IoT BASED SHOPPING CART

A project report submitted in fulfillment of the Requirements for the Award of the Degree of

BACHELOR OF TECHNOLOGY

In

COMPUTER SCIENCE AND ENGINEERING

By

CHINTHAKINDHI SOWMYA	**20VD1A0541**
KHAMMAMPATI ANIL KUMAR	**20VD1A0506**
CHITTIPROLU KUMARASWAMY	**20VD1A0517**
BANDILA SANGEETHA	**20VD1A0557**

Under the Guidance of

N. VAMSHI KRISHNA

(Assistant Professor of CSE),

Department of Computer Science and Engineering.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

UNIVERSITY COLLEGE OF ENGINEERING MANTHANI

Pannur (Vil), Ramagiri (Mdl), Peddapally-505212, Telangana (India).

2023-2024

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

UNIVERSITY COLLEGE OF ENGINEERING MANTHANI

Pannur (Vil), Ramagiri (Mdl), Peddapally-505212, Telangana (India).

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DECLARATION BY THE CANDIDATE

We,

CHINTHAKINDHI SOWMYA	**20VD1A0541**
KHAMMAMPATI ANIL KUMAR	**20VD1A0506**
CHITTIPROLU KUMARASWAMY	**20VD1A0517**
BANDILA SANGEETHA	**20VD1A0557**

hereby declare that the project report entitled ***IoT BASED SHOPPING CART*** under the guidance of **N. VAMSHI KRISHNA,** Asst. Professor, Department of Computer Science and Engineering, JNTUH University College of Engineering Manthani submitted in partial fulfilment for the award of the Degree of Bachelor of Technology in Computer Science and Engineering.

This is a record of bonafide work carried out by us and the results embodied in this project report have not been reproduced or copied from any source. The results embodied in this project have not been submitted to any other University or Institute for the award of any degree.

CHINTHAKINDHI SOWMYA	**20VD1A0541**
KHAMMAMPATI ANIL KUMAR	**20VD1A0506**
CHITTIPROLU KUMARASWAMY	**20VD1A0517**
BANDILA SANGEETHA	**20VD1A0557**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

UNIVERSITY COLLEGE OF ENGINEERING MANTHANI

Pannur (Vil), Ramagiri (Mdl), Peddapally-505212, Telangana (India).

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that the project report entitled ***IoT BASED SHOPPING CART*** is a bonafide work carried out by

CHINTHAKINDHI SOWMYA	**20VD1A0541**
KHAMMAMPATI ANIL KUMAR	**20VD1A0506**
CHITTIPROLU KUMARASWAMY	**20VD1A0517**
BANDILA SANGEETHA	**20VD1A0557**

in partial fulfillment of the requirements for the degree of **BACHELOR OF TECHNOLOGY** in **COMPUTER SCIENCE AND ENGINEERING** by the **Jawaharlal Nehru Technological University Hyderabad University College of Engineering, Manthani** during the academic year 2023-24.

The results of investigation enclosed in this report have been verified and found satisfactory. The results embodied in this project report have not been submitted to any other University or Institute for the award of any degree.

INTERNAL GUIDE
N. VAMSHI KRISHNA
(Assistant Professor of CSE)

HEAD OF THE DEPARTMENT

EXTERNAL EXAMINER
DATE:

ACKNOWLEDGMENT

We feel honored and privileged to place our warm salutation to our **Principal Dr. CH. SRIDHAR REDDY, Professor of Mechanical Engineering, JNTUH University College of Engineering Manthani,** who gave us the opportunity to have experience in engineering and profound technical knowledge.

We express our heartiest thanks to **Mr. B. V. RAM NARESH YADAV Professor & Head of the Department of Computer Science and Engineering, JNTUH University College of Engineering , Manthani,** for encouraging us in every aspect of our project and helping us realize our full potenetial.

We pay our deep sense of gratitude to **N. VAMSHI KRISHNA, Asst. Professor of Computer Science and Engineering, JNTUH University College of Engineering Manthani,** to encourage us to the highest peak and to provide us the opportunity to prepare the project. We are extremely grateful to his valuable suggestions and unflinching co-operation throughout project work.

We are immensely obliged to other faculty members of Department of CSE for their kind co-operation.

We wish to convey our thanks to one and all those who have extended their helping hands directly and indirectly in completion of our project.

Last, but not least, our parents are also an important inspiration for us. So, with due regards, we express our gratitude to them.

CHINTHAKINDHI SOWMYA	**20VD1A0541**
KHAMMAMPATI ANIL KUMAR	**20VD1A0506**
CHITTIPROLU KUMARASWAMY	**20VD1A0517**
BANDILA SANGEETHA	**20VD1A0557**

ABSTARCT

In traditional markets, shopping can be a labor-intensive and time-consuming task. The current bar-code scanning system used for billing is often slow, resulting in long queues during rush hours. In addition, there is no mechanism in place to show instantaneous total of the shopping cart. To address these issues, we propose an IoT-based shopping solution that leverages the power of RFID tags and smart security features to create a seamless and effortless shopping experience for customers. The proposed solution includes a smart billing system, personalized recommendations, and smart security features such as facial recognition and motion detection cameras. Future work for this solution includes integrating it with mobile apps, incorporating an AI-based recommendation engine, implementing real-time inventory management using IoT sensors,generating analytics and reporting, and integrating with online stores. These advancements will enhance the shopping experience for customers, increase efficiency and revenues for market owners, and drive the growth of the market.

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

1. INTRODUCTION

1.1. INTRODUCTION

Shopping experiences in traditional markets often fall short due to prolonged billing processes, resulting in frustratingly long queues and a lack of real-time visibility into total cart expenses. These limitations contribute to dissatisfied customers and reduced market revenues. In response, an innovative IoT-driven shopping solution is proposed to revolutionize this landscape. This proposed system harnesses the power of RFID tags, smart security measures like facial recognition and motion detection, and an advanced billing infrastructure to overcome these challenges. By integrating these technologies, the solution aims to expedite billing, furnish instant cart total displays, and fortify market security.

The proposed IoT-based shopping solution endeavors to bridge the gap between outdated market practices and modern consumer expectations. By implementing RFID tags, the system offers swift item identification and checkout processes, significantly reducing wait times. Moreover, the integration of facial recognition and motion detection enhances market security while providing a seamless and efficient shopping experience. This comprehensive approach not only addresses current inefficiencies but also sets the stage for a customer-centric and technologically advanced market ecosystem.

At its core, this proposal seeks to redefine the traditional market experience, emphasizing efficiency, convenience, and security. By revolutionizing billing systems, providing instantaneous cart total displays, and bolstering security measures, this IoT-driven solution aims to elevate customer satisfaction levels and drive market growth. The envisioned advancements aim not just to modernize the shopping process but also to empower market owners by boosting revenue streams and fostering a competitive edge in the retail landscape."

1.2. PROBLEM STATEMENT

Traditional marketplaces are grappling with inefficiencies that mar the shopping experience. Lengthy queues owing to slow billing processes, coupled with the absence of instantaneous cart total displays, lead to disgruntled customers and adversely impact market revenue. This status quo represents a significant challenge, highlighting the pressing need for a transformative solution. The inadequacy of existing systems not only diminishes customer satisfaction levels but also hampers the potential for market growth and competitiveness.

To alleviate these prevalent challenges, an innovative approach is imperative. By leveraging RFID tags and in this solution endeavors to revolutionize the shopping landscape. The system aims to overhaul the sluggish billing processes, offer instantaneous cart total displays within market premises.

1.3. SCOPE

The documentation outlining the proposed IoT-based shopping solution encompasses a comprehensive scope. It aims to revolutionize the shopping experience within traditional markets by introducing efficiencies and technological advancements. The primary objectives include expediting billing processes, introducing instantaneous cart total displays through RFID tags. This initiative extends beyond mere technological integration; it seeks to optimize market operations by reducing wait times, improving inventory management via IoT sensors, and implementing personalized recommendations based on AI-driven engines to cater to diverse customer preferences.

