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BELAGAVI-590 018, KARNATAKA

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JAIN INSTITUTE OF TECHNOLOGY

Davanagere-577003, KARNATAKA

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

FINAL YEAR B.E. (2023 – 2024)

A Project Report

On

"CartMate: An Automated Shopping Companion"

UNDER THE GUIDANCE OF

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J.I.T., Davanagere

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CERTIFICATE

This is to certify that the Project work entitled **"CartMate: An Automated Shopping Companion"** carried out by **Mr. Abdul Majeed Kaif N (4JD20EC001), Mr. Bharath B J (4JD20EC004), Mr. Mohammed Sanaulla (4JD20EC027), Mr. Akhilesh V Desai (4JD21EC400)** are bonafied students of **Bachelor of Engineering in Electronics and Communication** of the **Visvesvaraya Technological University, Belagavi** during the year 2023-2024.

It is certified that all corrections/suggestions indicated for internal assessment have been incorporated in the project report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the Bachelor of Engineering degree.

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EXTERNAL VIVA

Name of the Examiner	**Signature with date**
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Although a single sentence hardly suffices, We would like to thank almighty God for blessing us with his grace and taking our endeavour to a successful culmination.

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DECLARATION

We, Mr. Abdul Majeed Kaif N (4JD20EC001), Mr. Bharath B J (4JD20EC001), Mr. Mohammed Sanaulla (4JD20EC001) and Mr. Akhilesh V Desai (4JD21EC400) students of final year B.E in Electronics & Communication Engineering, Jain Institute of Technology, Davanagere hereby declare that the dissertation entitled **"CartMart: An Automated Shopping Companion"** has been carried out in a batch and submitted in the partial fulfillment of the requirement for the award of Bachelor's Degree in Electronics & Communication Engineering under Visvesvaraya Technological University, Belagavi during the academic year **2023-2024**.

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ABSTRACT

The Cartmate is an automated shopping companion that aims to enhance the shopping experience by providing a seamless and efficient shopping experience.This exciting plan aims to transform old-fashioned store visits by combining Embedded technologies. This technology upgrade is targeted at enhancing effectiveness and user friendliness in the retail field, thus enabling a simpler and more interesting shopping ordeal. The implementation of clever shopping wagons, a crucial part of this novelty, decreases checkout times and provides live data, resulting in a more effective shopping procedure. They are equipped with an automated human following mechanism, which allows the cart to autonomously follow the shopper, thereby reducing the physical effort required during shopping. In addition, the system incorporates an automatic bill generation feature, which calculates and displays the total cost of the items in the cart in real-time. This feature provides customers with a transparent view of their expenditure, enhancing their shopping experience. By integrating these advanced technologies, the project sets a new benchmark in the retail industry, demonstrating the transformative potential of technological advancements in traditional sectors

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CHAPTER 1

INTRODUCTION

CartMate, our cutting-edge automated shopping companion, redefines the traditional shopping experience by seamlessly integrating innovative technologies designed to enhance convenience and efficiency. CartMate effortlessly follows shoppers, eliminating the need for manual cart navigation. Additionally, CartMate streamlines the checkout process through automated billing capabilities, allowing customers to bypass long queues and enjoy a swift transaction.

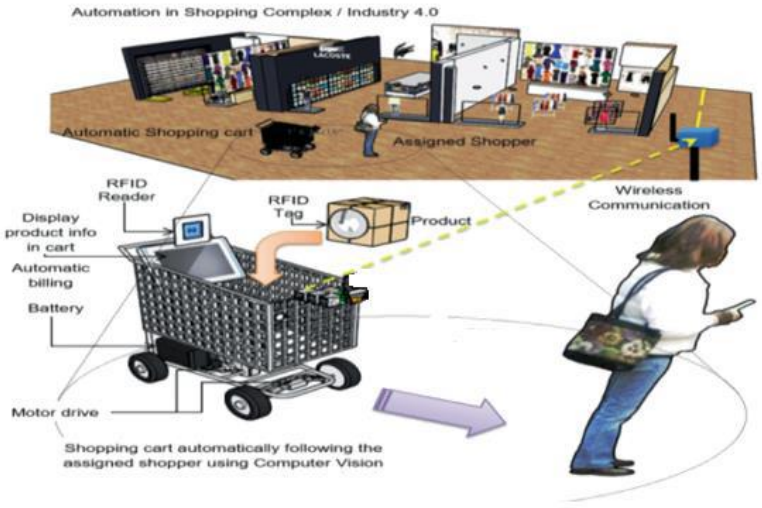

Figure 1.1 Introduction to CartMate

Safety and adaptability are prioritized with CartMate's obstacle detection system, ensuring smooth navigation through crowded aisles and busy store environments. Furthermore. Together, these features culminate in an unparalleled shopping companion that prioritizes convenience, efficiency, and customer satisfaction, setting a new standard in shopping automation.

1.1 PROBLEM STATEMENT

Shopping can be a tedious and time-consuming task, especially when you have a long list of items to purchase. It can be challenging to navigate through the store, locate the items you need, and wait in long lines during checkout. This can lead to frustrating during shopping and a waste of time. To overcome this problem in our proposed system the CartMate will be designed, which can automatically follow humans and generate bills which helps to reduce the checkout time.

