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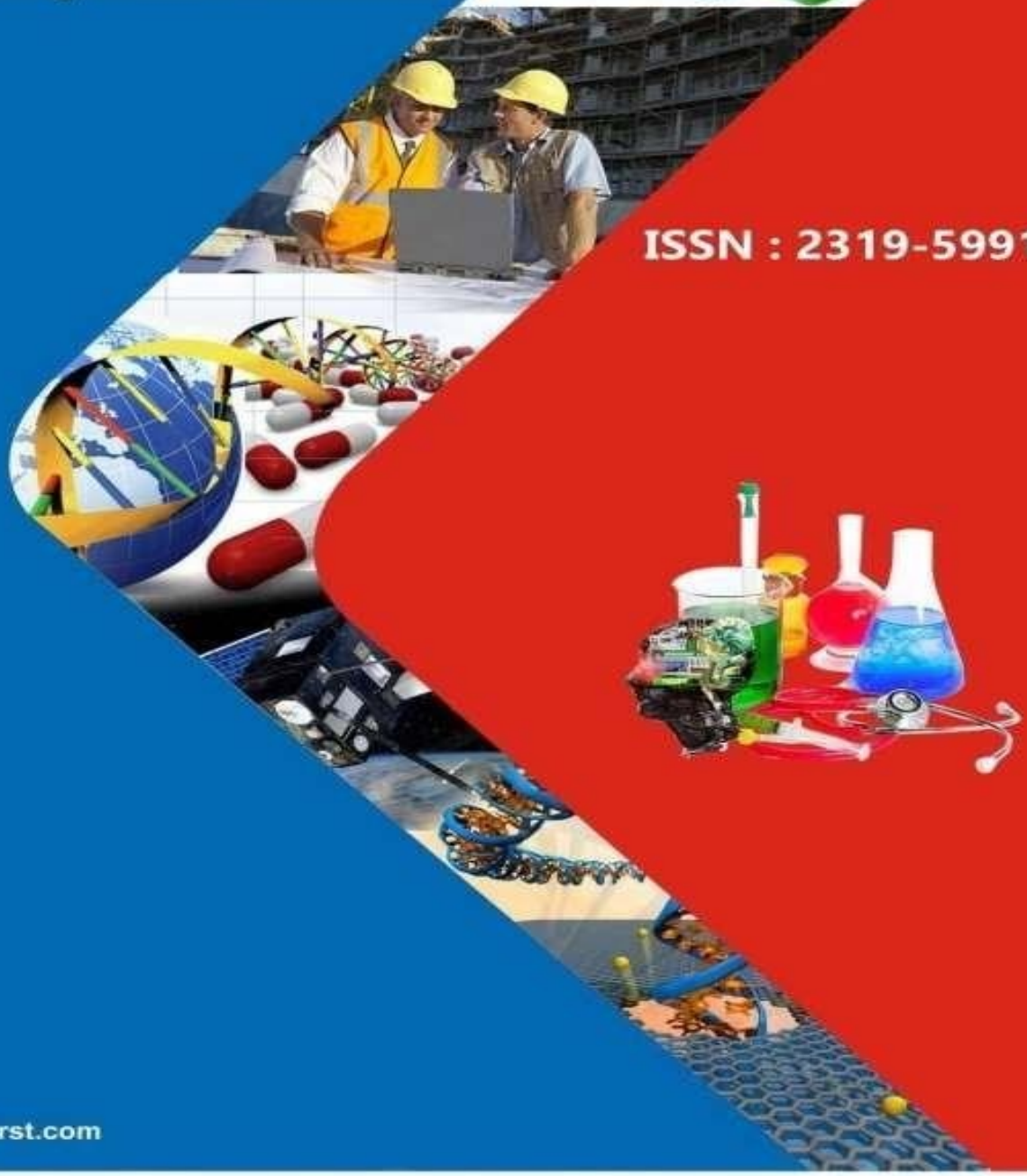

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RFID BASED SMART SHOPPING SYSTEM

