SMART SHOPPING CART

GE19612 - PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP

Submitted by

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MAY 2024

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BONAFIDE CERTIFICATE

Certified that this project report **"SMART SHOPPING CART"** is the bonafide work of **"MURALI KRISHNA. L (2116210801117), METHUN RAJ. M (2116210801108), KISHORE. M (2116210801088)"** who carried out the project work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate

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Submitted to Project and Viva-Voce Examination held on ______________

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ACKNOWLEDGEMENT

We thank God Almighty for enabling us to complete our project work. Our sincere thanks to our Chairperson **Dr. (Mrs.) Thangam Meganathan**, for her sincere endeavor in educating us in his premier institution. We like to express our deep gratitude to our beloved Vice Chairman **Mr. Abhay Shankar Meganathan, B.E., M.S.** for his enthusiastic motivation which is a lot in completing this project.

We would like to thank our Principal **Dr. S.N. Murugesan, M.E., Ph.D.,** for his kind support and the facilities provided to carry out our work. We would also like to thank our Head of the Department **Dr. L. Bhagyalakshmi, M.E., Ph.D.,** and Academic Head **Dr. S. Chitra, M.E., Ph.D.,** for giving the opportunity and facilities to complete our work in time.

We take this opportunity to express our profound gratitude and deep regards to our Supervisor **Dr. V. Anusooya, M.E, Ph.D, AP(SG)/ECE,** Department of Electronics and Communication Engineering for his/her exemplary guidance, monitoring and constant encouragement throughout the course of this project.

We express our gratitude to the project coordinators **Mr.D.Gururaj, Dr.B.Thilakavathi, Ms.P.Shanmuga Priya and Ms.D.Sasirekha** for their moral support and valuable suggestions in the project. We also would like to thank our parents and classmates for their kind cooperation in doing our project work.

ABSTRACT

The Smart Shopping Cart project improves the shopping experience by merging technology with convenience. It all starts with a user-friendly interface where customers input their shopping list to a user interface containing buttons and an OLED display screen. This streamlines the process of creating a list and ensures accuracy. Once the list is finalized, the cart, equipped with advanced features like a line follower and RFID reader, takes over. As it moves through the store, the RFID reader detects tags placed near each item, allowing the cart to autonomously navigate the aisles. When the cart encounters a tagged item matching the list, it halts, signaling a robotic arm nearby. The arm swiftly retrieves the item and places it in the cart, continuing until the list is complete. This synchronized process enhances efficiency, making shopping quicker and easier for customers. They can enjoy a hands-free experience as the cart takes care of the legwork. Meanwhile, store personnel benefit from streamlined operations, reducing the need for manual labor. Overall, the Smart Shopping Cart project represents a significant advancement in retail technology, promising a more seamless and enjoyable shopping experience for all involved.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF SYMBOLS

Kb	Kilo bits
KHz	Kilo Hertz
MHz	Mega Hertz
V	Voltage

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADC	Analog-to-Digital Converter
DC	Direct Current
EEPROM	Electrical Erasable Programmable Read Only Memory
IDE	Integrated Development Environment
LF	Low Frequency
NFC	Near Field Communication
OLED	Organic Light Emitting Diode
RFID	Radio Frequency Identification
UHF	Ultra High Frequency
UPC	Universal Product Code
USB	Universal Serial Bus

CHAPTER 1
INTRODUCTION

The Smart Shopping Cart project represents a significant advancement in retail technology, aiming to enhance the shopping experience for customers while optimizing operational efficiency for store personnel. At its core, the project integrates modern technology into the traditional shopping process, streamlining tasks and offering convenience at every step.

The project begins with an interactive interface designed to simplify the creation of a shopping list. Customers input their list to the interface which contains push buttons and an OLED display. By leveraging technology to digitize the shopping list creation process, the project ensures accuracy and reduces the time spent on manual list-making. Once the shopping list is finalized, the list is sent to the next phase of the system, which is the cart equipped with line follower with RFID reader concept, that allows the cart to autonomously move around the mart. The RFID tags are placed near their products on the line that the cart navigates through. If the RFID reader reads the tag that, the it stops immediately and sends signal to the next phase of the system, the robotic arm. After receiving the signal, the robotic arm pics the product in that place and places the item in the cart. This process repeats until the shopping list is over and returns back to the starting point where the end RFID card is placed and if it reads that card, the cart stops.

The Smart Shopping Cart project is trying to fix these problems by using technology to make shopping easier and more efficient. The project is creating a special kind of shopping cart that can help you with your shopping list and find items for you in the store. It's like having a personal shopping assistant right there with you. One of the main things the Smart Shopping Cart does is help you make your shopping list. Instead of writing your list on a piece of paper, you can use the cart's special screen to input all the things you need to buy. It's really easy to do – you just press some buttons to add items to your list. This way, you won't forget anything, and you'll know exactly what you need to buy when you get to the store.

Figure 1.1 Smart Shopping Cart

Once your list is ready, the Smart Shopping Cart goes to work. It's equipped with special sensors and technology like Line Follower with RFID tag reader concept that help it navigate around the store and find the items on your list. These sensors help the cart move safely within the Mart through the line. When the cart detects the RFID tag the resembles an item on your list, it stops and uses a robotic arm to pick up the item and put it in the cart for you. By using technology to automate these tasks, the Smart Shopping Cart project aims to make shopping faster, easier, and more enjoyable for everyone. You won't have to spend as much time wandering around the store looking for things, and you'll always be able to find what you need. Plus, store workers will have more time to help you and other shoppers, making the whole shopping experience better for everyone.

Figure 1.2 Crowd at Shopping Mart

The Smart Shopping Cart is all about using technology to make shopping easier and more enjoyable for everyone involved. It's like having a personal shopping assistant right there with you! One of the things it does is help you make your shopping list. Instead of writing your list on a piece of paper, you can use the cart's special screen to input all the things you need to buy. It's really easy to do – you just press some buttons on the screen to add items to your list. This way, you won't forget anything, and you'll know exactly what you need to buy when you get to the store.