1.2 OBJECTIVES

- It is designed to follow customers automatically by reducing the burden to pull the cart.
- It aims to reduce the time spent by eliminating the need to wait in long lines during checkout by automatic bill generation, making your shopping experience more convenient and stress-free.
- It keeps track of the items you've already picked so that you won't buy it twice.

1.3 MOTIVATION

The motivation behind the project of "CartMate: An Automated shopping companion" is to provide a seamless and efficient shopping experience for customers. The use of automated carts in shopping can help reduce the time and effort required to navigate through stores and aisles, and can also help reduce the physical strain of carrying heavy bags. By automating the billing process, customers can easily check the items they have picked and can make the payment online reducing the time for billing and payment, ultimately reducing the checkout time.

CHAPTER 2

LITRETURE SURVEY

1. Sharma N. et al. (2020) developed an RFID and sensor-based smart shopping cart with automated billing and personalized recommendations. The system's effectiveness and usability were validated, showing its potential to improve the shopping experience.

2. Wang L, & Zhang Q (2021) developed a smart shopping cart navigation system leveraging machine learning techniques. The system uses algorithms to analyze various factors and optimize navigation routes, aiming to enhance shopping efficiency, reduce congestion, and improve customer experience.

3. Chen X, & Liu Y (2021) investigated energy efficiency optimization in smart shopping carts through edge computing. They developed techniques to offload tasks to edge devices, aiming to reduce power consumption, prolong battery life, and enhance system sustainability.

4. Kim D, & Park S (2022) developed a smart shopping cart localization system utilizing computer vision techniques. They implemented algorithms to analyze visual data for precise localization, aiming to enhance cart positioning, facilitate navigation, and improve shopping efficiency.

5. Li Q & Wu J (2023) investigated inventory management in smart shopping carts using RFID technology. They implemented RFID tags and readers for real-time tracking, aiming to optimize inventory, reduce stockouts, and enhance supply chain efficiency.

CHAPTER 3

METHODOLOGY

The Block Diagram for the CartMate is depicted in fig 3.1

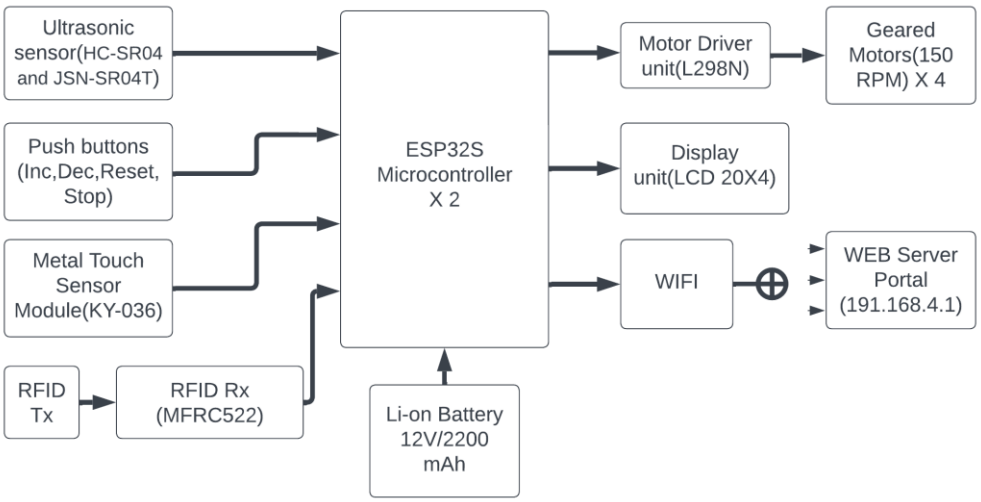

Figure 3.1 Block Diagram of CartMate.

In developing "CartMate - An automated shopping companion," we employed a comprehensive methodology to integrate various sensors and components for efficient functionality. The system relies on inputs from ultrasonic sensors, IR sensors, weight sensors, touch sensors, voltage sensors, RFID cards, and their respective readers. The Arduino Mega acts as the central processing unit, coordinating the gathered information. The RFID card reader authenticates users, while RF receivers and transmitters facilitate wireless communication. Additionally, battery voltage is monitored using the voltage sensor. The system outputs are managed through geared motors, providing mobility to CartMate, a display screen for user interaction, and a push button for manual control. This methodology ensures seamless communication between sensors, the Arduino controller, and the diverse output components, creating an intelligent and user-friendly automated shopping companion.

CHAPTER 4

HARDWARE AND SOFTWARE REQUIREMENTS

4.1 HARDWARE REQUIREMENTS

4.1.1 ESP 32S MICROCONTROLLER

- ESP32 is a dual-core XTensa LX7 MCU, capable of running at 240 MHz. Apart from its 512 KB of internal SRAM, it also comes with integrated 2.4 GHz, 802.11 b/g/n Wi-Fi and Bluetooth 5(LE) connectivity that provides long-range support. It has 45 programmable GPIOs and supports a rich set of peripherals.
- The ESP32 microcontroller board is a versatile and powerful development platform that has gained significant popularity in the world of embedded systems and Internet of Things (IOT) applications. It is based on the ESP32 system-on-chip (SOC) designed by Espressif Systems, a leading semiconductor company.
- The ESP32 board combines a dual-core processor, wireless connectivity options, and a rich set of peripherals, making it a suitable choice for a wide range of projects. It features two 32-bit Xtensa LX6 microprocessor cores, which can be clocked up to 240 MHz, offering substantial computational power for demanding tasks.