LITERATURE SURVEY

2. LITERATURE SURVEY

The literature survey for the proposed IoT-based shopping solution encompasses a comprehensive review of existing studies in retail technology. Research studies highlight the effectiveness of RFID technology in automating inventory management and item tracking. Additionally, there's significant discourse on smart security features such as automatic payment systems, and queue detection, emphasizing the need for enhanced security measures and streamlined payment processes within retail environments. Studies also emphasize customer-centric solutions, including feedback mechanisms, personalized recommendations, and optimized payment systems to elevate overall customer satisfaction. Furthermore, publications in reputable journals underscore the integration of IoT solutions with online platforms, analytics, and the evolving landscape of real-time inventory management, offering crucial insights into future trends and technological advancements in the retail sector.

2.1. MOTIVATION

The motivation behind the proposed IoT-based shopping solution documentation stems from a clear recognition of the pervasive inefficiencies within traditional marketplaces. The prevalent issues of slow billing processes, lengthy queues, and the absence of real-time cart total displays result in dissatisfied customers and reduced revenue streams for market owners. This discrepancy between consumer expectations and the limitations of existing systems acts as a catalyst for change.

The motivation lies in transforming the conventional shopping experience into a seamless, efficient, and technologically advanced environment. The aspiration to leverage IoT, RFID tags. By addressing these challenges head-on, the aim is to enhance market efficiency, elevate customer satisfaction levels, and foster market growth. By harnessing cutting-edge technology and innovations showcased in related research, the goal is to empower market owners, enhance security measures, and provide customers with an elevated and personalized shopping experience.

Ultimately, the motivation behind this proposed solution lies in reshaping traditional market dynamics, embracing technological advancements, and creating an ecosystem that not only meets but exceeds the expectations of both customers and market stakeholders.

2.2. OBJECTIVE

The primary objective of this IoT-based shopping solution is to revolutionize the traditional market landscape by addressing inefficiencies and enhancing customer satisfaction. The project aims to optimize the shopping experience by introducing RFID tags and IoT sensors to streamline billing processes. By automating item identification and expediting checkouts, the project endeavors to reduce wait times and enhance market efficiency. Real-time cart total displays will provide customers immediate visibility into expenses, alleviating frustrations associated with conventional shopping experiences and significantly improving customer satisfaction.

In addition to enhancing efficiency, fortifying market security stands as a pivotal objective. The project aims to deploy smart security measures. Strengthening security not only ensures the safety of customers and vendors but also fosters trust and confidence in the market environment. Creating a secure shopping space aligns with the goal of providing a positive and trustworthy experience, crucial for customer retention and market growth.

Furthermore, the future scope of project aims to personalize the shopping journey for customers. By integrating AI-driven recommendation engines with RFID technology, the objective is to offer tailored product suggestions based on individual preferences. This aspect seeks to elevate customer satisfaction levels and engagement.

2.3. HISTORY OF RETAIL TECHNOLOGY AND MARKET EVOLUTION

The history of retail technology and market evolution is a fascinating narrative encompassing significant shifts in consumer behavior, technological innovations, and market dynamics. It traces the evolution from traditional marketplaces relying on manual processes to the integration of advanced technologies in retail settings. The inception of retail technology can be traced back to early forms of trade and bartering, evolving through general stores, departmental chains, and the emergence of supermarkets in the 20th century.

With the advent of computing, the 1970s witnessed the introduction of barcode technology, revolutionizing inventory management and checkout processes. The following decades saw the integration of Point-of-Sale (POS) systems, streamlining transactions and enabling better data collection. The late 20th and early 21st centuries ushered in the era of e-commerce, fundamentally transforming consumer behavior and market landscapes. This digital shift led to the rise of online retail giants and the blending of online and offline shopping experiences.

Moreover, advancements such as RFID technology, IoT integration, and data analytics have reshaped retail operations. RFID tags enabled efficient inventory tracking, while IoT sensors facilitated real-time monitoring, optimizing supply chains and enhancing customer experiences. Simultaneously, personalized recommendations, AI-driven insights, and mobile commerce have become pivotal in meeting evolving consumer demands for convenience and customization.

This historical overview underscores the transformative journey of retail technology, showcasing how innovation and technological integration have continually reshaped market dynamics, consumer experiences, and the very essence of retail commerce.

2.4. APPLICATIONS

2.4.1. Efficient Billing Systems: The application of RFID tags and IoT sensors can streamline the billing process in retail markets. Automated identification of items and real-time tracking facilitates faster checkouts, reducing queues and enhancing overall operational efficiency.

2.4.2. Real-Time Inventory Management: Utilizing IoT sensors enables accurate and real-time tracking of inventory. This application ensures that market owners have precise visibility into stock levels, facilitating timely restocking and minimizing instances of out-of-stock products.

2.4.3. Personalized Customer Experience: Integrating AI-driven recommendation engines with RFID technology allows for personalized product suggestions based on customer preferences and shopping history. This application enhances the customer experience by offering tailored recommendations.

2.4.4. Data Analytics and Reporting: The application of data analytics tools on the gathered information provides insights into customer behavior, market trends, and inventory patterns. This facilitates informed decision-making for market owners and aids in strategic planning.

2.4.5. Mobile App Integration: Integrating the IoT-based shopping solution with mobile apps extends the reach of the market, allowing customers to access personalized recommendations, real-time cart displays, and seamless payment options through their smartphones.

SYSTEM ANALYSIS

3. SYSTEM ANALYSIS

The system analysis for the proposed IoT-based shopping solution encompasses a comprehensive evaluation of its components, functionalities, and interactions. It involves assessing individual elements like RFID sensors, IoT devices, and examining their compatibility and capabilities within the system. Evaluating data flow, information handling, and the overall architecture unveils how these components integrate and facilitate real-time cart displays, item identification, personalized recommendations, and security measures. Additionally, the analysis focuses on user experience, system performance, and scalability, aiming to ensure an intuitive, efficient, and adaptable solution that addresses the shortcomings of traditional market systems. This evaluation forms the basis for refining the system design and optimizing its effectiveness in revolutionizing the retail experience.

3.1. EXISTING SYSTEM

In traditional market setups, the existing system primarily revolves around manual processes for various retail operations. Billing procedures heavily rely on bar-code scanning at checkout counters, where each item's bar-code is individually scanned to calculate the total cost of the shopping cart. However, this method often proves to be time-consuming, especially during peak hours, resulting in prolonged queues and customer dissatisfaction. Furthermore, there's a notable absence of instant total cost displays for customers, leaving them unaware of their expenses until the end of their shopping, contributing to uncertainties and potential frustrations.

Regarding security measures, conventional setups typically incorporate basic surveillance systems to monitor the premises. These systems might include standard cameras for monitoring and deterrence purposes, lacking advanced features like facial recognition or intelligent motion detection. Consequently, the security infrastructure may not meet the demands for heightened security expectations in today's retail landscape.

Overall, the reliance on manual billing processes and the absence of real-time cart total displays significantly impact customer experiences, leading to inefficiencies and uncertainties during shopping. Additionally, the basic security measures might fall short in addressing contemporary security needs, calling for a more robust and technologically advanced solution to address these shortcomings.

3.2. PROPOSED SOLUTION

The proposed system introduces an IoT-based shopping solution designed to overhaul traditional market processes. Leveraging cutting-edge technologies such as RFID tags, IoT sensors, and smart security features, the system aims to revolutionize the retail experience. It introduces a smart billing system that enables instant cart total displays, offering customers real-time visibility into their expenses as they shop. RFID tags facilitate swift and accurate item identification, expediting the checkout process and reducing queue times.

This multifaceted approach not only addresses the inefficiencies of manual billing and inventory processes but also prioritizes customer convenience and security.Additionally, the system's road-map includes integrating with mobile apps for a more personalized shopping experience, implementing AI-based recommendation engines for tailored suggestions, and incorporating real-time inventory management to prevent stock-outs.

By embracing these advancements, the proposed system aims to enhance market efficiency, increase revenues for market owners, and significantly elevate the overall shopping experience for customers.