Once your list is ready, the Smart Shopping Cart goes to work. It's equipped with special sensors and technology that help it navigate around the store and find the items on your list. These sensors help the cart move safely through the aisles without bumping into anything or anyone. When the cart finds an item on your list, it stops and uses a robotic arm to pick up the item and put it in the cart for you.

Figure 1.3 Aged People Shopping at the Shopping Mart

This real-time inventory tracking has numerous benefits for both stores and shoppers. For stores, it means they can optimize their inventory levels, reducing the likelihood of overstocking or running out of popular items. This not only improves the shopping experience for customers but also helps stores maximize their profits by minimizing waste and ensuring they always have the products their customers want. Additionally, the Smart Shopping Cart project has the potential to transform the way stores interact with their customers.

Moreover, the Smart Shopping Cart project has the potential to drive innovation and collaboration within the retail industry. As more stores adopt this technology, there will be increased demand for solutions that integrate with the Smart Shopping Cart system, such as inventory management software and data analytics tools. This presents an opportunity for technology companies to develop new products and services tailored to the needs of retailers, driving innovation and growth in the retail technology sector. Furthermore, the Smart Shopping Cart project has implications beyond just the retail industry. Whether it's automating tasks, optimizing inventory management, or personalizing the customer experience, the principles behind the Smart Shopping Cart project can be applied to a wide range of sectors, driving progress and innovation across the board.

CHAPTER 2
LITERATURE SURVEY

[1] The paper titled **"A IoT-based Smart Cart System"**, Sakthivel S, Akash Ram R. K, Sidarth Sai B, Vijaya Kesavan K. M, Ganesh Kumar C, 2022, discusses about a system that combines artificial intelligence and IoT to optimize shopping experiences. This research underscores the IoT in creating intelligent retail solutions tailored to individual needs, promising more satisfying and tailored shopping experiences. Additionally, the real-time nature of the A IoT-based smart cart system enables retailers to adapt to changing customer preferences and market trends, ensuring a seamless and satisfying shopping experience for customers. Overall, this research demonstrates the potential of A IoT-based smart cart systems to revolutionize the retail industry, offering retailers a powerful tool to enhance customer satisfaction and drive sales.

[2] The paper titled **"IoT-based Smart Shopping System"**, Vidumith Perera, Lakdinu Ekanayake, Ama Bandara, Dinithi Shakya, Udesh S. Oruthota, 2021, discusses about the system designed to enhance convenience and sustainability in retail operations. Leveraging IoT devices and sensors, the system enables personalized shopping experiences, resource optimization, and reduced environmental impact. Overall, this research demonstrates the potential of IoT-based smart shopping systems to revolutionize the retail industry, offering retailers a powerful tool to enhance sustainability, efficiency, and customer satisfaction.

[3] The paper titled, **" Smart Shopping Cart using IOT and Robotic Arm "**, Anitta D, Sahana Siddappa Guddad, Anusha S, Karthik Yanamala, Sahithi S, 2021, introduce a novel smart shopping cart equipped with IoT capabilities and a robotic arm for enhanced functionality. The system enables automated item selection, placement, and checkout processes, reducing the need for manual intervention. Leveraging IoT and robotics, the smart cart offers unparalleled convenience and

efficiency, ushering in seamless, hands-free shopping experiences in retail environments. By automating the shopping process, the smart cart reduces wait times, minimizes errors, and enhances the overall shopping experience for customers. Overall, this research demonstrates the transformative impact of smart cart solutions in modernizing the retail industry, offering retailers a powerful tool to enhance customer satisfaction and drive sales.

[4] The paper titled, **“Smart Cart: A Distributed Framework”**, Bipin Kumar Yadav, Akash Burman, Abhoy Mahato, Manish Choudhary, and Anirban Kundu, 2020, propose a distributed framework for smart cart systems, prioritizing scalability and flexibility. This study underscores the necessity of robust infrastructure to support smart retail solutions, laying the foundation for scalable implementations in diverse retail environments. The distributed framework enables seamless communication and data sharing between cart components, ensuring efficient operation even in large-scale retail settings. By prioritizing scalability and flexibility, this research sets the stage for widespread adoption of smart cart technologies, promising improved efficiency and customer satisfaction in retail environments worldwide. Overall, this distributed framework represents a significant step forward in the evolution of smart retail solutions, offering retailers a scalable and adaptable platform to enhance their operations.

[5] The paper titled, **“A Smart Trolley for Smart Shopping”**, A. Yewatkar, F. Inamdar, R. Singh, Ayushya and A. Bandal, 2020, introduce a smart trolley concept aimed at elevating the shopping experience with advanced automation and connectivity features. By integrating IoT, the smart trolley facilitates real-time inventory management, personalized recommendations, and seamless checkout processes. This research underscores the potential of smart trolleys to reshape traditional shopping paradigms through data-driven insights and automation, promising enhanced convenience and efficiency. The seamless checkout process facilitated by the smart trolley further improves efficiency and reduces wait times,

enhancing the overall shopping experience. Overall, this research highlights the transformative impact of smart trolleys in modernizing retail operations, offering retailers a powerful tool to enhance customer satisfaction and drive sales.

[6] The paper titled **“Simultaneously Shop, Bag, and Checkout (2SBC-Cart): A Smart Cart for Expedited Supermarket Shopping”**, Thomas Arciuolo, Abdel-shakour Abuzneid, 2020, discusses about a smart shopping cart that will revolutionize supermarket visits. The innovative cart enables simultaneous selection, bagging, and checkout, reducing wait times and enhancing efficiency. This research emphasizes smart cart technologies' transformative role in retail, promising more seamless experiences for consumers and improved operational efficiency for retailers. The cart's intuitive design and user-friendly interface make it accessible to a wide range of consumers, regardless of technological proficiency. Overall, this innovative solution represents a significant advancement in smart retail technology, promising a more convenient and efficient shopping experience for consumers worldwide.