[1]Mr.G.Prabhakar,[2]A.Akansha,[3]T.Prassanna

[1]Assistant Professor,[23]Students

Department Of CSE

MallaReddy Engineering College For Women

ABSTRACT

While shopping may be really intriguing and seductive, it also wears you out since you have to wait in line to pay for your purchases. Therefore, the idea is to create a smart cart that can handle both invoicing and shopping. This allows the consumer to enter the store without delay, make purchases using the smart trolley, and then leave. He receives the electronic bill in the mail and uses the store's website to examine the specifics of his transaction. To make this a reality, we'll need an Arduino board, an RFID reader, an RFID tag, an LCD display, an ESP8266 Wi-Fi module, a database manager, and a website that will allow the administrator to view product and customer information from anywhere in the globe. This is an Internet of Things solution that allows the trolley to communicate with a global network.

Keywords: e-Billing, smart cart, RFID tag, RFID reader, Internet of Things.

I. INTRODUCTION

The Smart Trolley for Supermarkets is a state-of-the-art system that uses RFID technology to monitor items automatically, transforming the shopping experience. This creative method changes the way people purchase by improving efficiency and convenience for both consumers and merchants.

Manually scanning things at the checkout at traditional supermarkets may be laborious and error-prone. By automatically monitoring products as they are added to or withdrawn from the trolley using RFID tags, the Smart Trolley removes these inefficiencies. RFID technology is used to identify every item, allowing for seamless tracking of the whole shopping experience.

The trolley's integrated sensors detect the weight of the products exactly, so there's no need for human scanning during checkout to ensure appropriate invoicing. Customers save time with this improved approach, which also shortens checkout lines and improves convenience overall.

Retailers can more effectively monitor stock levels and enhance inventory management thanks to the Smart Trolley's real-time inventory updates. Retailers may minimize out-of-stock situations and increase consumer happiness by swiftly restocking shelves with immediate insight into product availability.

Customers' shopping experience is enhanced with the Smart Trolley, which makes navigating the aisles effortless. Customers like a smooth and effective shopping experience since they can explore and make purchases with ease.

To sum up, the Smart Trolley for Supermarkets is a noteworthy development in retail technology that will improve productivity, shorten checkout lines, and improve the entire shopping experience. This invention provides merchants with real-time inventory management capabilities while streamlining the shopping experience for consumers and saving time via the use of RFID technology and embedded sensors.

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Fig .1: Smart trolley

1.1: Problem Statement:

In the retail industry, traditional shopping experiences are often hindered by inefficient checkout processes and manual inventory management, leading to longer wait times and potential errors in billing. Supermarkets face the challenge of enhancing customer satisfaction while optimizing operational efficiency. To address these challenges, there is a pressing need for a Smart Trolley solution that revolutionizes the shopping experience through the integration of RFID technology and advanced sensors.

Current shopping practices rely heavily on manual scanning of items at checkout counters, which can be time-consuming and prone to errors. Additionally, traditional inventory management methods lack real-time updates, making it challenging for retailers to maintain accurate stock levels and efficiently manage inventory.

The introduction of a Smart Trolley for supermarkets seeks to address these challenges by leveraging RFID technology for automatic item tracking and integrated sensors for precise weight measurement. Each item in the supermarket is tagged with an RFID tag, allowing for seamless monitoring of additions and removals from the trolley. The integrated sensors precisely measure the weight of items, ensuring accurate billing without the need for manual scanning at checkout.

The primary objective of this project is to develop a Smart Trolley system that streamlines the shopping process, saves time, and enhances convenience for customers. By automating item tracking and billing processes, the Smart Trolley eliminates the need for manual scanning, reducing checkout queues and improving the overall shopping experience.

Furthermore, with real-time inventory updates, retailers can efficiently manage stock levels, minimize out-of-stock situations, and optimize inventory control. By providing retailers with accurate and up-to-date inventory information, the Smart Trolley system enables proactive decision-making and enhances operational efficiency.