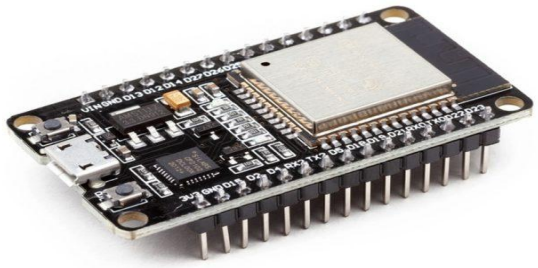

Figure 4.1 ESP32 MICROCONTROLLER

- One of the standout features of the ESP32 is its comprehensive wireless capabilities. It supports Wi-Fi, both 2.4 GHz and 5 GHz bands, allowing seamless connectivity to local networks or the internet.
- The ESP32 board also offers a multitude of interfaces and peripheral options, including GPIO (General Purpose Input/Output) pins, I2C, SPI, UART, ADC, DAC, and more. These interfaces enable easy integration with various sensors, actuators, displays, and other components, facilitating the development of complex and interactive projects.

4.1.2 COMPONENTS OF ESP32 BOARDS:

- Pin Description of ESP32 Microcontroller board as shown in below Figure

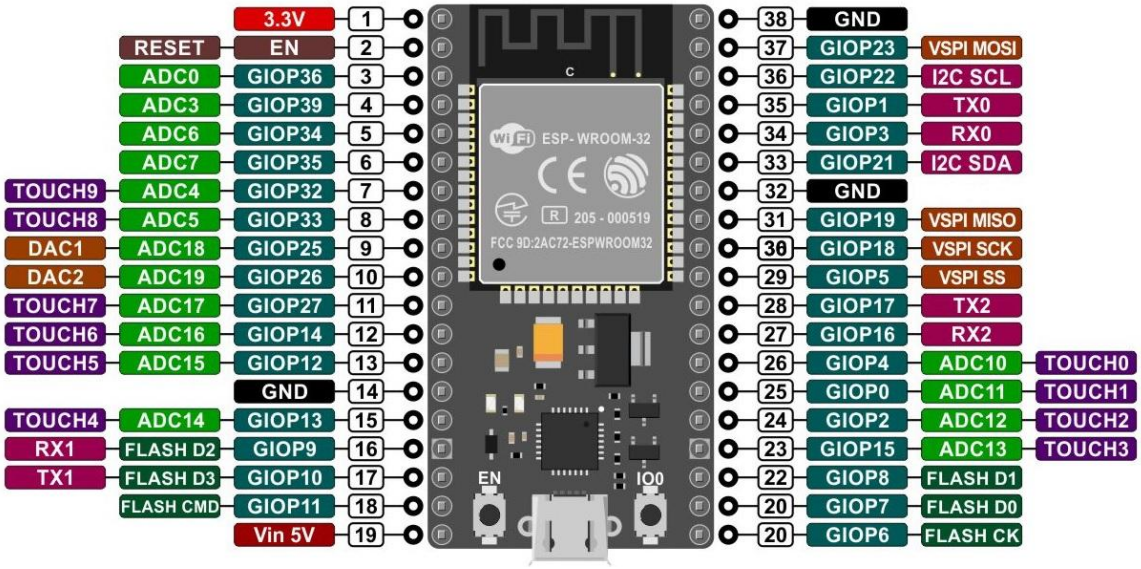

Figure 4.2 Pin Description of ESP32 Microcontroller Board

Functional Description of the Pins

- **GPIO Pins**: General Purpose Input /Output pins used for digital input/output operations. They can be configured as digital input or output, and some pins have additional functionality such as PWM, I2C, SPI, etc
- .**Analog Input Pins**: These pins allow analog voltage measurements using the built-in ADC (Analog-to-Digital Converter) of the ESP32. They can measure voltages ranging from 0 to 3.3V.

- **UART Pins**: Universal Asynchronous Receiver/Transmitter pins used for serial communication. They enable the board to communicate with other devices using protocols such as RS-232, RS-485, or MIDI.
- **I2C Pins**: Inter-Integrated Circuit pins used for connecting the ESP32 to I2Ccompatible devices like sensors and displays. I2C allows for multiple devices to be connected on the same bus using only two wires (data and clock).
- **SPI Pins**: Serial Peripheral Interface pins used for high-speed synchronous serial communication between the ESP32 and peripheral devices like sensors, displays, and memory chips. SPI supports full-duplex communication and can connect multiple devices using chip select lines.
- **PWM Pins:** Pulse Width Modulation pins used to generate analog-like signals with varying duty cycles. These pins are often used to control the brightness of LEDs, control motor speed, or generate audio signals.
- **DAC Pins:** Digital-to-Analog Converter pins used to generate true analog voltage signals. They provide a higher resolution for analog output compared to PWM pins.
- **RTC GPIO Pins**: These pins can be used for various purposes, including deep sleep wake-up sources, external interrupt inputs, or pulse counter inputs.
- **Touch Sensor Pins:** The ESP32 has built-in touch sensor support, and these pins are used to connect touch-enabled electrodes or capacitive touch sensors.
- **ADC Reference Voltage Pins:** These pins are used to set the reference voltage for the ADC. They allow you to select the voltage range for analog measurements.
- **Power Supply Pins:** These pins provide power to the ESP32 board. They include VCC (3.3V or 5V), GND (Ground), and VIN (Voltage Input) for external power supply.
- **LED Pins:** These pins are typically connected to LEDs on the board, which can be used for status indication or custom use.