[7] The paper titled, **“IoT-enabled smart shopping system”**, Ruinian Li, Tianyi Song, Nicholas Capurso, Jiguo Yu, Jason Couture, Xiuzhen Cheng, 2017, emphasizing security and efficiency. By integrating RFID and sensor technologies, the system ensures secure transactions and smooth shopping experiences. This study showcases IoT's potential in enhancing retail processes while addressing security concerns, marking a significant stride in smart retail solutions. Leveraging IoT, the system enables real-time inventory tracking, personalized recommendations, and streamlined checkout processes, offering consumers a seamless and secure shopping experience. The integration of IoT in retail not only enhances operational efficiency but also opens avenues for personalized marketing and customer engagement. By leveraging data insights, retailers can gain a deeper understanding of consumer behaviour and preferences, thereby improving product offerings and driving sales. Additionally, the enhanced security measures provided by IoT technologies mitigate

risks associated with theft and fraud, fostering trust and confidence among consumers. Overall, this research underscores the transformative impact of IoT in revolutionizing traditional retail paradigms.

[8] The paper titled, **"Smart Shopping Cart"**, Akshay Kumar, Abhinav Gupta, S. Balamurugan, S. Balaji, R. Marimuthu, 2017, introduce a smart shopping cart with advanced features to enrich user experiences and streamline shopping processes. By integrating IoT and sensors, the smart cart facilitates automated item tracking, navigation assistance, and personalized recommendations. This study highlights the potential of smart cart solutions to revolutionize retail experiences through cutting-edge technologies, offering unparalleled convenience and efficiency to shoppers. The smart cart's advanced features, such as automated item tracking and personalized recommendations, enhance the shopping experience by reducing friction points and providing valuable insights to customers. Additionally, the integration of IoT sensors enables retailers to gather data on customer behavior and preferences, allowing for targeted marketing and improved inventory management. Overall, this research demonstrates the transformative impact of smart cart solutions in modernizing the retail industry, offering retailers a powerful tool to enhance customer satisfaction and drive sales.

CHAPTER 3
EXISTING METHOD

The 2SBC-Cart is a Smart Cart designed to revolutionize the traditional supermarket shopping experience. The 2SBC-Cart aims to streamline the shopping process by combining shopping, bagging, and checkout into one seamless activity, eliminating the need for multiple loading and unloading of groceries. This innovative technology leverages RFID and barcode scanning, IoT connectivity, and cloud-based data storage to create a more efficient and convenient shopping experience for both customers and store management.

The traditional process of supermarket shopping involves customers navigating through aisles, selecting items, placing them in a cart, proceeding to the checkout counter, unloading the items for scanning, bagging the items, and then reloading them back into the cart for departure. This process is labor-intensive and time-consuming, often requiring multiple handling of products. The 2SBC-Cart proposes a new methodology that simplifies this process by integrating shopping, bagging, and checkout into a single unified activity.

At the core of the 2SBC-Cart is the use of advanced technology components such as RFID and barcode scanners, load cells for weighing items, Raspberry Pi microcontrollers, WiFi connectivity, GPS devices, and a cloud-based server. These components work together to enable the cart to scan items as they are placed in the cart, weigh the items for verification, and communicate with the cloud for data storage and analysis. The integration of these technologies allows for real-time tracking of customer activities, accurate purchase verification, and seamless communication between the cart and the cloud-based server.

The 2SBC-Cart is designed to enhance the shopping experience for customers by simplifying the process of selecting and purchasing items. Customers can scan items with RFID or barcode tags as they place them in the cart, eliminating the need for manual scanning at the checkout counter. The cart's load cells ensure that the weight of the items matches the expected weight stored in the cloud database, providing a reliable verification mechanism. Additionally, the cloud-based storage system allows customers to review their current list of items and provides store management with valuable data for analysis and decision-making.

Figure 3.1 2SBC – Cart Components

The 2SBC-Cart offers a valuable case study in the application of IoT technology in a real-world setting. By studying the design and functionality of the 2SBC-Cart, students can gain insights into how IoT devices, sensors, and cloud computing can be integrated to create innovative solutions for everyday challenges. The use of Raspberry Pi microcontrollers and WiFi connectivity demonstrates how hardware and software components can work together to automate processes and improve efficiency.

The implementation of the 2SBC-Cart involves the use of seven Raspberry Pi units, with one unit serving as the central control unit for the cart. This unit is equipped with a scanner/camera for RFID and barcode scanning, load cells for weighing items, and a GPS device for customer location tracking. The cart communicates with the cloud-based server via WiFi, enabling data transfer and remote monitoring of cart activities. A custom Python program is developed to manage the cart's operations, including weighing items, extracting RFID/barcode data, and activating GPS for location tracking.

The high-level diagram of the 2SBC-Cart illustrates the connection of its major components to the Raspberry Pi microcontroller and the cloud-based server. The diagram shows how the cart communicates with the server via WiFi, enabling real-time data transfer and analysis. The system is designed to provide a seamless shopping experience for customers, allowing them to scan items, weigh them, and track their purchases without the need for manual intervention.

The 2SBC-Cart represents a significant advancement in supermarket shopping technology, offering a more efficient and convenient alternative to traditional shopping methods. By combining RFID and barcode scanning, IoT connectivity, and cloud-based data storage, the 2SBC-Cart streamlines the shopping process and enhances the overall customer experience. The integration of advanced technology components and the use of a custom control program demonstrate the potential of IoT solutions in optimizing everyday tasks and improving operational efficiency.

The 2SBC-Cart presents a compelling solution to the challenges of traditional supermarket shopping, offering a more efficient and user-friendly alternative for customers and store management. By leveraging IoT technology and cloud-based data storage, the 2SBC-Cart simplifies the shopping process, reduces the need for manual handling of products, and provides valuable insights for store management. The innovative design and functionality of the 2SBC-Cart showcase the potential of IoT solutions in transforming everyday tasks and enhancing the overall shopping experience.

