sensor - HC-SR04, IR Sensor, Arduino IDE, VS Code, Node.js, and REST.

The proposed system has the potential to revolutionize shopping in rural areas by making it more efficient and convenient. It can be easily implemented and tested at a commercial scale under a real scenario in the future. The system's automated features will make shopping easier, faster, and more accessible for customers in rural areas, ultimately improving their quality of life.

II. LITERATURE REVIEW

Implementing an IoT-based system, specifically an RFID-enabled smart shopping cart, can be advantageous for clothing retailers. Each product has an RFID label instead of a barcode, and the shopping cart has an RFID reader built in. The technology calculates the price and subtracts any discounts as soon as a product enters the RFID reader's range, then displays the final price on a TV screen within the cart. The consumer can then make a payment for the amount shown at checkout after the data has been wirelessly sent to the cashier using NRF24L01. A classification algorithm, such as the ID3 decision tree algorithm, is required to calculate discounts because it has been shown to have more accuracy and precision than other approaches..

By instantly counting and displaying the price of the items in the cart, this system eliminates the issue of lengthy checkout queue wait times. In addition to the price, each product's RFID tag is attached with extra data about the item. Based on the customer's past purchases, the system can make recommendations for products, cutting down on the amount of time spent looking through the shelves. By offering an Android mobile application that lets users alter product information and preferences, the system can also stop clients from obtaining expired or undesirable goods.

Tools like the Arduino Uno, RFID, Visual Studio Code, Flutter, PostgreSQL, REST, React, and Node.js can be used to create the proposed system. Regression analysis can be used to optimise entrance and exit times, cutting down on checkout line wait times. The system offers a central database for tracking online purchases of items and billing. In general, the use of an RFID-based smart shopping cart system provides a more effective and convenient shopping experience for customers, benefiting both the store and the consumer.

The system suggested in [12] also makes use of an IoT-based smart shopping cart that has an Android mobile application, an RFID reader, and a barcode scanner. Customers can use the mobile app to scan a product's barcode or RFID tag and add it to their shopping cart. Additionally, the app gives users access to product details including price, ratings, and nutritional information. Additionally, the system provides tailored product recommendations based on the customer's tastes and past purchases.

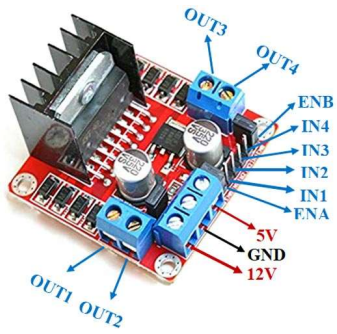
The suggested solution includes extra features to improve the shopping experience in addition to streamlining the checkout process. For instance, the system can promote products based on past purchases made by the user, advertise sales, and even suggest substitutes for things that are out of stock. Customers can also manage their shopping lists, find items inside the store, and get alerts for sales or promotions by downloading the smartphone app.

In conclusion, implementing an IoT-based smart shopping cart system using RFID technology can greatly improve the shopping experience for customers by reducing waiting times, providing personalized product recommendations, and allowing for easy payment processing. The use of RFID tags instead of barcodes enables automatic product identification and pricing, further streamlining the checkout process. With the development of more advanced technologies and algorithms, the potential for further innovation and improvement in the field of smart shopping carts is vast.

The efficiency of the checkout process in clothing retailers can be greatly increased by integrating RFID technology and smart shopping carts. The system can automatically add product prices, figure out discounts, and display the total cost on an LCD screen within the cart by using RFID labels rather than barcodes. The ID3 decision tree algorithm can also be used to calculate discounts and make product recommendations to customers. Overall, this method provides a smooth and practical shopping experience, cutting down on wait times and raising client happiness.

III. COMPONENTS

L298N-Motor Driver: The L298N motor driver is an integrated circuit used to control DC motors and stepper motors. It is widely used in various electronic projects that require motor control, such as robots, drones, and electric vehicles.



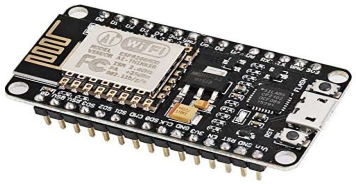
The L298N motor driver is a dual H-bridge module that can control two DC motors or one stepper motor. It is capable of controlling motors with a voltage range from 5 to 35V and can provide a maximum current of 2A per channel. The module has four input pins that control the direction and speed of the motor, and two output pins that connect to the motor.

The L298N motor driver is a popular choice for motor control due to its simplicity and versatility. It can be easily controlled

using a microcontroller, such as an Arduino or Raspberry Pi. The module is also relatively inexpensive and widely available, making it accessible to hobbyists and students.