4.1.3 ULTRASONIC SENSOR (HC-SR04)

- An ultrasonic sensor is a device that uses ultrasonic waves to measure distances and detect objects.
- It operates based on the principle of sending out ultrasonic sound waves and then measuring the time it takes for the waves to bounce back after hitting an object.
- Ultrasonic sensors typically operate at frequencies ranging from 20 kHz to several tens of kHz.
- Measurement range 2 to 400 cm and the operating range is 5V.

Figure 4.3 Ultrasonic sensor

4.1.4 METALTOUCH SENSOR (KY-036)

- Touch sensors work similar to a switch. When they are subjected to touch, pressure or force they get activated and acts as a closed switch. When the pressure or contact is removed they act as an open switch. The operating voltage range is 2V - 5.5V DC.
- This is used to disable all the movements which are generated electrically hence making it act like a mechanical cart which can be pulled manually.

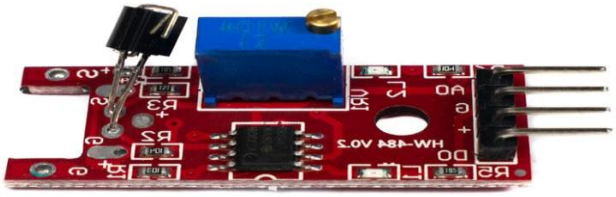

Figure 4.4 Metal touch sensor KY-036

4.1.5 PUSH BUTTONS

- A push-button (also spelled pushbutton) or simply button is a simple switch mechanism to control some aspect of a machine or a process.
- Buttons are typically made out of hard material, usually plastic or metal.
- The surface is usually flat or shaped to accommodate the human finger or hand, so as to be easily depressed or pushed.

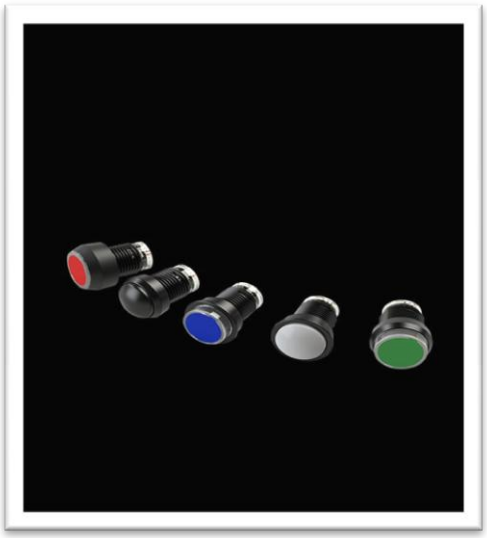

Figure 4.5 Push Buttons

4.1.6 RFID CARD AND RFID READER (MFRC522)

- An RFID card is equipped with radio frequency identification technology.
- EM-18 RFID Reader Module 125 KHz, is one of the commonly used modules for Radio Frequency Identification Projects. It can be directly interfaced with a microcontroller using UART communication.
- This module can work with any 125KHz RFID tags.
- This RFID card with reader is used in this prototype to detect cart item and their details such as price, name and type.
- The user should slide a RFID card on the reader which is installed in cart to detect and generate the BOM.

Figure 4.6 RFID Card and Reader

4.1.7 GEARED MOTORS (150RPM)

- These motors are designed to generate high torque at very low RPM.
- The operating voltage of this motor is12v.
- It is driven by the motor driver board L298N.
- The wheels will be installed on to the rotor.The 4 motors are installed in this prototype model to get back and forth movements of the cart.

Figure 4.7 Geared motor (25GA)

4.1.8 MOTOR DRIVER (L298N)

- This L298N Motor Driver Module is a high power motor driver module for driving DC Motors.
- This module consists of an L298 motor driver IC.Motor Supply Voltage (Maximum) is 46V.Motor Supply Current (Maximum) is 2A.Logic Voltage is 5V.Driver Voltage ranges from 5-35V.
- This driver is used to amplify the weak signal of the Arduino mega 2560 to power the high torque 25GA motors.

Figure 4.8 Motor driver (L298N)

4.1.9 BATTERY (12V/2200mAh)

- Battery is combination of cells connected in series which helps to store electrical power.
- In this prototype the voltage of 12V and capacity of 2200mAhis used to power the electrical equipments.

Figure 4.9 Battery (12V/7AH)

4.1.10 LCD DISPLAY (20x2)

- LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation.
- LCD's are used to visualize the characters, numbers or any special characters graphically on the screen.
- The LCD of 20x2 is used to display the cart items and their details in this prototype.