3.3. METHODOLOGY OF PROPOSED SYSTEM

The methodologies employed in developing the proposed IoT-based shopping solution encompass several key approaches:

3.3.1. Technology Integration: The methodology focuses on seamlessly integrating various cutting-edge technologies such as RFID (Radio-Frequency Identification), IoT sensors, and smart security features into a cohesive system. This involves robust hardware integration, firmware development, and software implementation to ensure interoperability and efficient functioning.

3.3.2. Iterative Development: Adopting an iterative development approach, akin to Agile methodologies, allows for continuous improvement and adaptation. Through iterative cycles of planning, development, testing, and feedback, the system evolves gradually, ensuring responsiveness to changing requirements and enhancing its effectiveness.

3.3.3. Prototyping and Testing: Employing prototyping methodologies involves creating functional prototypes or minimum viable products (MVP's) to validate concepts and gather user feedback. Thorough testing, both in controlled environments and real-world simulations, helps identify and address system flaws or inefficiencies.

3.3.4. User-Centric Design: Prioritizing user-centric design methodologies ensures that the system is intuitive, user-friendly, and caters to the needs and preferences of both customers and market owners. UX/UI research, usability testing, and iterative design improvements contribute to an enhanced overall experience.

3.3.5. Security and Compliance Measures: Implementing robust security methodologies involves stringent protocols for data protection, encryption mechanisms, and compliance with industry standards and regulations. Security audits and continuous monitoring are integral parts of the development process.

3.3.6. Collaborative and Cross-Functional Teams: Emphasizing collaborative and cross-functional team structures fosters effective communication, knowledge sharing, and synergy among developers, designers, security experts, and stakeholders. This collaborative approach ensures a holistic and well-rounded development process.

SYSTEM REQUIREMENT ANALYSIS

4. SYSTEM REQUIREMENT ANALYSIS

Software Requirements Specification plays an important role in creating quality software solutions. Specification is basically a representation process. Requirements are represented in a manner that ultimately leads to successful software implementation. Requirements may be specifiedin a variety of ways. However, there are some guidelines worth following:

- Representation format and content should be relevant to the problem.
- Information contained within the specification should be nested
- Diagrams and other notational forms should be restricted in number.

4.1. FUNCTIONAL REQUIREMENTS

4.1.1. Real-time Cart Total Display: The system should instantly calculate and display the total cost of items in the customer's shopping cart as they add or remove products, providing real-time visibility into expenses.

4.1.2. RFID-Based Item Identification: Utilizing RFID technology, the system must accurately identify and track items, enabling swift and automated identification during checkout without the need for manual scanning.

4.1.3. Smart Billing System: Implementing a smart billing mechanism, the system should seamlessly process transactions, handle various payment methods, generate itemized receipts, and ensure a smooth checkout experience.

4.1.4. Personalized Recommendations: Incorporating AI-driven recommendation engines, the system should offer personalized product suggestions based on customer preferences, purchase history, and current shopping choices.

4.1.5. Smart Security Features: The system should enhance market security by identifying potential threats, monitoring activities, and preventing unauthorized access.

4.1.6. Mobile Application Integration: Integrating with mobile apps, the system should provide customers with a convenient interface to view product details, receive promotions, manage shopping lists, and seamlessly transition between online and offline experiences.

4.1.7. Inventory Management: Implementing IoT sensors for real-time inventory tracking, the system should monitor stock levels, trigger alerts for restocking, and synchronize inventory data between physical and digital platforms.

4.2. NON-FUNCTIONAL REQUIREMENTS

4.2.1. Performance: The system should exhibit high responsiveness, ensuring rapid RFID tag detection, swift transaction processing, and minimal latency in displaying cart totals. It should handle peak loads during rush hours without compromising performance.

4.2.2. Reliability: The system should operate consistently, minimizing downtime and ensuring uninterrupted service availability. It should also maintain data integrity and accuracy in item identification and billing processes.

4.2.3. Security: Robust security measures should safeguard sensitive customer data, transactional information, and market operations. It should comply with industry standards, ensuring encryption, access controls, and protection against cyber threats.

4.2.4. Scalability: The system should accommodate increased user traffic and market growth, allowing for scalability without compromising performance. It should easily adapt to changing demands and expansions.

4.2.5. Interoperability: The system components should seamlessly integrate and communicate with various hardware and software components. It should support interoperability with existing market systems and future technologies.

4.2.6. Usability and Accessibility: The interface should be intuitive, user-friendly, and accessible to diverse user demographics. It should accommodate different devices, be compliant with accessibility standards, and provide a seamless experience

4.2.7. Maintainability: The system should be easy to maintain, update, and manage. It should facilitate efficient troubleshooting, debugging, and system upgrades without disrupting operations.

4.2.8. Compliance and Ethical Considerations: Adherence to legal, regulatory, and ethical standards concerning customer privacy, data protection, and fair business practices is imperative. The system should uphold ethical guidelines and comply with relevant laws.

4.2.9. Performance Monitoring and Logging: Continuous monitoring capabilities should track system performance, record errors, and log user activities for auditing and system optimization purposes.

4.3. HARDWARE REQUIREMENTS

4.3.1. Arduino ESP32: The central microcontroller device that serves as the core processing unit and manages communication between different hardware components.

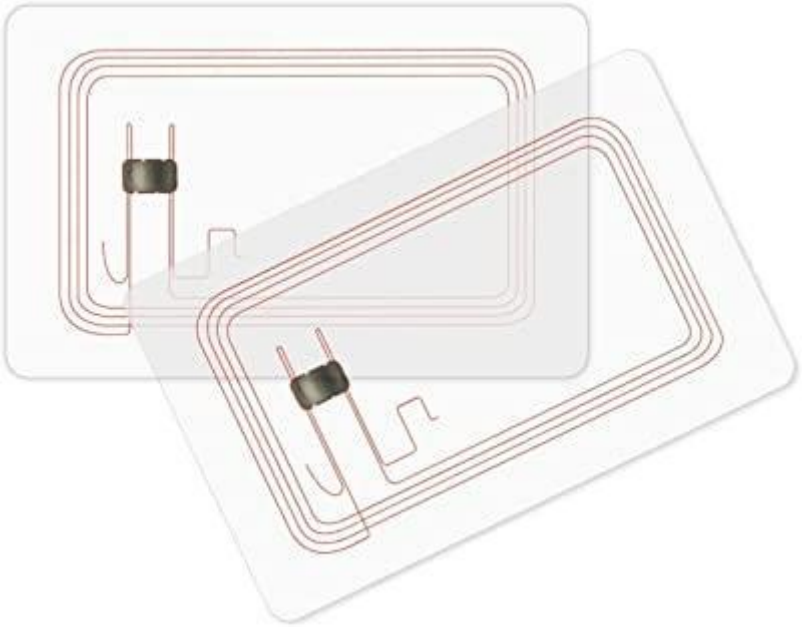

Fig 4.3.1.1. ESP32

4.3.2. RFID Sensors: These sensors facilitate the identification and tracking of items using radio-frequency technology, enabling seamless checkout processes without manual scanning

Fig 4.3.2.1. RFID Sensor

4.3.3. RFID Tags: Attached to each product, these tags store unique identification information that RFID sensors can read and process.

4.3.4. Buzzer System: Provides auditory cues or alerts during certain events, such as successful RFID tag detection or system notifications.

4.3.5. User's Smartphone: Integration with smartphones for customer interaction, through mobile apps or other communication methods.

4.3.6. 12V Adapter: Power supply device converting AC voltage from outlets to regulated 12V DC, necessary for powering various electronic components within the system.

4.3.7. Jumper Wires: Essential for connecting and establishing electrical pathways between different hardware components, often used on breadboards or circuit boards during prototyping and development.

4.4. SOFTWARE REQUIREMENTS

4.4.1. Arduino Compiler: Used for programming and uploading code to the Arduino ESP32 micro-controller, allowing developers to create firmware for the hardware components.

4.4.2. Cloud Service: Utilized for data storage, processing, and enabling remote access or synchronization of information collected from RFID sensors, inventory data, and transnational details.

4.4.3. Android Application: Required for integrating mobile app functionalities, enabling customer interaction, personalized services, and seamless connectivity with the system.