In addition to controlling motors, the L298N motor driver can also be used as a power supply for other components in a project. It has an onboard 5V regulator that can provide power to a microcontroller or other low-power devices. Overall, the L298N motor driver is an essential component for any project that involves motor control. Its ease of use, versatility, and affordability make it a popular choice for hobbyists and professionals alike.

NodeMcu: It is an open-source firmware and development board based on the ESP8266 Wi-Fi module. It was developed to provide an easy-to-use platform for building Internet of Things (IoT) applications. It is a popular choice among hobbyists and developers due to its low cost and ease of use. The NodeMCU board is equipped with a microcontroller unit (MCU) and a Wi-Fi module, allowing it to connect to the internet and communicate with other devices. It is compatible with the Arduino IDE, making it easy to program using the C++ language. Additionally, it has a Lua-based firmware that allows developers to write scripts and execute them directly on the board.One of the most significant advantages of NodeMCU is its ability to connect to the internet wirelessly. This allows for the creation of IoT applications that can be controlled and monitored remotely. For example, a NodeMCU board can be used to monitor the temperature and humidity of a room and



send alerts if they reach a certain threshold. NodeMCU is also highly customizable and can be extended with various add-ons and sensors. For example, a NodeMCU board can be equipped with a temperature sensor to monitor the temperature of a room or a motion sensor to detect movement

In summary, NodeMCU is a powerful development board that offers a cost-effective and easy-to-use platform for building IoT applications. Its versatility, ease of use, and low cost make it an attractive option for hobbyists and developers looking to build connected devices

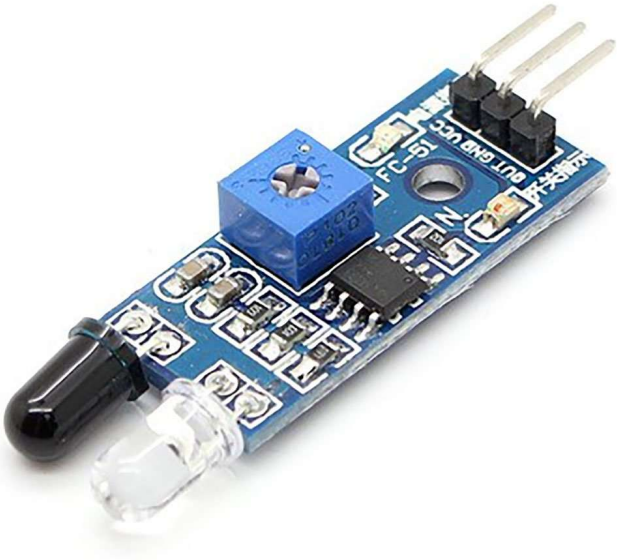
HCSR-04 ULTRASONIC SENSOR: The HC-SR04 ultrasonic sensor is a popular device used in a variety of applications, including distance measurement, object detection, and obstacle avoidance. It uses ultrasonic waves to measure distance between the sensor and an object, and it can accurately measure distances up to several meters away. The HC-SR04 sensor operates by transmitting ultrasonic waves and then measuring the time it takes for the waves to bounce back from the object being measured. This measurement is then used to calculate the distance between the sensor and the object. The sensor is equipped with both a transmitter and a receiver, which work together to ensure accurate distance measurements.

One of the main advantages of the HC-SR04 sensor is its accuracy. It is capable of measuring distances with an accuracy of up to 3mm, making it a highly reliable tool for distance measurement applications. Additionally, the sensor is easy to use and can be interfaced with microcontrollers such as the Arduino using just a few simple connections. Another advantage of the HC-SR04 sensor is its versatility. It can be used in a variety of applications, from measuring the distance of a car in a parking space to detecting obstacles in a robot's path. Its compact size and low power consumption also make it ideal for use in portable and battery-powered applications.

In conclusion, the HC-SR04 ultrasonic sensor is a highly versatile and accurate device that is widely used in a variety of applications. Its ability to accurately measure distances and detect objects makes it an essential tool in the fields of robotics, automation, and IoT.

Infrared Sensor: Electronic devices called infrared sensors are used to monitor and detect infrared radiation, a form of electromagnetic radiation that is invisible to the human eye. The wavelength of infrared radiation is longer than that of visible light but shorter than that of microwaves. Remote controllers, motion detectors, temperature sensors, and proximity sensors are just a few of the uses for infrared sensors. A change in the amount of infrared radiation being released by an object is detected by infrared sensors. They have

a tiny infrared emitter that emits a beam of infrared radiation, and a detector that monitors how much of that radiation is reflected back to the emitter. A portion of the infrared radiation is reflected back when an object enters the infrared beam's path.