Figure 4.10 LCD(20x2)

4.2 SOFTWARE REQUIREMENTS

4.2.1 ARDUINO IDE

The software used is Arduino IDE 1.8.19. The open source Arduino software (IDE) makesit easy to write codeand upload it to the board.The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Microcontroller. Arduino IDE is the computer software. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment.The open sourceArduino IDE makes it easy to write code and upload it to the Arduino Uno for execution.

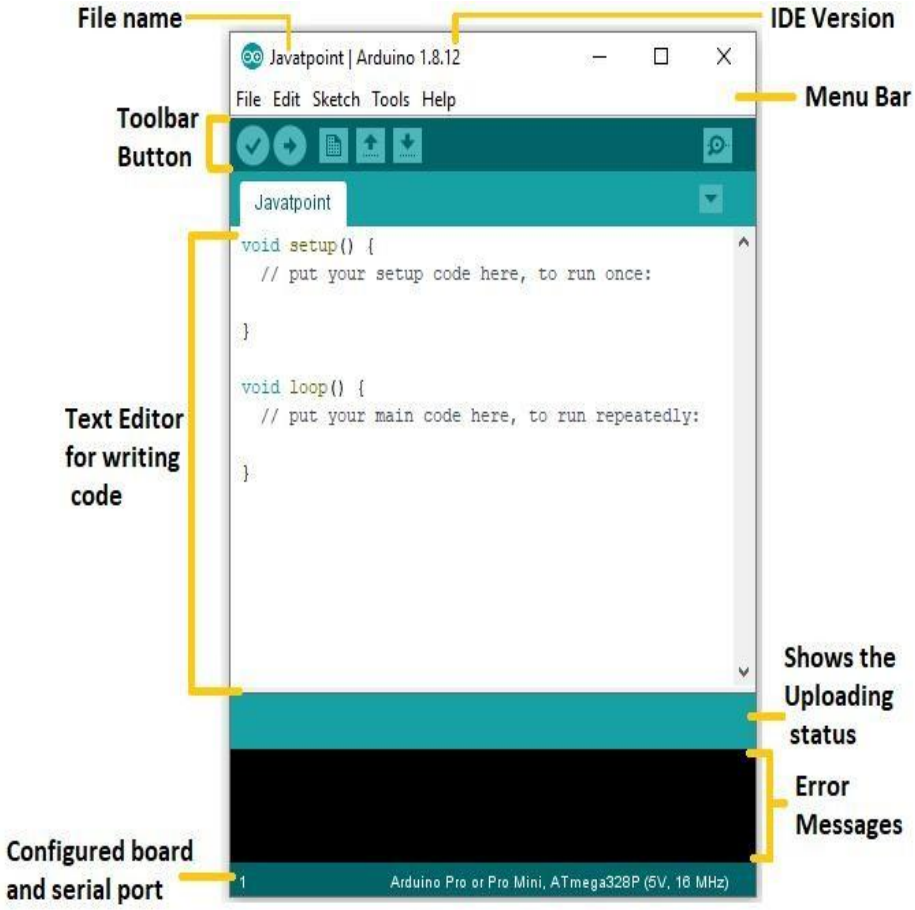

Figure 4.11 Arduino IDE Page

CHAPTER 5

WORKING PRINCIPLE AND IMPLEMENTATION

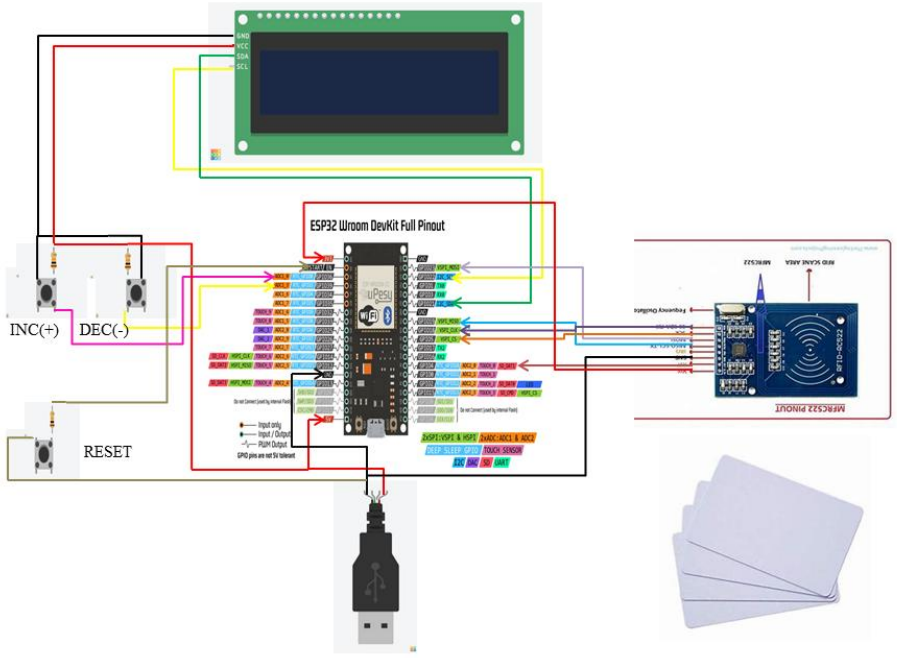

Figure 5.1 Implementation Diagram for Shopping System

"CartMate: An Automated Shopping Companion", is an innovative solution in the field of Retail industry. It is a smart shopping cart system designed to enhance the shopping experience by integrating automation and real-time connectivity.