4.4.4. Esp Now Library: Essential for setting up communication between ESP32 devices, facilitating data transmission and reception in an ESP-NOW network.

4.4.5. Web Server Framework: Enables the creation of web-based interfaces, aiding in dashboard development, customer interactions, or system administration.

4.4.6. SPI Library: Used for Serial Peripheral Interface (SPI) communication, allowing devices to exchange data and communicate with each other in the system.

4.4.7. MFRC522 Library: Specific library for interfacing with RFID modules, facilitating the reading and writing of RFID tags and managing RFID-related functionalities.

SYSTEM DESIGN

5. SYSTEM DESIGN

System design is the process of defining the elements of a system such as the architecture, modules and components, the different interfaces of those components and the data the goes through that system. It is meant to satisfy specific needs and requirements through the engineering of a coherent and well-running system.

CONCEPT OF UML

UML is a standard language for specifying, visualizing, constructing, and documenting the artifacts of software systems. UML stands for Unified Modelling Language. UML is different from the other common programming languages such as C++, Java, COBOL, etc., UML is a pictorial language used to make software blueprints. There are a number of goals for developing UML but the most important is to define some general-purpose modelling language, which are modelers can use and it also needs to be made simple to understand and use.

UML DIAGRAMS:

UML stands for Unified Modeling Language. UML is a standardized general-purpose modeling language in the field of object-oriented software engineering. The standard is managed, and was created by, the Object Management Group.

The goal is for UML to become a common language for creating models of object-oriented computer software. In its current form UML is comprised of two major components: a Meta-model and a notation. In the future, some form of method or process may also be added to; or associated with, UML.

The Unified Modeling Language is a standard language for specifying, Visualization, Constructing and documenting the artifacts of software system, as well as for business modeling and other non-software systems.

The UML is a very important part of developing objects-oriented software and the software development process. The UML uses mostly graphical notations to express the design of software projects.

5.1. USE CASE DIAGRAM

The use case diagram for the IoT-based shopping solution offers a succinct portrayal of the primary interactions between different actors and the system's functionalities. It delineates three key actors: the Customer, Market Owner, and System Admin. The Customer actor encompasses essential interactions such as browsing products, managing the shopping cart, and completing transactions, emphasizing the core functionalities crucial for a seamless shopping experience. The Market Owner actor focuses on inventory management, sales monitoring, and security oversight, highlighting their pivotal role in market operations. Lastly, the System Admin actor engages in crucial system-level tasks including monitoring, updates, and security patches, ensuring the system's robustness and integrity. This visual representation encapsulates the core functionalities catered to distinct user roles, providing a holistic view of the system's interactions and functionalities.

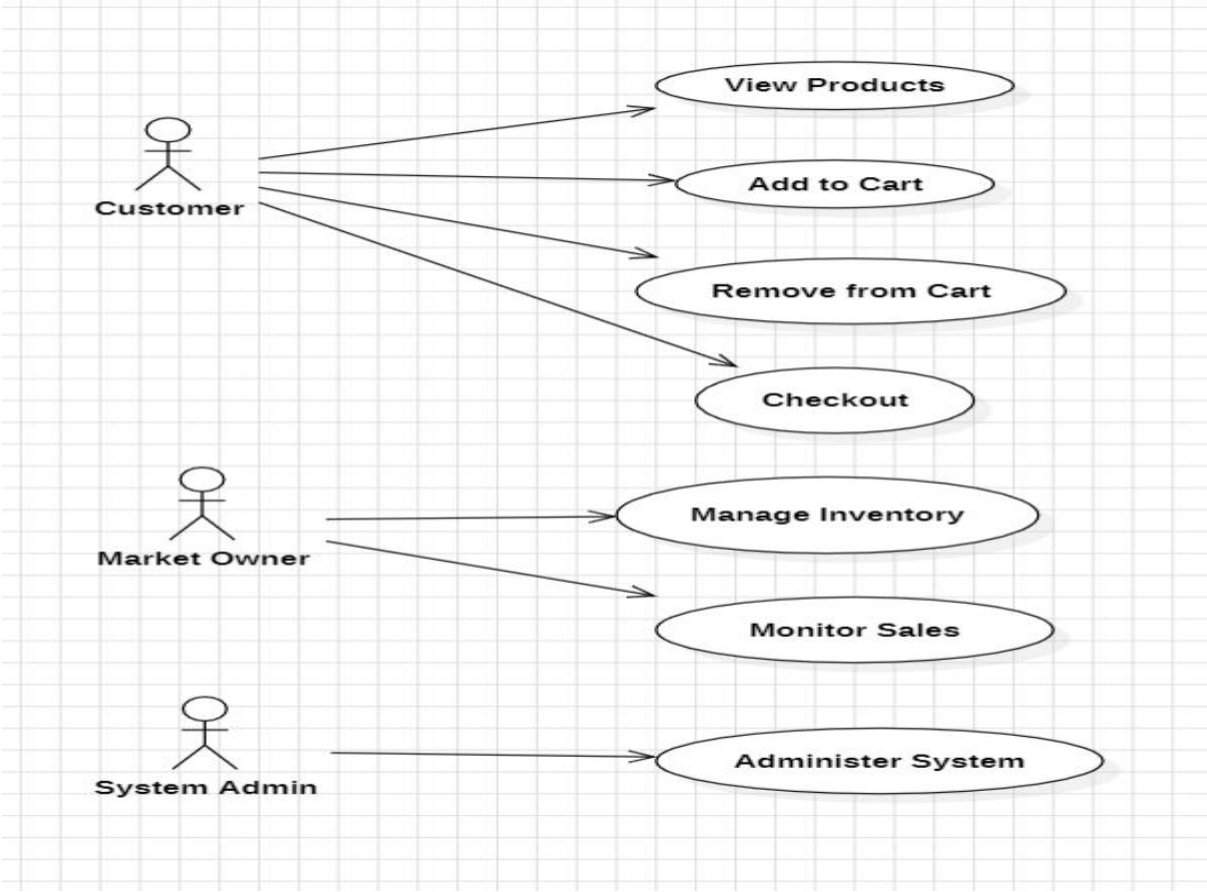

Fig 5.1.1. Use Case Diagram

5.2. CLASS DIAGRAM

The class diagram for the IoT-based shopping solution presents a structured depiction of the system's fundamental entities and their relationships. It outlines key classes, including Customer, Market Owner, Cart, and Inventory, encapsulating their respective attributes and associations. The Customer class represents customers with attributes like customerId, name, and a reference to their cart, delineating their role in the shopping process. The Market Owner class encompasses attributes such as ownerId, name, and associations with managed markets, spotlighting their involvement in market management. The Cart class holds details like cartId, items, and total cost, reflecting the customer's selected items and their aggregated cost during shopping. The Inventory class manages product-related information such as inventoryId, itemName, quantity, price, and location, crucial for effective stock management. This visual representation encapsulates the core entities and relationships within the system, offering a comprehensive overview of its structural elements and their associations.