Infrared sensors are useful in many applications because they can detect the presence of an object without physical contact. This makes them ideal for use in situations where physical contact is either difficult or impossible, such as in remote controls or motion detectors. They are also useful for measuring temperature in applications where direct contact with the object being measured is not desirable or possible. In addition, infrared sensors are often used in industrial automation and control systems, where they can detect the presence or absence of objects on a conveyor belt or in a production line.

RC522 Reader Module: The RC522 reader module is a Radio Frequency Identification (RFID) reader module that operates at 13.56 MHz frequency. It is commonly used in projects that require contactless communication with RFID cards or tags. The module is based on the Philips MFRC522 chip and comes with an integrated PCB antenna. The RC522 reader module supports different types of RFID cards such as MIFARE 1 S50, MIFARE 1 S70, and MIFARE Ultralight. It also supports ISO/IEC 14443 A/MIFARE mode, ISO/IEC 14443 B, and FeliCa RF cards. The module communicates with a microcontroller using a Serial Peripheral Interface (SPI) protocol and can operate in either 3.3V or 5V power supply. The RC522 reader module is ideal for applications such as access control, identification, and tracking systems. It is easy to use and can be interfaced with different microcontrollers such as Arduino, Raspberry Pi, and ESP8266. The module also comes with a comprehensive library that simplifies the programming process.

Overall, the RC522 reader module is a reliable and cost-effective solution for RFID communication. Its small form factor and low power consumption make it suitable for both small and large scale projects.

IV. METHORDOLOGY

- → **Go-kart setup** - In this step, the setup of the Go-kart is described, which includes a node MCU (ESP8266) connected to the four wheels through an L-298N motor driver. Two infrared (IR) sensors are mounted in front of the robotic vehicle to detect human movement and determine its left and right orientation. Additionally, an ultrasonic sensor is used for forward motion and to track the distance between the carriage and the person.
- → **RFID-based system** - This step explains the RFID-based system that is implemented on top of the cart, containing an MFRC522 RFID reader connected to the NodeMCU. The reader automatically scans the items put in the cart, and unique details of the product associated with the RFID tag are obtained such as price, manufacturing date, expiry date, and other essential information.
- → **Web portal** - The final step describes the web portal, which is used to view the data obtained from the RFID reader. Each user is assigned a unique IP

address, and users can see the list of purchased products and the total cost. The web portal also includes a payment gateway to pay bills, which eliminates the need to wait in long queues for checkout.

→ **Data Collection**: In this step, we collect data related to the relay and the components used in the Go-kart. This includes the specifications of the electromagnetic attraction relay, the node MCU (ESP8266), L-298N motor driver, infrared sensors, ultrasonic sensor, MFRC522 RFID reader, and web server technology. We also collect data related to the functionality and programming of these components.

→ **Implementation**: The implementation involves the physical integration of the components and programming the functionality of the Go-kart. The relay is connected to the node MCU, which is then connected to the L-298N motor driver to move the Go-kart. The IR sensors are mounted in front of the vehicle and are programmed to detect human movement on either side. The ultrasonic sensor continuously tracks the distance between the carriage and the person, and the trolley will stop when the distance between the two is less than 50 cm. The RFID reader is connected to the node MCU to automatically scan the items put in the cart, and the web server technology is used to display the data on the web portal.

→ **Testing and Evaluation**: In this step, we test the functionality of the Go-kart and evaluate its performance against the requirements specified in the previous steps. We check if the relay operates correctly and the Go-kart moves in the desired direction using the IR and ultrasonic sensors. We also test the RFID reader to ensure it can automatically detect the products and display their information on the web portal. Any issues or bugs found during the testing phase are addressed and fixed.

→ **Maintenance and Support**: After the Go-kart is tested and evaluated, it is ready for deployment. We provide maintenance and support to ensure that the Go-kart operates smoothly and efficiently. We monitor the performance of the Go-kart and provide updates and upgrades as necessary. We also provide training to users on how to use the Go-kart and troubleshoot any issues that may arise.

V. LIMITATION

As the system is Wi-Fi and power-dependent, areas with a lack of connectivity and with a lack of social control might fail to benefit. Other concerns that might be faced in the system by the user during enforcement of the system are as follows:

- A final reconciliation of the invoice with the purchased product may be required to avoid possible theft.
- The shopper must take her shopping cart to the cashier even if he wants to buy one item. This is useful.
- Since it is an electric smart cart, regular maintenance and battery replacement are required, and additional costs may be incurred.
- For small supermarkets and stores, this technique may not be cost-effective.
- The user has to make sure to be around the range of the system to make sure it follows