The heart of the system is an ESP microcontroller, which serves as the central processing unit. It is connected to various input and output devices that enable the functionality of the CartMate.

The input devices include:

- An **Ultrasonic Sensor** located at the front of the CartMate. This sensor is responsible for the automatic human-following feature. It detects the presence and distance of the shopper and guides the CartMate to follow them at a safe distance.
- An **RFID Transceiver** used for scanning the barcodes of the shopping items. Each item, when scanned, is automatically added to the shopping list.

- A **Metal Touch Sensor** which allows the user to deactivate the automatic human-following feature for a specific duration, providing flexibility and control to the shopper.
- A **Motor Driver Unit** that manages the operations of the Geared Motor Drivers, controlling the direction of the CartMate and the direction of rotation of the wheels.

The output devices include:

- **Geared Motor Drivers** that control the movement of the CartMate based on the inputs from the Ultrasonic Sensor and the Motor Driver Unit.
- An **LCD Display** that shows real-time information about the currently scanned item, enhancing the user's awareness of their shopping list.
- A **Wi-Fi Module** integrated in the ESP microcontroller. This module sends the final bill to the customer's mobile phone upon completion of shopping, providing a paperless and efficient billing solution.

Hence, CartMate is a comprehensive, automated, and user-friendly shopping companion that leverages advanced electronics and communication technologies to revolutionize the traditional shopping experience. This methodology ensures seamless communication between sensors, the ESP-32 controller, and the diverse output components, creating an intelligent and user-friendly automated shopping companion.

5.1 FLOWCHART

Figure 5.2 illustrates the flowchart detailing the methodology of the proposed work, which conveys the process of identifying and following the human utilizing various sensors.

Step 1: The CartMate is initialized using the switches on its dashboard. The customer should connect to the CartMate's Wi-Fi.

Step 2: Once the system is initialized, the ultrasonic sensor continuously checks for any intervention using sound waves. If the distance is equal to the default distance (the distance set for the CartMate to follow the individual), then the CartMate will follow the customer.

Step 3: The customer scans the item to be purchased using the RFID scanner available on the dashboard. They can increment or decrement the number of items.

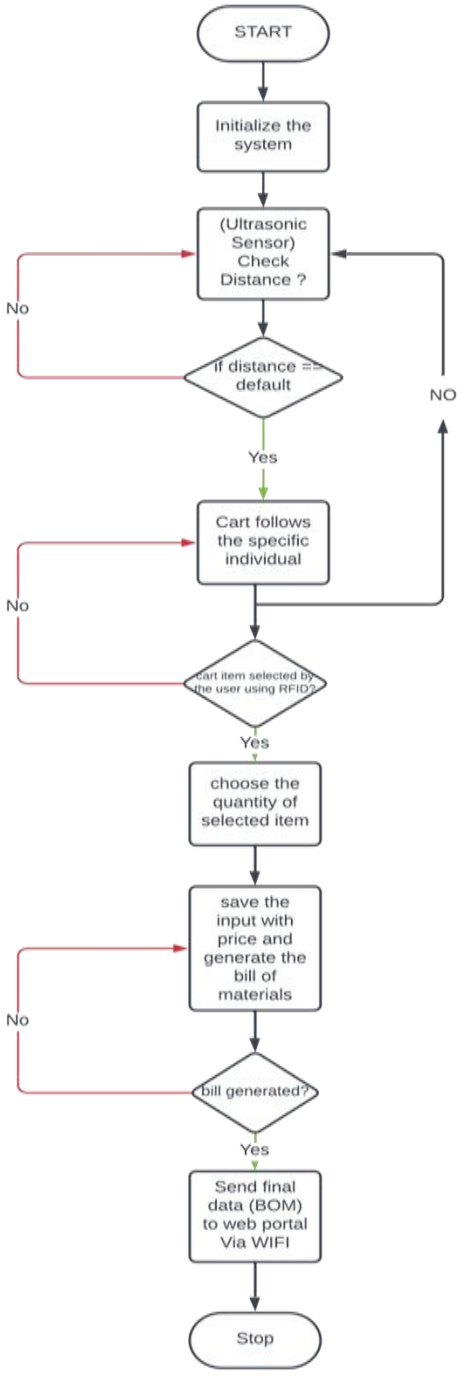

Figure 5.2 Flowchart of the proposed model

Step 4: The list of items purchased is updated on the website in real time through the customer's mobile phone. The customer can initiate payment using the payment gateway available on the website.

Step 5: Upon successful payment, the customer can leave the shopping area hassle-free.

.CHAPTER 6

RESULTS AND DISCUSSION

Figure 6.1 The CartMate Prototype

Figure 6.1 illustrates the prototype circuitry of the CartMate system. Upon initialization (powering on), the user is required to connect to the CartMate's local Wi-Fi network. It is essential for the user to remain within the operational range of the CartMate for it to effectively follow the user. This range is typically set between 30 to 40 cms to prevent interference from other users within proximity of the CartMate.