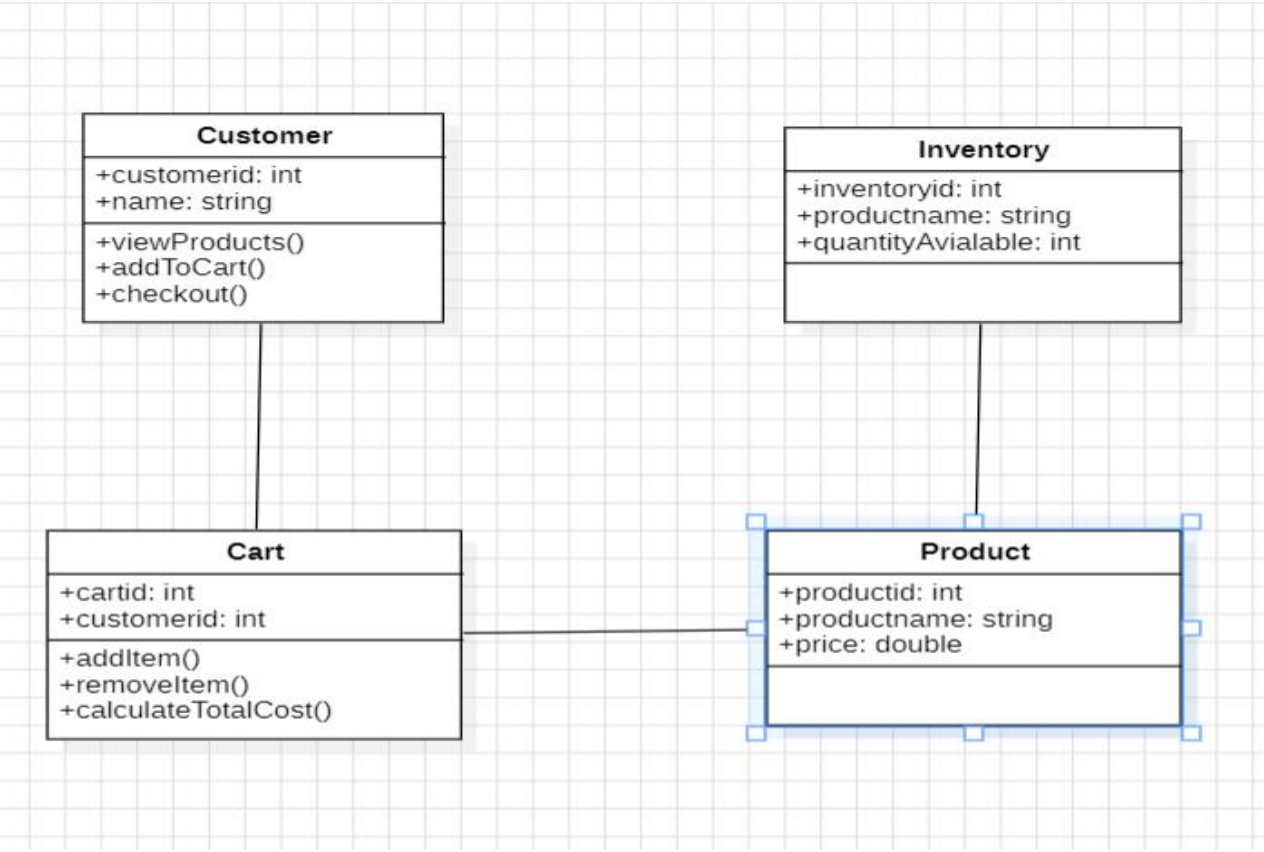

Fig 5.2.1. Class Diagram

5.3. ACTIVITY DIAGRAM

The activity diagram for the IoT-based shopping solution offers a detailed breakdown of sequential actions and interactions within the system. It delineates various activities undertaken by distinct user roles and system components. For instance, the Customer engages in a sequence of actions, starting from browsing products, adding items to the cart, reviewing the cart, proceeding to checkout, entering payment details, and completing transactions. Simultaneously, the Market Owner conducts activities such as inventory management, sales monitoring, and overseeing security measures within the market. Additionally, the System Admin undertakes crucial tasks like system monitoring, software updates, and applying security patches to ensure the system's reliability and resilience. Each step in this visual representation unfolds a series of activities executed by different stakeholders or system components, providing a comprehensive view of their interrelated actions within the IoT-based shopping ecosystem.

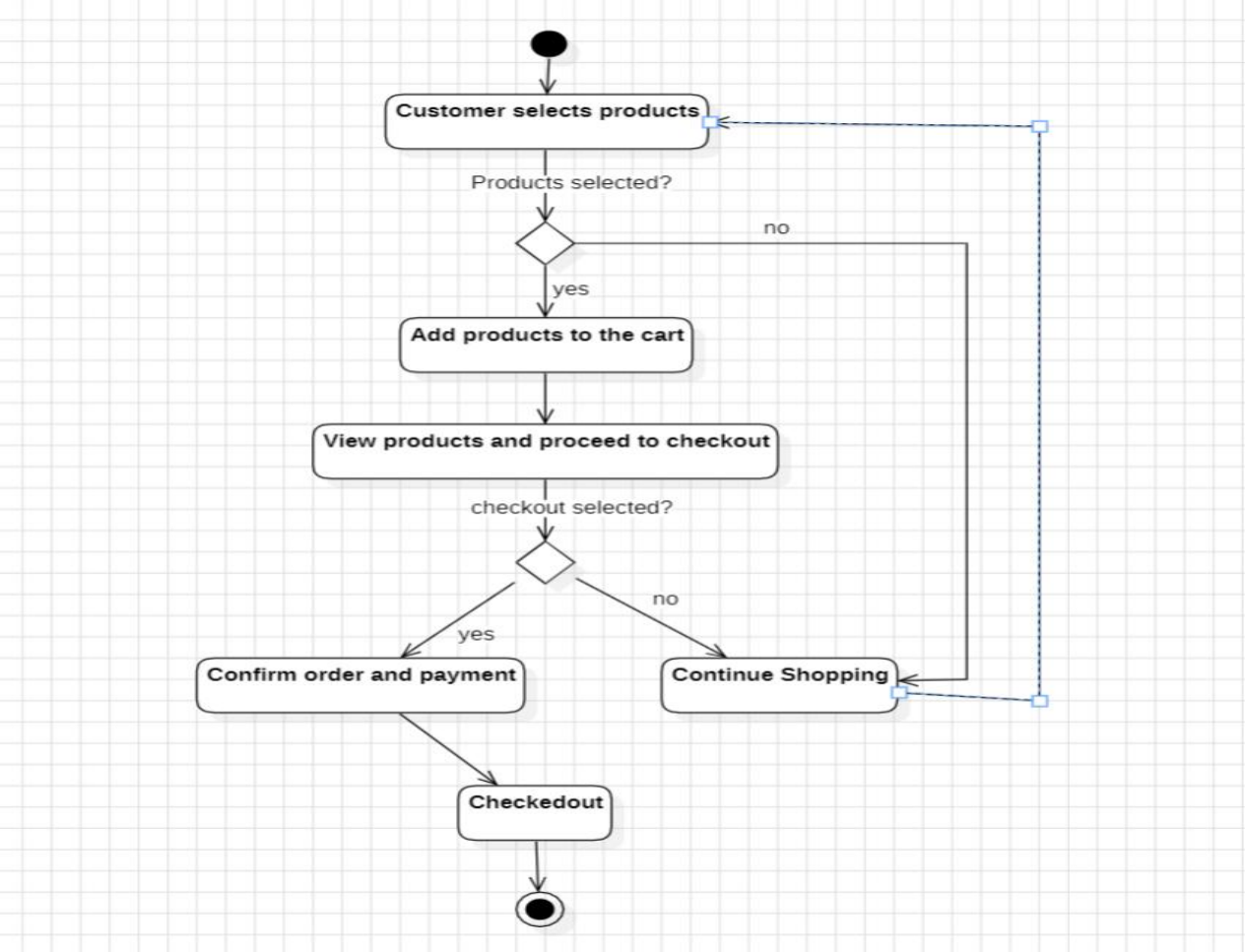

Fig 5.3.1. Activity Diagram

5.4. MODEL ARCHITECTURE

The model architecture of the IoT-based shopping solution is structured into several layers, each serving distinct functionalities within the system. At the presentation layer, user interfaces like customer applications, market owner dashboards, and administrative panels facilitate interactions, enabling activities such as browsing products, managing carts, overseeing inventory, and administering the system. The application layer embodies the core logic, managing customer requests, inventory control, transaction processing, and security features like facial recognition and motion detection. An integration layer orchestrates seamless communication between system components, interfacing with IoT devices, payment gateways, and external services for analytics or security measures. Ensuring system integrity and user data protection, a dedicated security layer implements encryption, access controls, secure payment gateways, and surveillance features, collectively establishing a robust and interconnected ecosystem for efficient and secure IoT-driven shopping experiences.