CHAPTER 4
PROPOSED METHODOLOGY

In order to achieve our objective for the Smart Shopping Cart, we have to build a hardware system that consists of an User Interface consists of OLED Display, Arduino UNO R3 and push buttons, Line-Follower with RFID Reader configuration consists IR Sensors, RFID reader, Arduino UNO R3, L298N Motor Driver and BO Motors, and a Robotic Arm made up of Servo Motors and Arduino UNO R3. The User Interface will be attached in the Cart where the user can give the shopping list to the cart.

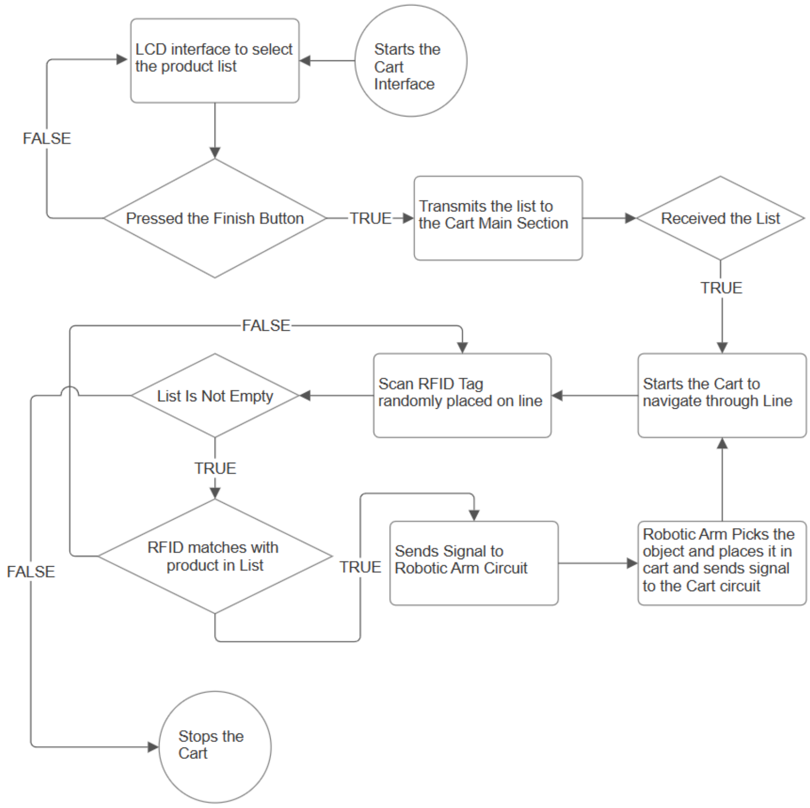

Figure 4.1 Block Diagram of Proposed Methodology

Consider the Figure 3.2, which represents the Block Diagram of our proposed system. Our main objective is to make shopping easier and stressless to the customers and as well as to the Shop-Keepers. We know that in most of the shops, there will be some crowd which delays the shopping time of the shoppers. It creates complication for the elder people in their shopping experience. It is also difficult for shop-keepers to manage so much customers at a time and do all their needs at the same time. It is also difficult for big shops to manage their inventory data such as how much of the stock of the product is available. To overcome these problems, we have proposed this system. The components used in the block diagram from Figure 3.1 is explained below individually.

First, there will be a User Interface made up of OLED Display and push buttons all connected to an Arduino UNO R3. The list of the products available in the Shopping Mart is displayed on the OLED Screen in order wise where there will be a box that will hover around the product name in the display which will act as a cursor for that interface. The user can navigate around the product list with the help of up and down buttons where the box on the screen simultaneously moves up and down. When the user gets to the required product name, he can use the select button to select the product, which will be added to the list.

After Finalizing the list, the customer can use the fourth button which is used to finish the list selection process and send the list to the second phase of the system, the Line-Follower and RFID Tag reader module, which is the main phase of the system. When the Arduino receives the list from the Interface Arduino, it starts the whole phase to operate. At first it starts to read signals from the IR Sensors and simultaneously send signals according to that to the L298N Motor Driver which is used to control BO Motors which causes the movement of cart. The cart follows the line and navigates across the Mart. There are RFID Tags placed on the line near the products placed. The RFID Reader continuously reads the RFID cards detected on the line during its navigation. If the detected RFID Card matches the product in the list, it stops there and send signal to the third phase of the system, the Robotic Arm module.

When the Arduino receives the signal from the Line-Follower Arduino, it starts the robotic arm to pic and place the product with pre-coded angles give to each servo motors to predict their position in picking up the product and placing them in the cart. After this process, the Arduino send a signal back to the Line-Follower Arduino. If the Line-Follower Arduino detects the signal sent by the Robotic-Arm Arduino, it continuous to navigate through the line around the Mart. This process continuous till the Shopping List gets over.

4.1 MICROCONTROLLER ARDUINO UNO R3

Arduino Uno R3 is a widely used microcontroller board that serves as the foundation for countless projects across various domains, from hobbyist electronics to professional prototyping. With its user-friendly interface, extensive community support, and versatility, the Arduino Uno R3 has become synonymous with innovation and creativity in the realm of embedded systems development.

The Arduino Uno R3 is based on the ATmega328 microcontroller, featuring 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. Its compact size, low power consumption, and ease of use make it an ideal choice for both beginners and experienced electronics enthusiasts alike. One of the key features of the Arduino Uno R3 is its simplicity and accessibility. Designed with beginners in mind, the board can be easily programmed using the Arduino Integrated Development Environment (IDE), which provides a user-friendly interface for writing, compiling, and uploading code. The IDE supports a simplified version of the C++ programming language, making it accessible to users with varying levels of programming experience.