Figure 6.2 CartMate greeting customers

Figure 6.2 demonstrates that the CartMate system is in ‘follow’ mode, ready to accompany the user. This state is signified by a specific greeting displayed on the LCD dashboard of the CartMate.

Figure 6.3 After Scanning The Item

Figure 6.3 depicts the initial item scanned (represented by ‘bingo’ in the referenced image). This action is accomplished by utilizing the RFID scanner located on the CartMate’s dashboard.

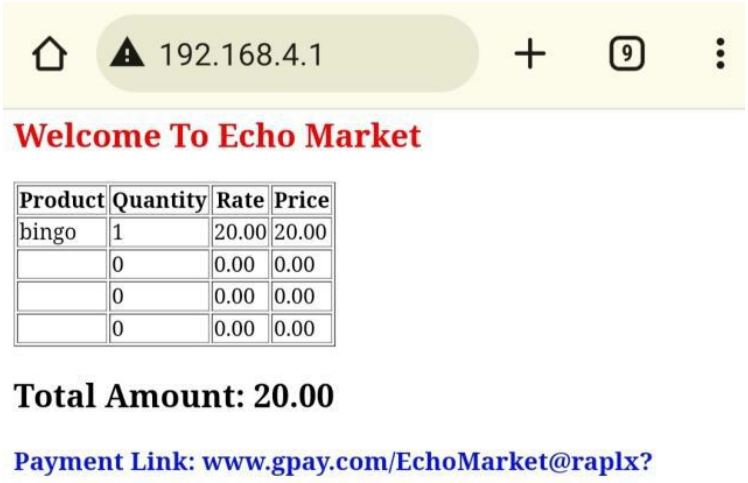

Figure 6.4 Scanned Item is Updated in Customers Mobile Phone

Figure 6.4 illustrates that the information of the initial scanned item is transmitted in real-time to the user’s mobile device via Wi-Fi.

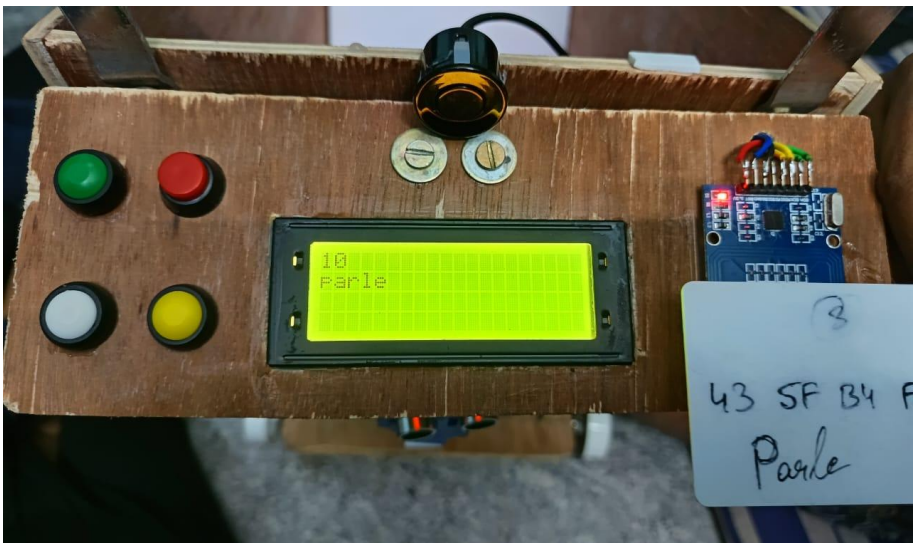

Figure 6.5 Next Scanned Item

Figure 6.5 presents the second item scanned (represented by ‘parle’ in the referenced image). This process is also executed by using the RFID scanner integrated into the CartMate’s dashboard.

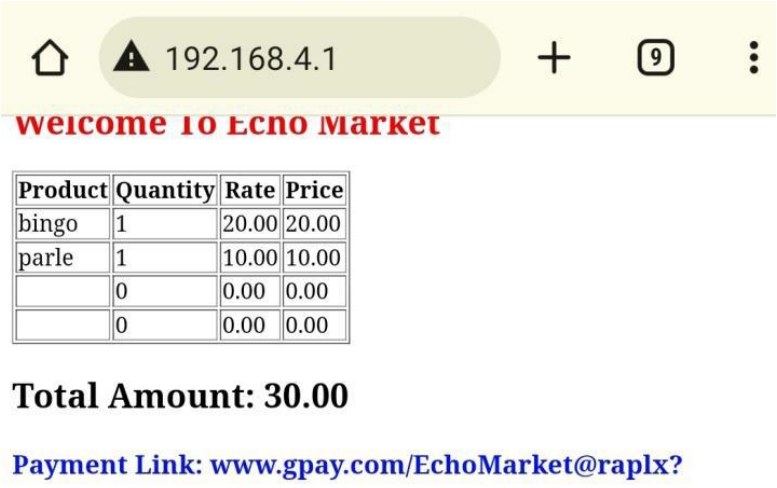

Figure 6.6 Next Scanned Item Updated

Figure 6.6 illustrates that the second item, once scanned, is updated in real-time to the customer’s mobile phone via Wi-Fi.