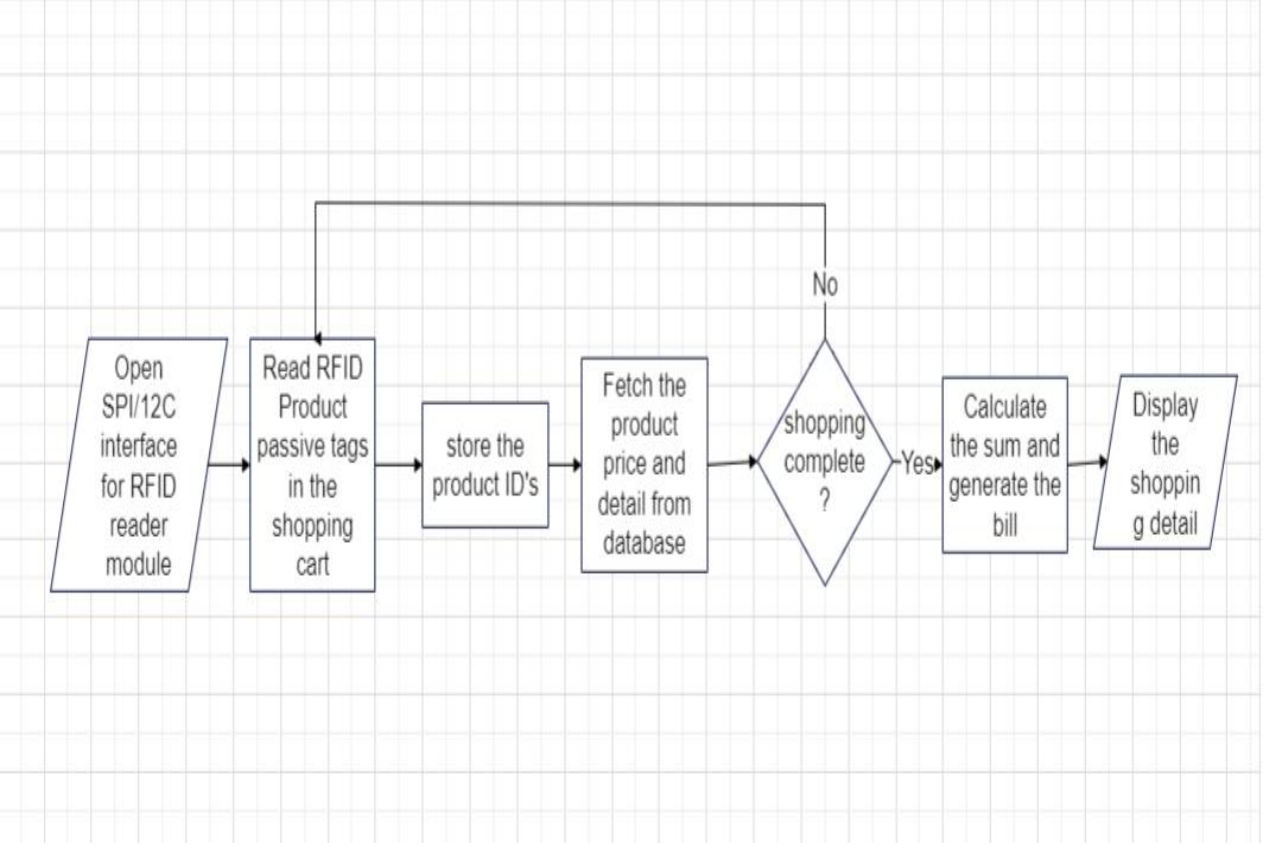

Fig 5.4.1. Model Architecture

IMPLEMENTATION

6. IMPLEMENTATION

6.1 WORKING DESCRIPTION

The proposed IoT-based smart shopping solution revolutionizes traditional retail practices by seamlessly integrating RFID technology, real-time billing systems, personalized recommendations, and advanced security features. RFID-based product identification automates the checkout process, eliminating manual scanning and reducing wait times for customers. Real-time billing systems provide immediate feedback on purchases, empowering customers to make informed decisions and enhancing transparency.

Personalized recommendations leverage AI algorithms to offer tailored suggestions based on customer preferences, enhancing the shopping experience and driving engagement. Smart security measures, including facial recognition and motion detection cameras, ensure a safe and secure shopping environment, instilling confidence in customers and deterring theft.

Looking forward, the solution holds potential for further enhancements, such as mobile app integration for on-the-go access to shopping carts and recommendations, as well as real-time inventory management to optimize stock levels. Advanced analytics capabilities will provide valuable insights into customer behavior, enabling retailers to make data-driven decisions and enhance operational efficiency.

Overall, the IoT-based smart shopping solution represents a transformative approach to retail, offering convenience, personalization, and security to customers while driving growth and innovation in the industry.

6.2 IMPLEMENTATION

6.2.1.Hardware Setup:

- Install RFID readers strategically throughout the store to detect RFID tags on products.

-Install the device to all the shopping cats available.

- Configure digital screens or displays for showing personalized recommendations and real-time billing information.

6.2.2. RFID Tagging:

- Tag each product in the store with an RFID tag containing a unique identifier.
- Ensure that RFID tags are placed in a location that is easily detectable by RFID readers.

6.2.3. Software Development:

- Develop software to interface with RFID readers and capture data about detected items in real-time.
- Implement algorithms for personalized recommendations based on customer preferences and shopping history.
- Integrate facial recognition and motion detection software for security purposes.

6.2.4. Real-Time Billing System:

- Develop a billing system that calculates the total cost of items in the shopping cart in real-time.
- Implement a user-friendly interface to display the total cost and provide feedback to customers as they shop.

6.2.5. Mobile App Integration (Optional):

- Develop a mobile app that allows customers to access their shopping carts, receive personalized recommendations, and make payments.
- Ensure seamless integration with the existing system for a unified shopping experience across different channels.

-This is the advanced for integrating the proposed system to incorporate the AI-Based recommendations, real-time inventory management and also to keep the sales of individual products.

6.2.6. Testing and Optimization:

- Conduct thorough testing of the system to ensure that all components function as intended.
- Optimize algorithms and software for performance and accuracy.
- Solicit feedback from customers and store staff to identify areas for improvement.

6.2.7. Deployment:

- Deploy the system in the store environment, ensuring that all hardware and software components are properly configured and operational.
- Train store staff on how to use the system effectively and provide ongoing support as needed.

6.2.8. Monitoring and Maintenance:

- Continuously monitor the system for any issues or anomalies.
- Perform regular maintenance to ensure optimal performance and reliability.
- Stay abreast of technological advancements and opportunities for further enhancements.

6.3 SOURCE CODE

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);
void printDetail(uint8_t type, int value);
#define D6 6
#define led1 3
#define led2 4
char input[12];
int count = 0;
int a;
int p1 = 0, p2 = 0, p3 = 0, p4 = 0;
int c1 = 0, c2 = 0, c3 = 0, c4 = 0;
 //void printDetail(uint8_t type, int value);
double total = 0;
```

```
int count_prod = 0;
void setup ()
{
   Serial.begin(9600);
  pinMode(D6, INPUT_PULLUP);
  pinMode(3, OUTPUT);
  pinMode(4, OUTPUT);
 // pinMode(6, OUTPUT);
 lcd.init();
  lcd.backlight();
  lcd.setCursor(0,0);
  lcd.print(" AUTOMATIC BILL");
  lcd.setCursor(0, 1);
  Serial.begin(9600);
  lcd.print(" SHOPPING CART ");
  delay (2000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("WELCOME TO");
  delay (2000);
  lcd.setCursor(3, 1);
  lcd.print("SUPER MARKET");
  delay (2000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Plz Add iTem");

}
void loop()
{
  int a = digitalRead(D6);
  if (Serial.available()) {
    count = 0;
  while (Serial.available() && count < 12)
```

```
{
  input[count] = Serial.read();
  count++;
  delay(5);
}
//int a = digitalRead(D7);
if (count == 12) {
if ((strncmp(input, "1E0034B21D85", 12) == 0) && (a == 1))
{
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Butter Added       ");
  lcd.setCursor(0, 1);
  lcd.print("Price :- 10.00      ");
  p1++;
  digitalWrite(led1, HIGH);
  digitalWrite(led2,LOW);
 // digitalWrite(buzzer, HIGH);
  delay(2000);
  total = total + 10.00;
  count_prod++;
  digitalWrite(3, LOW);
  digitalWrite(4, HIGH);
 // digitalWrite(buzzer, LOW);
 lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print("Total Price:-");
      lcd.setCursor(0, 1);
      lcd.print(total);
}
else if ((strncmp(input, "1E0034B21D85", 12) == 0) && (a == 0))
{
  if (p1 > 0)
  {
```