In summary, the Smart Trolley for supermarkets aims to revolutionize the shopping experience by leveraging RFID technology and integrated sensors to automate item tracking and billing processes. This innovation enhances efficiency, reduces checkout queues, and elevates the overall shopping experience for both customers and retailers.

1.2: Problem Scope:

The implementation of a Smart Trolley System for supermarkets addresses several challenges and deficiencies within traditional shopping experiences, aiming to enhance efficiency, convenience, and customer satisfaction.

Manual Item Tracking and Billing:

Traditional shopping carts rely on manual item tracking and scanning at checkout counters, leading to inefficiencies and delays in the billing process.

Human errors during manual tracking and scanning may result in inaccurate billing and discrepancies in the final purchase total.

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Manual scanning contributes to longer checkout queues and increased waiting times for customers.

Limited Inventory Management:

Existing systems lack real-time monitoring of inventory levels within shopping carts, hindering retailers' ability to manage stock levels effectively.

- Inaccurate inventory tracking may lead to stockouts or overstocking of items, impacting sales and operational efficiency.
- Without real-time inventory updates, retailers struggle to make informed decisions regarding restocking and inventory control.

Friction in Shopping Experience:

Customers experience friction in the shopping process due to manual item tracking and checkout procedures.

- Cumbersome scanning processes and checkout queues detract from the overall shopping experience, leading to customer dissatisfaction.
- Lack of convenience and efficiency in traditional shopping methods diminishes customer loyalty and retention.

Operational Inefficiencies:

Manual item tracking and checkout processes contribute to operational inefficiencies for both retailers and customers.

- Retailers allocate resources to manual scanning and checkout procedures, leading to increased labor costs and reduced operational productivity.
- Customers spend more time navigating aisles and waiting in checkout lines, impacting their overall shopping experience and satisfaction.

Addressing these challenges within the defined problem scope requires the development and implementation of a comprehensive Smart Trolley System. This system leverages RFID technology, integrated sensors, and real-time data processing to streamline the shopping process and enhance efficiency for both retailers and customers.

By automatically tracking items within the trolley, the Smart Trolley System eliminates the need for manual scanning at checkout counters, reducing checkout times and improving overall operational efficiency. Additionally, real-time inventory updates enable retailers to optimize stock levels and improve inventory control, leading to enhanced profitability and customer satisfaction.

Ultimately, the Smart Trolley System aims to revolutionize the shopping experience by offering seamless item tracking, accurate billing, and enhanced convenience for customers, while also providing retailers with the tools they need to optimize operations and drive business success in the competitive retail landscape.

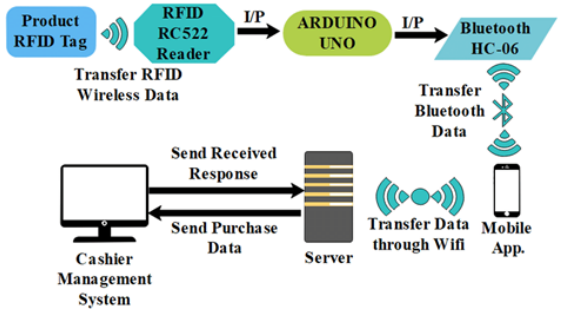

Figure .2: Technology behind Smart Trolley

1.3: Advantages of Implementing a Green Building Energy Saving System:

The implementation of a Smart Trolley for supermarkets introduces numerous advantages, revolutionizing the shopping experience for customers and streamlining operations for retailers. Key advantages include:

Seamless Item Tracking:

RFID technology enables automatic tracking of items added to or removed from the trolley, eliminating the need for manual scanning.

Accurate Billing:

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Integrated sensors precisely measure the weight of items in the trolley, ensuring accurate billing at checkout without the need for manual scanning.

Time-saving Convenience:

The innovation streamlines the shopping process, saving time for customers by eliminating the need to scan each item individually.

Real-time Inventory Updates:

Retailers benefit from real-time inventory updates, allowing them to efficiently manage stock levels and improve inventory control.

Frictionless Shopping Experience:

Customers enjoy a frictionless experience as they navigate aisles and make purchases with ease, enhancing overall satisfaction.