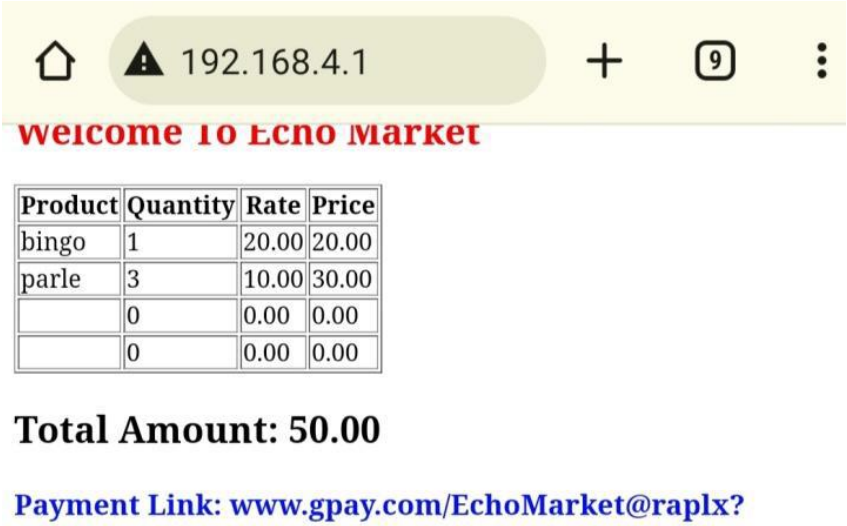

Figure 6.7 Items Incremented, Total Amount an Payment Gateway Displayed

Figure 6.7 demonstrates that upon completion of the customer's shopping, the website displays the total number of items added to the cart, the total payable amount, and provides a payment gateway integrated within the website for the customer's convenience to complete the payment.

CHAPTER 7

ADVANTAGES AND DISADVANTAGES

7.1 ADVANTAGES

- The CartMate uses various sensors to follow the customer around the store, providing a hands-free shopping experience.
- The system generates the bill automatically through WiFi, eliminating the need for manual checkout.
- The bill is directly sent to the customer's mobile phone, making it easy to keep track of purchases, in the context of the pandemic, this system provides a contactless and hygienic shopping experience.
- Automated shopping carts significantly reduce the time spent shopping by integrating with your shopping list and automatically checking off items as you pick them.

7.2 DISADVANTAGES

- The technology behind autonomous checkout may require a larger investment, which could be a barrier for some retailers.
- The automated system reduces the amount of human interaction, which some customers may miss.

CHAPTER 8

APPLICATIONS

- The CartMate can be used in supermarkets and grocery stores to provide a seamless shopping experience.
- Departmental stores can use this technology to enhance the shopping experience and increase efficiency.
- In large warehouse stores, CartMate can help customers navigate and manage their purchases efficiently.
- Pharmacies can use CartMate to provide a contactless shopping experience, especially beneficial for elderly or immunocompromised customers.
- In electronics stores, where products can be expensive, CartMate can provide additional security by tracking the items in the cart.
- In clothing stores, CartMate can provide a unique shopping experience by automatically adding items to the bill when customers decide to purchase them.
- Libraries can use CartMate for an automated check-out and check-in system for books.
- In cafeterias, CartMate can be used for automatic billing of food items, reducing the need for manual checkouts.
- In hardware stores, where items can be bulky, CartMate can provide a hands-free shopping experience.
- In exhibitions and trade fairs, CartMate can be used for automatic billing of items, making the purchasing process smooth and efficient.

CHAPTER 9

CONCLUSION AND FUTURE SCOPE

In conclusion, CartMate: An Automated Shopping Companion" is a groundbreaking project in retail technology. It enhances the shopping experience with a human-following feature and an automated billing system. The former provides customer assistance and reduces physical strain, while the latter streamlines checkout, reduces wait times, and improves customer satisfaction by using advanced scanning and payment technologies. This solution allows retail staff to focus on complex customer issues, improving service quality. CartMate sets a new standard for retail experiences, demonstrating the transformative potential of technology in retail operations. It paves the way for future innovations in the sector.

- **FUTURE SCOPE**

The future scope of this project in the retail industry is immense. As retail spaces continue to evolve, technologies like CartMate can be further enhanced to include features like personalized product recommendations based on shopping history, real-time inventory management, and seamless integration with online platforms for a unified shopping experience. Moreover, with the advent of Internet of Things (IoT) and Artificial Intelligence (AI), CartMate can be equipped with predictive analytics for anticipating customer needs, smart inventory replenishment, and even autonomous navigation within complex retail environments.

In essence, CartMate sets a new standard for retail experiences, demonstrating the transformative potential of technology in retail operations. It not only paves the way for future innovations in the sector but also serves as a testament to the limitless possibilities that lie at the intersection of technology and customer service. It is a beacon of the future of retail, shining light on the path towards a more efficient, customer-centric, and technologically advanced retail industry.

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BUDGET DETAILS

Budget	Amount
a) Materials / Consumables: ESP32 Microcontroller, Ultrasonic Sensor, RFID Transreceiver, Geared Motors, Motor Driver Unit, Battery, LCD Display, Push Buttons, Cart Container, PCB Board, RFID Cards	14000
b) Labour Prototype making charges	2000
c) Travel Transportation Charges for project survey	1500
d) Miscellaneous Report, Hardcopy, Binding	2500
Total	20000