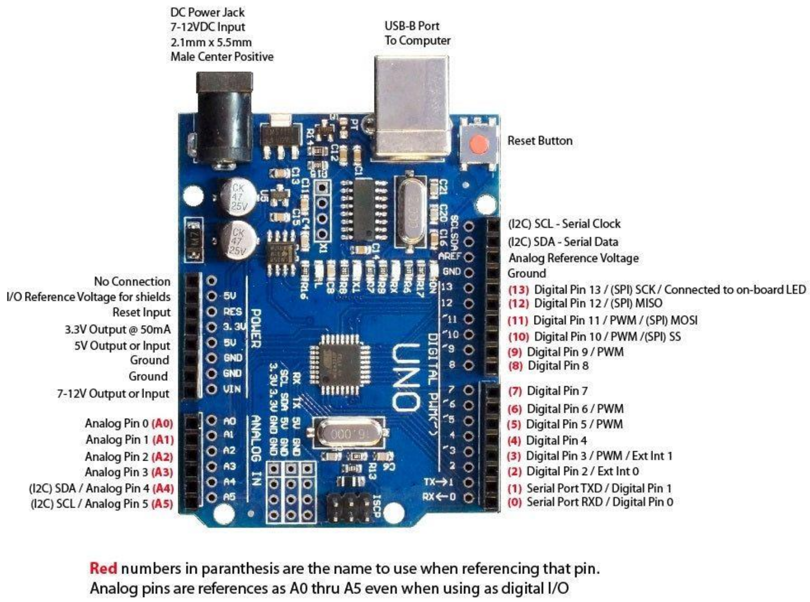

Figure 4.2 Arduino UNO R3

One of the most attractive aspects of the Arduino Uno R3 is its vibrant and supportive community. From online forums and tutorials to local maker spaces and workshops, Arduino enthusiasts have access to a wealth of resources and expertise to help them learn, troubleshoot, and collaborate on projects. This sense of community fosters creativity, innovation, and collaboration, driving the development of new and exciting projects that push the boundaries of what is possible with the Arduino platform. In terms of technical specifications, the Arduino Uno R3 features a 16 MHz crystal oscillator, which provides the clock signal for the microcontroller. This clock speed is sufficient for most embedded applications, allowing for fast and efficient execution of code. Additionally, the board is equipped with 32 KB of flash memory, 2 KB of SRAM, and 1 KB of EEPROM, providing ample storage for program code and data.

4.2 Infra-Red Sensor

Infrared (IR) sensors are electronic devices that detect infrared radiation emitted or reflected by objects in their vicinity. These sensors are widely used in various applications, including proximity sensing, motion detection, temperature measurement, and remote control systems. With their ability to detect heat and motion, IR sensors play a crucial role in modern technology, enabling automation, security, and convenience in a wide range of settings. At their core, IR sensors consist of an emitter and a detector. The emitter emits infrared radiation, while the detector detects the reflected or emitted radiation. When an object is within the sensor's detection range, it reflects or emits infrared radiation, which is then detected by the detector. This detection triggers a response or action, depending on the application and configuration of the sensor.

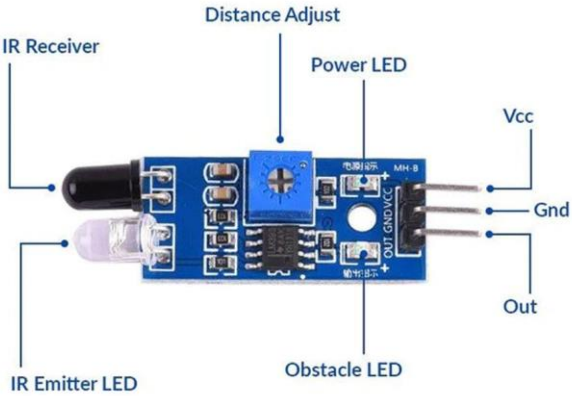

Figure 4.3 Infra-Red Sensor

One of the key advantages of IR sensors is their ability to detect objects without physical contact, making them ideal for applications where contact-based sensors are impractical or undesirable. For example, IR sensors can be used to detect the presence of objects in hazardous environments, such as in industrial settings where contact-based sensors may be damaged by exposure to chemicals or extreme temperatures. Another advantage of IR sensors is their ability to operate in various environmental conditions, including low light and darkness. Unlike optical sensors, which rely on visible light to detect objects, IR sensors can detect infrared radiation regardless of lighting conditions, making them suitable for use in indoor and outdoor environments.

4.3 RFID Reader MRFC522

Radio-frequency identification (RFID) readers are electronic devices that are designed to read and transmit data stored on RFID tags. These readers utilize radio waves to communicate with RFID tags, which contain electronically stored information that can be read remotely. RFID technology has become increasingly prevalent in various industries due to its ability to track and identify objects quickly and efficiently. At the heart of an RFID reader is an antenna, which emits radio waves and receives signals from RFID tags. When an RFID tag comes within range of the reader's antenna, it is powered by the reader's radio waves, allowing it to transmit its stored data back to the reader. The reader then decodes this data and processes it according to the application's requirements. RFID readers come in various forms, ranging from handheld devices to fixed readers installed in walls or ceilings. Handheld RFID readers are commonly used for inventory management, asset tracking, and retail applications, allowing users to quickly scan RFID tags on items to obtain information such as product details, location, and status.