Reduced Checkout Queues:

By eliminating the need for manual scanning, the smart trolley reduces checkout queues, leading to faster and more efficient transactions.

Enhanced Efficiency:

The smart trolley enhances operational efficiency for both customers and retailers, streamlining the shopping process and reducing wait times.

Improved Customer Satisfaction:

With its convenience and time-saving features, the smart trolley improves customer satisfaction and loyalty, leading to repeat business.

Data-driven Insights:

Retailers can gain valuable insights into customer purchasing behavior and preferences through data collected by the smart trolley, enabling targeted marketing strategies and inventory management.

Environmental Benefits:

By reducing the need for paper receipts and manual scanning, the smart trolley contributes to environmental sustainability by minimizing paper waste and energy consumption.

Overall, the implementation of a Smart Trolley for supermarkets offers a range of benefits for both customers and retailers, enhancing the shopping experience, improving operational efficiency, and promoting environmental sustainability.

1.4 Proposed Solution:

The proposed solution for optimizing the traditional shopping experience with a Smart Trolley involves the integration of RFID technology and advanced sensors to create a seamless and efficient shopping process. Key components of the solution include:

1. RFID Technology:

Each item in the supermarket is tagged with RFID (Radio Frequency Identification) tags, enabling automatic item tracking as they are added or removed from the trolley.

RFID technology allows for quick and accurate identification of items, eliminating the need for manual scanning at checkout.

2. Integrated Sensors:

The smart trolley is equipped with integrated sensors, including weight sensors, to precisely measure the weight of items placed inside.

These sensors ensure accurate billing and provide real-time feedback on the contents of the trolley, enhancing convenience and efficiency for customers.

3. LCD Screen:

An LCD screen integrated into the trolley displays real-time information, including a list of items currently in the trolley, total cost, and promotions or discounts available.

The screen enhances the shopping experience by providing customers with instant feedback and relevant information as they shop.

4. Real-time Inventory Updates:

The RFID-enabled smart trolley continuously updates the inventory system with real-time data on items added or removed from the trolley.

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Retailers can efficiently manage stock levels and improve inventory control, ensuring that shelves are adequately stocked and reducing the likelihood of out-of-stock situations.

5. Frictionless Shopping Experience:

Customers enjoy a frictionless shopping experience as they navigate the supermarket aisles with the RFID-enabled smart trolley.

With automatic item tracking and accurate billing, customers can quickly and easily complete their shopping without the need for manual scanning or checkout queues.

6. Enhanced Efficiency and Convenience:

The smart trolley streamlines the shopping process, saving time and effort for both customers and retailers.

By automating tasks such as item tracking and billing, the smart trolley reduces checkout queues and elevates the overall shopping experience.

By implementing this solution, supermarkets can leverage RFID technology and advanced sensors to optimize the shopping experience, enhance efficiency, and improve customer satisfaction. The smart trolley represents a significant advancement in retail technology, offering a seamless and convenient way for customers to shop while providing retailers with valuable insights into inventory management and customer behavior.

1.5 Aim and Objectives

Aim:

The aim of developing the smart trolley for supermarkets is to redefine the shopping experience by leveraging RFID technology and integrated sensors to streamline the process of item tracking, billing, and inventory management. This innovative solution aims to enhance convenience for customers and efficiency for retailers by automating item tracking, ensuring accurate billing, and providing real-time inventory updates. The primary objectives include creating a frictionless shopping experience for customers, reducing checkout queues, optimizing inventory control, and improving overall operational efficiency in supermarkets. By achieving these goals, the smart trolley aims to elevate the shopping experience, save time for both customers and retailers, and enhance convenience and satisfaction in the retail environment.

Objectives:

Automatic Item Tracking: Develop a smart trolley system equipped with RFID technology to automatically track items as they are added or removed from the trolley. Each item will be tagged with an RFID tag for seamless monitoring throughout the shopping process.

Precise Weight Measurement: Integrate sensors into the trolley to precisely measure the weight of items placed within it. This feature ensures accurate billing at checkout without the need for manual scanning, enhancing convenience for both customers and store staff.