```
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Butter Removed!!!  ");
    digitalWrite(3, LOW);
    digitalWrite(4, HIGH);
   //  digitalWrite(buzzer, HIGH);
    delay(2000);
    p1--;
    total = total - 10.00;
    count_prod--;
    lcd.clear();
    digitalWrite(4, LOW);
    digitalWrite(3, HIGH);
   //  digitalWrite(buzzer, LOW);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Total Price :-");
    lcd.setCursor(0, 1);
    lcd.print(total);
   }
   else
   {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("PLZ SCAN ITEMS ");
    lcd.setCursor(0,1);
    lcd.print("TO CART");
   }
}
 else
  {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("PLZ SCAN ITEMS ");
```

```
      lcd.setCursor(0,1);
      lcd.print("TO CART");
    }
  }
   else
    {
      lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print("PLZ SCAN ITEMS ");
      lcd.setCursor(0,1);
      lcd.print("TO CART");
    }
  }
}
```

TESTING

7. TESTING

7.1. UNIT TESTING:

Unit testing for the IoT-based smart shopping solution begins with scrutinizing the RFID reader integration. This entails verifying its accuracy in detecting RFID tags on products and ensuring reliable data capture. Through simulated scenarios and edge cases, the reader's performance is evaluated for real-world reliability and seamless communication with other system components.

Simultaneously, the personalized recommendation engine undergoes meticulous examination. Test cases cover various customer profiles and purchase histories to validate the engine's ability to generate relevant product suggestions. Through iterative testing, the recommendation engine is fine-tuned to deliver personalized recommendations that enhance the shopping experience.

Concurrently, the real-time billing system is subjected to comprehensive validation. Tests simulate shopping scenarios to ensure accurate calculations of total costs, considering discounts and promotions. The system's responsiveness and ability to provide instant feedback to customers are evaluated, ensuring reliable and seamless integration within the smart shopping solution.

7.2. INTEGRATION TESTING:

Integration testing for the IoT-based smart shopping solution ensures the seamless interaction among its components. Initially, it verifies the integration between the RFID reader system and the real-time billing system. This ensures accurate data capture from RFID readers and real-time updates of total costs in the billing system.

Concurrently, it extends to the interaction between the personalized recommendation engine and the user interface. This confirms that product recommendations generated by the engine are correctly displayed to customers, enhancing their shopping experience.

Lastly, integration testing includes coordination between security features like facial recognition and motion detection and the overall system. It validates that security alerts triggered by these features are effectively communicated to store staff, maintaining a secure shopping environment.

7.3. ACCEPTANCE TESTING:

Acceptance testing for the IoT-based smart shopping solution focuses on validating its functionality and usability according to predefined acceptance criteria. Firstly, it involves testing the RFID reader system and real-time billing integration to ensure accurate data capture and seamless updates of total costs in the billing system. This verifies that the system meets requirements for efficient checkout processes and transparent billing.

Subsequently, acceptance testing extends to the interaction between the personalized recommendation engine and the user interface. This confirms that product recommendations are displayed correctly to customers, aligning with their preferences and enhancing their shopping experience. It ensures that the system meets expectations for personalized service delivery.

Lastly, acceptance testing includes validating the coordination between security features such as facial recognition and motion detection and the overall system. This ensures that security alerts are appropriately communicated to store staff, maintaining a secure shopping environment as per specified security standards. It verifies that the system meets requirements for ensuring customer safety and preventing theft or unauthorized access.