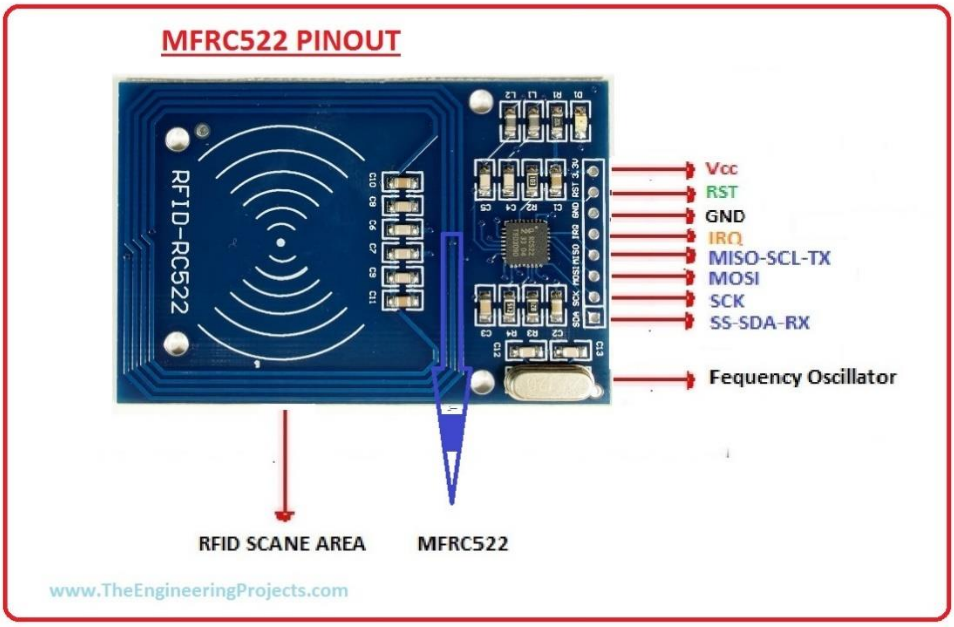

Figure 4.4 RFID Reader Module – MFRC522

RFID readers operate using different frequency bands, including low frequency (LF), high frequency (HF), and ultra-high frequency (UHF). Each frequency band offers distinct advantages and is suited to different applications. LF RFID readers typically have a shorter read range but are less susceptible to interference from metal or liquid objects, making them ideal for applications such as access control, animal tracking, and vehicle identification. HF RFID readers offer a longer read range and faster data transfer rates, making them suitable for applications such as contactless payment systems, transit ticketing, and library book tracking. UHF RFID readers have the longest read range and are commonly used in supply chain management, logistics, and inventory tracking applications due to their ability to read tags from a distance of several meters away.

4.4 RFID Tag – Mifare

RFID tags are small electronic devices that contain an integrated circuit and an antenna, enabling them to store and transmit data wirelessly using radio frequency signals. These tags come in various shapes and sizes, ranging from tiny microchips to larger cards or labels, and are commonly used for tracking and identification purposes in a wide range of applications. At the core of an RFID tag is an integrated circuit (IC) or microchip, which stores digital information such as a unique serial number or product code. This information can be pre-programmed onto the tag during manufacturing or written to the tag's memory later on. The microchip also contains circuitry for modulating and demodulating radio frequency signals, as well as for powering the tag's operation. Surrounding the microchip is an antenna, which is responsible for transmitting and receiving radio frequency signals to and from an RFID reader. The antenna can be designed in various shapes and configurations depending on the tag's intended use and operating frequency. When activated by an RFID reader's radio waves, the tag's antenna absorbs energy and uses it to power the microchip, allowing it to transmit data back to the reader.

Figure 4.5 RFID Tag – Mifare Reader/writer 13.56 MHz

RFID tags operate using different frequency bands, including low frequency (LF), high frequency (HF), and ultra-high frequency (UHF). Each frequency band offers distinct advantages and is suited to different applications. LF tags typically have a shorter read range but are less susceptible to interference from metal or liquid objects, making them ideal for applications such as access control, animal tracking, and vehicle identification. HF tags offer a longer read range and faster data transfer rates, making them suitable for applications such as contactless payment systems, transit ticketing, and library book tracking. UHF tags have the longest read range and are commonly used in supply chain management, logistics, and inventory tracking applications due to their ability to read tags from a distance of several meters away.

4.5 DC Geared BO Motor

A DC geared motor combines the functionality of a DC motor with that of a gearbox to achieve precise control over motion and torque. The DC motor converts electrical energy into rotational motion, serving as the primary driving force. Meanwhile, the gearbox plays a crucial role in modifying the motor's output characteristics by reducing its speed and increasing its torque. This reduction in speed and amplification of torque are achieved through the interplay of gears with varying sizes and configurations within the gearbox. By meshing gears of different diameters, the gearbox can effectively adjust the rotational speed and torque transmitted to the motor's output shaft. This feature makes DC geared motors suitable for applications requiring precise control over motion and the ability to drive heavy loads at low speeds. Additionally, the gearbox provides mechanical protection to the motor and enhances its efficiency by optimizing power transmission. Overall, the combination of a DC motor and gearbox in a geared motor offers a versatile and reliable solution for various industrial and commercial applications, including robotics, conveyor systems, and automotive mechanisms.

Figure 4.6 DC Geared BO Motor with Wheels

4.6 Servo Motor

A servo motor is an electromechanical device that converts electrical signals into precise mechanical motion. It is widely used in various applications, including robotics, industrial automation, RC vehicles, and 3D printing. The unique characteristics of servo motors, such as precise control, high torque, and feedback mechanism, make them indispensable in many fields.

At the heart of a servo motor is a closed-loop control system consisting of several key components: the motor, gearbox, position sensor (encoder or potentiometer), controller, and driver. These components work together to provide accurate and repeatable motion control. The motor itself is usually a brushless DC (BLDC) motor, although some servo motors use brushed DC motors or even AC motors. BLDC motors offer advantages such as high efficiency, low maintenance, and long lifespan, making them popular choices for servo applications. The gearbox is often included to reduce the motor's speed and increase its torque output. This gearing mechanism allows the servo motor to achieve higher precision and finer control over motion, especially at low speeds.