Streamlined Shopping Experience: Redefine the shopping experience by streamlining the process through the use of smart trolley technology. Customers will enjoy a frictionless experience as they navigate aisles, add items to their trolley, and make purchases with ease.

Real-Time Inventory Updates: Enable real-time inventory updates through the smart trolley system. By continuously monitoring item additions and removals, retailers can efficiently manage stock levels, reduce out-of-stock situations, and improve overall inventory control.

Enhanced Efficiency: Reduce checkout queues and waiting times by implementing the smart trolley system. With automatic item tracking and precise weight measurement, the checkout process becomes faster and more efficient, enhancing the overall shopping experience for customers.

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Improved Customer Convenience: Enhance convenience for customers by providing real-time updates on their purchases via an integrated LCD screen on the trolley. Customers can easily view their shopping list, total bill, and promotional offers as they shop.

Optimized Inventory Management: Empower retailers with valuable insights into customer shopping behavior and inventory levels. By analyzing data collected from the smart trolley system, retailers can make informed decisions to optimize inventory management and enhance sales performance.

Seamless Integration: Ensure seamless integration of RFID technology and LCD screen into the design of the smart trolley. The components should work harmoniously to deliver a user-friendly and reliable shopping experience for both customers and retailers.

By achieving these objectives, the smart trolley for supermarkets aims to revolutionize the shopping experience, offering customers convenience, efficiency, and a seamless checkout process, while empowering retailers with improved inventory management capabilities and enhanced customer satisfaction.

II. LITERATURE SURVEY

The advent of Smart Trolleys for supermarkets has ushered in a new era of shopping convenience, as evidenced by the burgeoning literature in this field. Researchers have delved into the transformative impact of RFID technology in redefining the shopping experience, particularly in terms of automatic item tracking and accurate billing. By equipping each item with RFID tags, supermarkets can seamlessly monitor additions and removals from trolleys, streamlining the checkout process and enhancing customer satisfaction.

Integrated sensors play a pivotal role in ensuring the accuracy of billing by precisely measuring the weight of items in the trolley. This innovation not only eliminates the need for manual scanning at checkout but also minimizes errors, thus enhancing efficiency and reducing checkout queues. The literature highlights the significant time savings and convenience afforded to customers through this frictionless shopping experience, ultimately elevating the overall shopping experience.

Real-time inventory updates facilitated by Smart Trolleys enable retailers to efficiently manage stock levels and improve inventory control. By harnessing RFID technology and integrated sensors, supermarkets can optimize their inventory management processes, leading to reduced stockouts, minimized wastage, and increased profitability. Customers benefit from the availability of products and enjoy a seamless shopping experience as they navigate aisles and make purchases with ease.

The literature survey emphasizes the multifaceted advantages of Smart Trolleys for both retailers and customers. From enhancing efficiency and reducing checkout queues to improving inventory control and elevating the overall shopping experience, Smart Trolleys represent a significant advancement in the retail sector. The exploration of RFID technology, integrated sensors, and real-time inventory management underscores a concerted effort to innovate and enhance the retail landscape, ultimately shaping the future of shopping.

III. BLOCK DIAGRAM

The methodology for implementing a Smart Trolley for supermarkets with RFID technology follows a systematic approach tailored to the unique demands of modern retail environments. It begins with a comprehensive needs assessment involving stakeholders such as supermarket management and customers. Through this assessment, critical requirements and operational challenges associated with traditional shopping processes are identified,

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including the need for efficient inventory management, streamlined checkout procedures, and an enhanced customer experience.

Subsequently, both functional and technical requirements for the Smart Trolley system are clearly defined. These requirements encompass automatic item tracking using RFID technology, integration with supermarket inventory systems, and real-time data updates to ensure accurate billing and inventory management.

The selection of components for the Smart Trolley system is conducted meticulously, taking into account factors such as compatibility, reliability, and cost-effectiveness. Key components include RFID tags and readers for automatic item tracking, as well as an LCD screen for displaying item information and transaction details to customers.