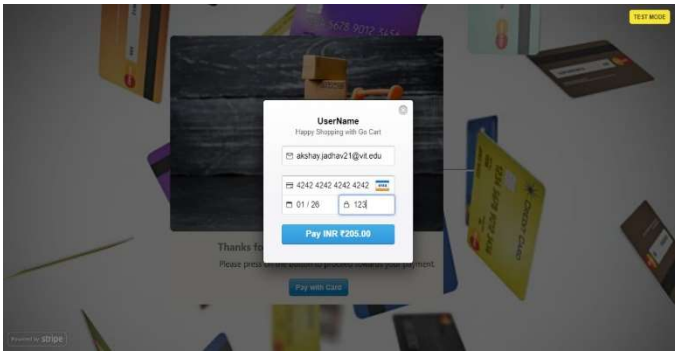
VI. RESULTS AND DISCUSSIONS

The Go Kart can follow the user wherever he/she goes in the convenience store. The basket size can be tailored and adjusted as per the store's needs. During the prototyping phase, the cart is deployed by integrating the proposed methodology.

The user can purchase goods as per requirements by scanning the respective item's RFID tag with the RFID scanner which is installed inside the shopping cart. Thereafter, after choosing all the items you want to buy, we can move to the billing part of your shopping experience by going to our locally hosted website. This is where you can view all products you have purchased and the total billing amount.

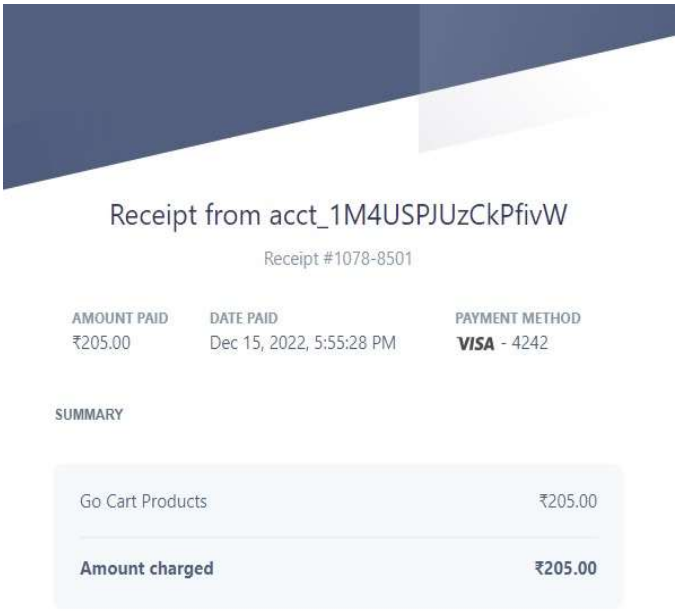
After clicking on the Pay Now button the user will be redirected to the payment portal.

Click on the Pay with Card option after which the website will ask for the user's card details.



Clicking on the pay button will complete the transaction after which a successful payment message will be displayed to ensure the user with payment confirmation.

Other than this, a copy of the bill will also be sent to the user's respective email ID so that the user can also keep record of his transactions at all times.



VII. CONCLUSION

In this study, the main concerns, and technologies required regarding the deployment of automatic shopping systems, while at the same time keeping in mind the users' shopping experience were discussed. Enforcement limitations can be overcame with cooperation from the users should be encouraged and disobeying individuals should be dealt with accordingly.

The emergence of science and technology is now unstoppable. A future realm without technology is unimaginable. Apart from that, the Go-kart can be used to purchase products in malls, supermarkets, shopping malls, etc. Here, using RFID technology, there is a record of the products purchased, allowing both users and sellers to securely claim items. Once the product is scanned and added to the shopping cart, all the necessary details of the product will be displayed on her web portal on the user's phone.

A major feature of this technology is that it can automatically follow the user inside the convenience store by automatically detecting and avoiding obstacles around the user. Therefore, the user does not have to manually push or pull the cart. In summary, this project helps protect product purchases in stores and save time waiting for billing while ensuring to enhance the customers' shopping experience at the same time.

VIII. FUTURE SCOPE

The study aims to create an automatic shopping system that performs all the tasks of carrying around the stored items, following the user, and also generating payments based on bought items. The entire system is aimed to be real-time connected with the web-portal and will help people to be comfortable with it.

This field of smart shopping is rapidly emerging in the wide era of technology and making shopping easier, faster and convenient for the customers. Other things that can be included in this are common goals like greater security and more efficient use of energy, improving the customers' shopping experience, and trying to reduce installations cost and space, increase productivity and reduce time and cost.

Undoubtedly, automation testing holds a very bright future, as it offers the promise of increased productivity, competitiveness, and well-being. Thus, the era of evolution and growth will continue for years to come. We can add new skills and functions to our system based on the suggestions of people and can discover new areas of things and make shopping as convenient and "smart" as possible.

The 2-phased prototyping model can be further deployed using a GPS module to automatically follow the user more accurately via a Bluetooth tag. Thus, Smart Shopping System is one such desire that can be developed over time to make shopping convenient.

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