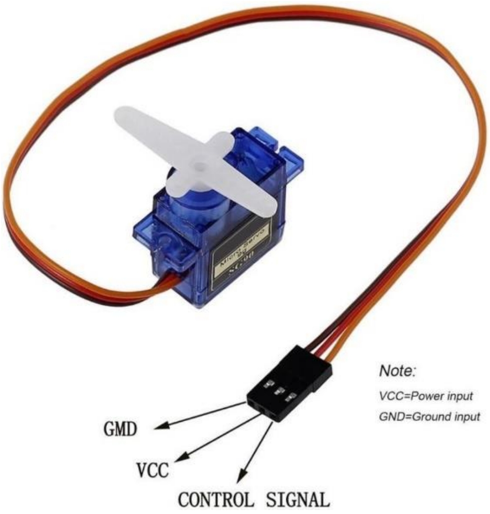

Figure 4.7 Servo Motor

Another advantage of servo motors is their versatility. They can be easily integrated into existing control systems and adapted to a wide range of applications. With the right combination of motor, gearbox, and control electronics, servo motors can be customized to meet specific performance requirements, such as speed, torque, and precision. In addition to their precision and versatility, servo motors offer excellent reliability and durability. Thanks to their brushless design and closed-loop control system, they are less prone to wear and tear compared to brushed DC motors and stepper motors. This makes them suitable for continuous operation in demanding industrial environments.

4.7 L298N Motor Driver

The L298N motor driver is a versatile integrated circuit commonly used to control DC motors and stepper motors in various electronic projects. Its dual H-bridge configuration allows independent control of two motors, making it suitable for robotics, automation, and DIY electronics projects. With features such as high current capability, wide operating voltage range, built-in diodes for protection, and thermal shutdown, the L298N offers reliability and ease of use.

The L298N operates based on the principles of H-bridge motor control, allowing bidirectional control of DC motors. By applying logic high signals to the appropriate input pins, the motor's direction can be controlled, while pulse-width modulation (PWM) signals applied to the enable pins control the motor's speed. This versatility makes the L298N suitable for various applications, including robotics, RC vehicles, automation systems, DIY electronics, and educational projects.

Table 3.1, which depicts the various features that has been used in the L298N Motor driver is given below for your reference.

Table 4.1 Features of L298N Motor Driver

Feature	Description
Dual H-Bridge	Allows independent control of two motors
High Current Capability	Each H-bridge can handle continuous currents of up to 2A and peak currents of up to 3A
Wide Operating Voltage	Typically operates from 5V to 35V, compatible with various power sources
Built-in Diodes	Internal freewheeling diodes provide protection against back electromotive force (EMF) from the motors
Thermal Shutdown	Built-in thermal shutdown protection prevents overheating and damage to the IC under high load
PWM Input	Supports pulse-width modulation (PWM) input for controlling motor speed and direction
Enable Pins	Each H-bridge has an enable pin for enabling or disabling the corresponding motor driver channel

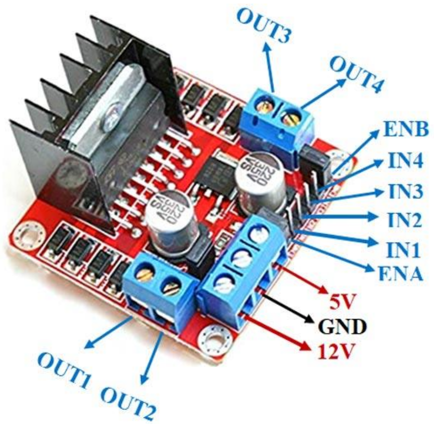

Figure 4.8 L298N Motor Driver

The L298N supports pulse-width modulation (PWM) input for controlling motor speed. PWM is a technique where the average voltage applied to the motor is varied by rapidly switching the power on and off. By adjusting the duty cycle of the PWM signal, users can control the speed of the motor. In addition to PWM control, the L298N also features enable pins for each H-bridge. These pins can be used to enable or disable the corresponding motor driver channel, allowing for finer control over the motors. For example, by disabling one H-bridge while leaving the other enabled, users can control the direction of rotation of a stepper motor.

CHAPTER 5
RESULTS AND DISCUSSION

The implementation and testing of the Smart Shopping Cart project yielded significant insights into its potential to revolutionize the retail shopping experience. The project aimed to address common challenges faced by both customers and store personnel by leveraging modern technology to streamline the shopping process. A key component of the Smart Shopping Cart is its user-friendly interface, which allows customers to input their shopping lists effortlessly. With the integration of an OLED display and push buttons, customers can easily navigate through their list, select items, and finalize their selections with minimal effort. This intuitive interface was designed to cater to a wide range of users, including elderly individuals and those with limited mobility, ensuring accessibility for all shoppers.

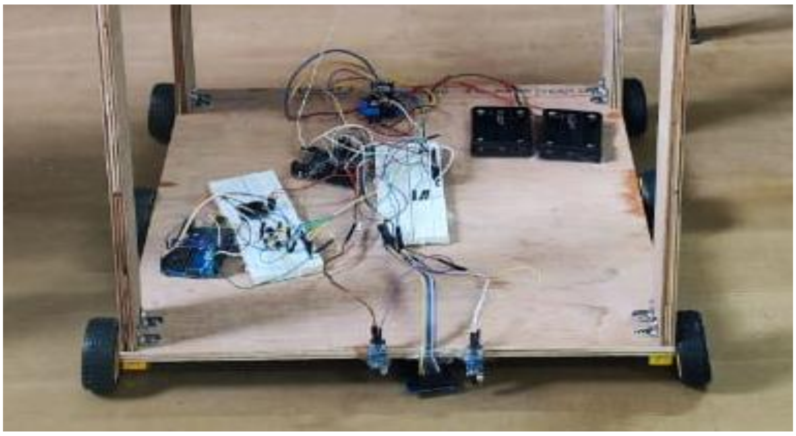

Figure 5.1 Interface and Line-Follower Cart

Once the shopping list is inputted, the Smart Shopping Cart utilizes advanced technology to autonomously navigate the store and retrieve the specified items. The cart is equipped with a line-following mechanism and an RFID reader, allowing it to traverse predefined paths within the store and identify items tagged with RFID labels. As the cart moves along the designated route, it continuously scans for RFID tags corresponding to the items on the shopping list. Upon detecting a matching RFID tag, the cart halts its movement and signals the robotic arm to initiate the item retrieval process. This seamless integration of hardware components enables efficient and accurate item retrieval, minimizing the time and effort required to locate and collect each item.