System development focuses on seamlessly integrating RFID technology for automatic item tracking and weight sensors for precise billing. The development process also entails designing a user-friendly interface on the LCD screen to display item details, prices, and total costs. Real-time inventory updates are implemented to enable efficient stock management and enhance overall operational efficiency.

Security implementation is prioritized to protect customer data and ensure the integrity of transactions. Encryption protocols and authentication mechanisms are incorporated to safeguard sensitive information transmitted between the Smart Trolley and supermarket systems.

Integration with existing supermarket infrastructure, including inventory management systems and checkout terminals, is carefully addressed to ensure interoperability and seamless data exchange.

Once developed, the Smart Trolley system undergoes rigorous testing to verify functionality, reliability, and accuracy. Any issues or discrepancies identified during testing are addressed promptly to ensure optimal system performance.

Training programs are provided to supermarket staff on the operation and maintenance of the Smart Trolley system. Deployment is carried out in phases, starting with pilot testing in select supermarket locations before full-scale implementation. Continuous monitoring and feedback gathering enable ongoing optimization and improvement of the Smart Trolley system to meet evolving supermarket needs and customer expectations.

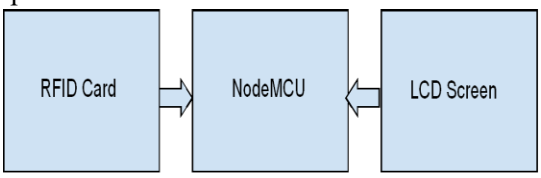

Figure 3: Block Diagram of the Smart Trolley

IV. HARDWARE COMPONENTS

4.1 NodeMCU (ESP8266)

The NodeMCU ESP8266 is a powerful and versatile platform designed for Internet of Things (IoT) development. It is a cost-effective Wi-Fi microchip known for its capability to enable wireless communication in IoT applications. NodeMCU, on the other hand, is an open-source firmware and development kit that simplifies the process of prototyping and programming the ESP8266, built-in Wi-Fi connectivity, the NodeMCU ESP8266 allows devices to connect to the internet wirelessly, making it suitable for a wide range of IoT projects. One notable feature is its support for the Lua scripting language, providing a high-level programming environment for developers. Additionally, it is compatible with the Arduino IDE, allowing those familiar with Arduino to use the NodeMCU platform. Equipped with General Purpose Input/Output (GPIO) pins, the ESP8266 facilitates interfacing with various electronic components, making it ideal for applications such as home automation and

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sensor networks. It has garnered significant community support, resulting in an extensive collection of libraries and documentation, making it a popular choice for rapid IoT prototyping and development.

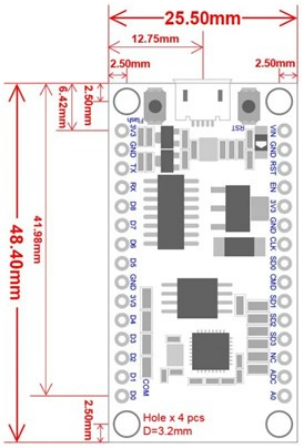

Figure 4: NodeMCU 2D View

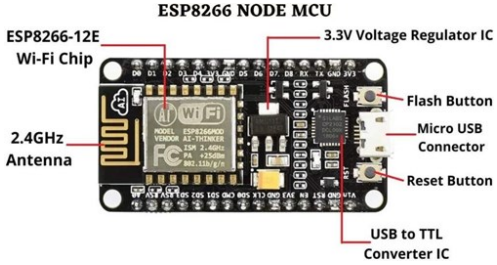

Figure 5: NodeMCU Parts

The NodeMCU ESP8266 development board typically has GPIO (General Purpose Input/Output) pins that can be used for various purposes, including interfacing with sensors, actuators, and other electronic components. Below is a common pinout configuration for the NodeMCU development board