7.4. TESTING ON OUR SYSTEM:

Testing on your system is essential to ensure the reliability and functionality of the smart shopping solution. Unit testing checks individual components such as the RFID reader and recommendation engine, ensuring they perform accurately. Integration testing ensures seamless communication between these components, validating their interoperability within the system.

Acceptance testing verifies if the system meets predefined criteria, including accurate data capture and real-time billing updates. Performance testing evaluates system responsiveness and scalability under various conditions, ensuring optimal performance during peak shopping hours. Security testing focuses on identifying and addressing vulnerabilities in security features like facial recognition and motion detection.

User acceptance testing gathers feedback on usability and functionality from end-users, ensuring an optimized shopping experience. By systematically executing these tests, you can ensure that your system delivers a reliable and effective smart shopping solution.

RESULT

8. RESULT

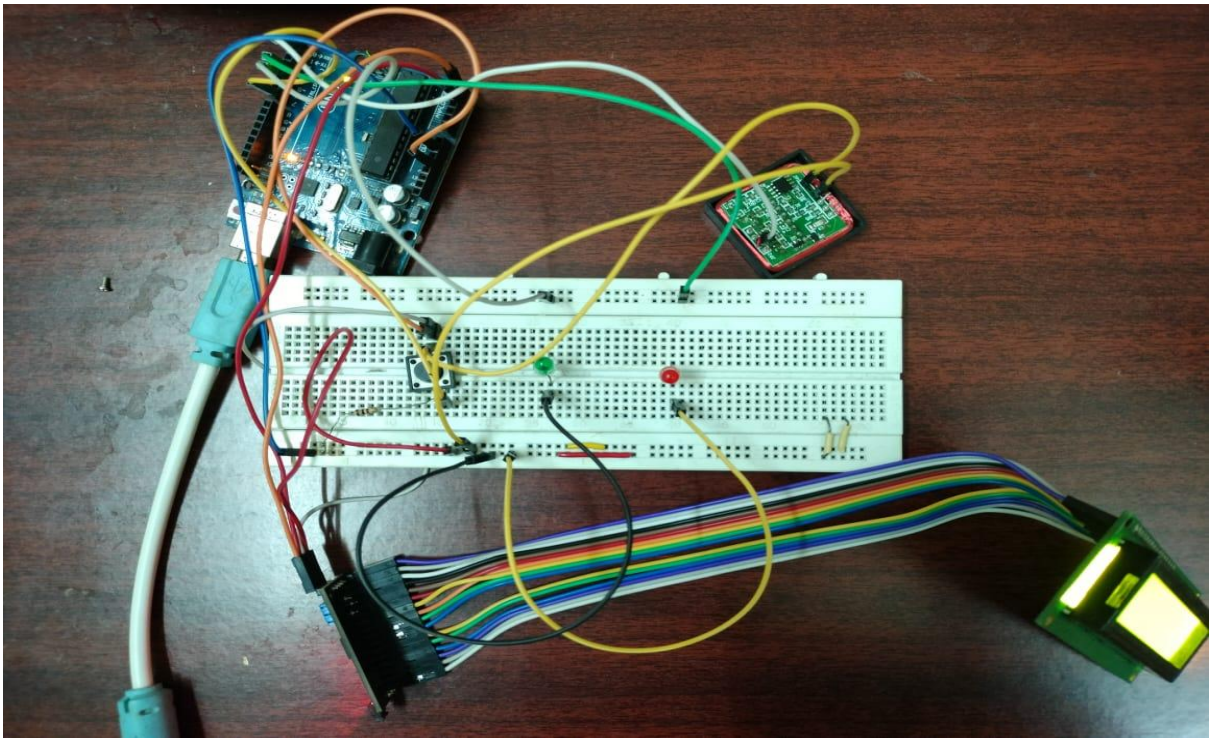

Fig 8.1 Device Set-up

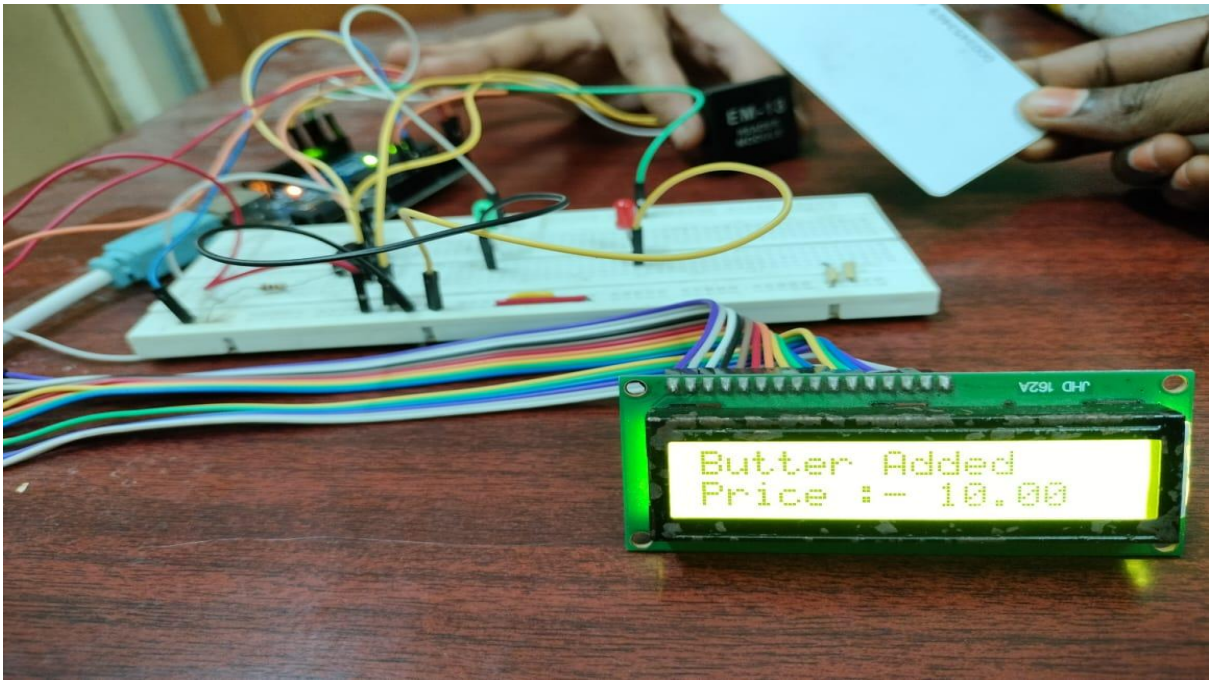

Fig 8.2 Scanning the RFID tag

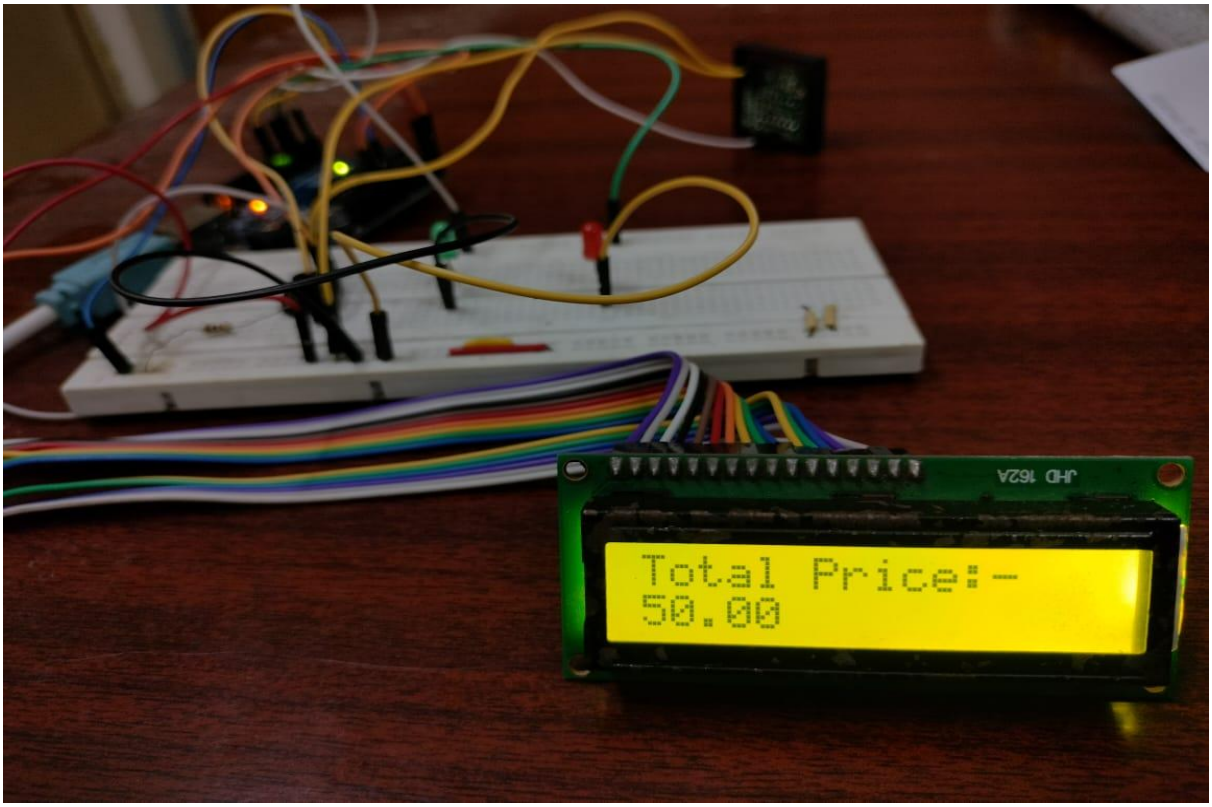

Fig 8.3 Final sum displayed in LCD display

CONCLUSION

8. CONCLUSION

The IoT-driven shopping solution represents a pivotal evolution in traditional market dynamics, revolutionizing the retail landscape by amalgamating cutting-edge technology with consumer-centric efficiency. Its implementation of RFID tags, IoT sensors, and intelligent security measures has transcended conventional shopping paradigms, offering customers an unparalleled, frictionless experience. Instantaneous billing, personalized recommendations, and enhanced security measures like facial recognition redefine convenience while reducing wait times and empowering users with real-time transaction data. Simultaneously, market owners witness elevated operational efficiency, streamlined inventory management, and augmented revenues, marking a paradigm shift in market dynamics. However, the solution's evolution doesn't cease here; future enhancements encompass integrating mobile apps, AI-powered recommendations, real-time inventory monitoring, and seamless integration with online platforms. This trajectory of innovation underscores the solution's role as a trailblazer in retail, promising not just convenience but an adaptable, tech-driven retail ecosystem shaping the future of consumer experiences.

In essence, this IoT-powered solution serves as a blueprint for an industry poised for transformation, seamlessly intertwining technology, efficiency, and consumer-centricity. Its success not only redefines shopping experiences but sets the stage for a future where technology enriches and revolutionizes the very core of retail, promising a landscape of unparalleled convenience and adaptability for both customers and market owners alike.

BIBLOGRAPHY

9. BIBLOGRAPHY

1. “Intelligent Shopping Cart for Product Recommendation and Interaction in Retail“ L. Xue, et al. Journal of Ambient Intelligence and Humanized Computing in 2022 DOI: 10.1007/s12652-021-03486-7.

2. "Design and Development of a Smart Shopping Cart Using IoT and Machine Learning" M. H. Ahmed, et al Journal of Sensors in 2021 DOI: 10.3390/s21010257

3. "Smart Shopping Cart with Voice Control and Automatic Payment“ M. Yang, et al. Published in the Journal of Sensors in 2021 DOI: 10.3390/s21123963.

4. " Smart Shopping Cart with Automatic Payment and Queue Detection” J. Wu, et al. Published in the IEEE Internet of Things Journal in 2020 DOI: 10.1109/JIOT.2020.2982337.

5. "Smart Shopping Cart with Customer Feedback and Payment System“ Y. Zhu, et al. Published in the Journal of Sensors in 2020 DOI: 10.3390/s20030651.

6. "Smart Shopping Cart with Personalized Recommendations and Feedback" Y. Song, et al. Published in the Journal of Retailing and Consumer Services in 2019 DOI: 10.1016/j.jretconser.2019.02.012.