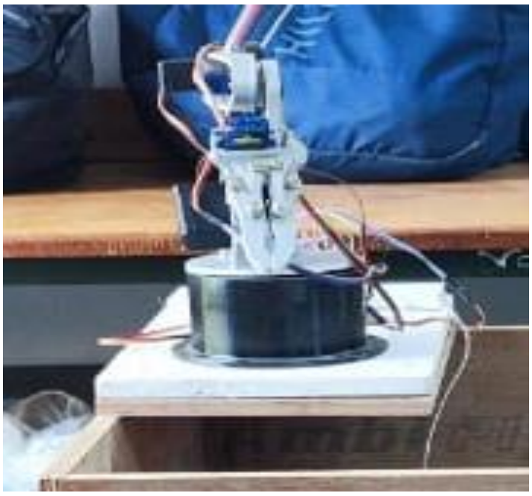

Figure 5.2 Robotic Arm

The performance of the Smart Shopping Cart was evaluated based on several key metrics, including accuracy in list interpretation, navigation efficiency, item retrieval speed, and overall reliability. Results from the evaluation demonstrated that the Smart Shopping Cart successfully interpreted and displayed shopping lists entered by customers with a high degree of precision. Furthermore, the line-following cart exhibited nimble navigation capabilities, adeptly maneuvering through store aisles and halting at designated locations to retrieve items. The robotic arm demonstrated swift and precise item retrieval, ensuring items were collected and placed in the cart without delay. The proposed smart shopping cart prototype is depicted in the figure 5.3.

Figure 5.3 Proposed Smart Shopping Cart Prototype

In addition to its benefits for customers, the Smart Shopping Cart project also offered significant advantages for store personnel and operations. By automating the shopping process, the Smart Shopping Cart project optimized inventory management and operational efficiency within the store. Real-time inventory tracking enabled by RFID technology allowed store personnel to monitor stock levels and replenish items proactively, mitigating instances of stockouts and overstocking. Expanding upon the unique aspects of the Smart Shopping Cart project, it's worth noting its potential to enhance the overall shopping experience through personalized recommendations and promotions. By integrating machine learning algorithms and customer purchasing data, the Smart Shopping Cart can analyze shopping patterns and preferences to offer tailored suggestions and discounts to shoppers in real-time. This interactive approach not only enhances the shopping experience but also creates opportunities for cross-selling and upselling, thereby increasing revenue for the store.

The Smart Shopping Cart project represents a groundbreaking innovation in the retail industry, offering a range of unique features and benefits that have the potential to transform the shopping experience for both customers and retailers. From its user-friendly interface and autonomous navigation capabilities to its personalized recommendations and dynamic pricing strategies, the Smart Shopping Cart project demonstrates the power of technology to revolutionize the way we shop.

CHAPTER 6
CONCLUSION

In conclusion, the Smart Shopping Cart project presents a transformative solution to the challenges faced in traditional retail environments. By leveraging cutting-edge technology such as RFID readers, line-following carts, and robotic arms, the project aims to revolutionize the shopping experience for both customers and store personnel. Through the implementation of user-friendly interfaces and advanced automation, the project simplifies the process of creating shopping lists and navigating through stores. Customers benefit from greater convenience and efficiency, as they can easily input their shopping items and rely on the smart cart to locate and retrieve them. This hands-free approach to shopping not only saves time but also enhances the overall experience, making it more enjoyable and stress-free.

Moreover, the Smart Shopping Cart project addresses common inventory management issues faced by stores, such as stockouts and shelf replenishment. By providing real-time visibility into inventory levels and automating restocking processes, the project helps stores optimize their operations and ensure that shelves are always stocked with the items customers want.

From a broader perspective, the project signifies the potential of technology to transform traditional retail practices and improve customer satisfaction. By embracing innovation and harnessing the power of automation, the Smart Shopping Cart project sets a precedent for future advancements in the retail industry. In summary, the Smart Shopping Cart project offers a glimpse into the future of retail, where technology seamlessly integrates with everyday shopping experiences to enhance efficiency, convenience, and customer satisfaction. As technology continues to evolve, projects like this pave the way for a more connected and automated retail landscape.

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APPENDIX

RAJALAKSHMI ENGINEERING COLLEGE

DEPARTMENT OF ECE

PROGRAM OUTCOMES(POs)

Engineering Graduates will be able to:

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: An ability to carry out research in different areas of Electronics and Communication Engineering fields resulting in journal publications and product development.

PSO2: To design and formulate solutions for industrial requirements using Electronics and Communication engineering

PSO3: To understand and develop solutions required in multidisciplinary engineering fields.

COURSE OUTCOMES (COs)

CO1	To acquire practical knowledge within the chosen area of technology for project development.
CO2	To identify, analyze, formulate and handle projects with a comprehensive and systematic approach.
CO3	To contribute as an individual or in a team in development of technical projects.
CO4	To develop effective communication skills for presentation of project related activities.
CO5	To extend the work and make it as a final year project.

GE19612

PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP

Project Title: SMART SHOPPING CART

Batch Members :

Murali Krishna L (2116210801117)

Methun Raj M (2116210801108)

Kishore M (2116210801088)

Name of the Supervisor : **Dr. V. Anusooya M.E, Ph.D, AP(SG)/ECE**

CO - PO – PSO matrices of course

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	3	2	3	3	2	2	3	3	3	3
CO2	3	3	2	3	3	1	1	2	3	2	2	2	3	3	3
CO3	3	2	2	1	1	2	3	3	3	1	2	2	3	3	3
CO4	3	2	2	2	2	3	3	1	3	3	2	3	1	1	1
CO5	3	2	2	2	1	2	1	3	3	2	2	2	3	3	3
Average	3	2.4	2	1.8	1.8	2.2	2	2.4	3	2	2	2.4	2.6	2.6	2.6

Note: Enter correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High), If there is no correlation, put -“

Signature of the Supervisor