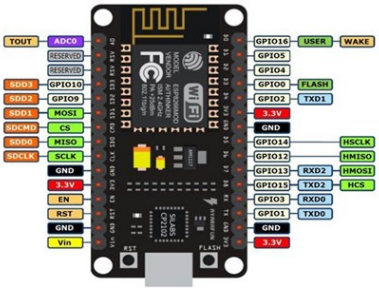

Figure 6 : NodeMCU ESP8266 Pinout

4.2 Arduino software:

Arduino microcontrollers are programmed using the Arduino IDE (Integrated Development Enironment). Arduino programs, called "sketches", are written in a programming language similar to C and C++. Every sketch must have a setup () function (executed just once) followed by a loop () function (potentially executed many times); add "comments" to code to make it easier to read. Many sensors and other hardware devices come with prewritten software line for sample code, libraries (of functions). Libraries are a collection of code that makes it easy for you to connect to a sensor, display, module, etc. For example, the built-in Liquid Crystal library makes it easy to talk to character LCD displays. There are hundreds of additional libraries available on the internet for download.

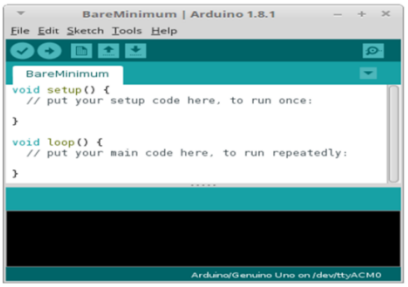

Fig 7: Arduino IDE

4.3 Liquid Crystal Display (LCD):

Figure 8: Liquid Crystal Display

A LCD is a tool used for visual display of the output. The liquid -crystal display has the distinct advantage of having low power consumption than the LED. It is typically of the order of microwatts for the display in comparison to the some order of milli watts for LEDs. Low power consumption requirement has made it compatible with MOS integrated logic

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circuit. Its other advantages are its low cost, and good contrast. The main drawbacks of LCDs are additional requirement of light source, a limited temperature range of operation (between 0 and 60° C), low reliability, short operating life, poor visibility in low ambient lighting.

3.4 RFID:

Radio frequency identification (RFID) is a cutting-edge technology that harnesses radio waves to identify and monitor objects or people effortlessly without physical contact. This innovative system comprises three essential elements:

RFID tags, which are tiny devices that store data
RFID readers, which wirelessly communicate with the tags
A backend system, which manages and processes the collected information

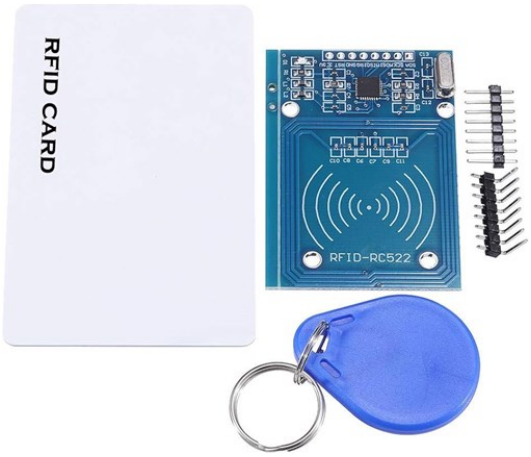

Figure 9: RFID

V. CONCLUSION

Every item in the store has an RFID tag, and every cart has an RFID reader. Customers use their cards to make payments. The smart trolley system is very effective for both store owners and shoppers. Because it can function both online and offline, this system is reliable and consistent. People have always desired to purchase new items to fulfill their wants, but some people detest it mostly due to the crowds, lengthy lines at the store, the bill, etc. It might be rather challenging to look for a certain product in a large shopping center. Given this, it seems that the smart trolley is a superior option for all of these woos.

Rather of using smart cards, this method may be further enhanced in the future by adding facial recognition. This way, all information is kept online and the customer's face serves as their identification. This encourages customers to visit the store, load up on a trolley, make all of their purchases, and then leave. The client's smart card is not required. Payment for the bill may be made directly from the customer's bank account, and it will be delivered to his postal address. However, by protecting customer privacy and ensuring safe online transactions, smart trolleys may also be made more secure.

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