DESIGN AND IMPLEMENTATION OF AN IOT BASED SMART TROLLEY AND BILLING SYSTEM FOR SUPER SHOP

An Undergraduate CAPSTONE Project
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Faculty of Engineering
American International University - Bangladesh

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A CAPSTONE Project submitted to the Faculty of Engineering, American International University - Bangladesh (AIUB) in partial fulfillment of the requirements for the degree of Bachelor of Science in their mentioned respective programs.

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DECLARATION

This is to certify that this project titled "**Design and Implementation of an IoT-based Smart Trolley and Billing System for Super Shop"** is our own work. No part of this work has been submitted elsewhere partially or fully for the award of any other degree or diploma. Any material reproduced in this project has been properly acknowledged.

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APPROVAL

The CAPSTONE Project titled **Design And Implementation Of An IoT Based Smart Trolley And Billing System For Super Shop** has been submitted to the following respected members of the Board of Examiners of the Faculty of Engineering in partial fulfillment of the requirements for the degree of Bachelor of Science in the respective programs mentioned below in **October 2023** by the following students and has been accepted as satisfactory.

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ABSTRACT

Supermarkets are becoming more popular in today's consumer environment, drawing a varied range of people owing to their vast product offerings. Supermarkets provide a large variety of things, including fresh vegetables, meats, dairy, and packaged goods, as well as home essentials, making them an excellent one-stop destination for completing all shopping at once. This convenience, however, is not without its drawbacks. Long lineups can make shopping experiences unpleasant, leading supermarkets to utilize techniques such as technological improvements to enhance the shopping experience—especially during peak periods when many offers are available. The billing method is typically time-consuming and hectic, requiring the inclusion of more human resources in the billing area. Customers often have trouble operating excessively loaded carts. Manual computations of purchases and budget comparisons until the scanning process in the invoicing area add another degree of aggravation. To address these concerns, an extraordinary idea encompassed with IoT and RFID scanners are implemented into shopping trolley. As clients load items into the trolley, the RFID reader automatically reads product data such as item names, prices, and weights. A speaker will declare the goods that buyers have chosen, as well as their price and weight. This information is then shown on a screen, allowing buyers to inspect goods and alter pricing by rescanning. Furthermore, the trolley is designed to move, eliminating the need for customer to push it back and forth. Customers may pay with cards while shopping by simply putting the card in front of the RFID, and the payment is completed in seconds. An SMS will be delivered to the customer's phone number to confirm the payment, and the payment procedure will also trigger an announcement over the speaker if the card does not have an adequate balance. When a customer is done shopping, they can easily take their cart to the payment area. This cuts down on the time-consuming physical counting process and makes shopping less tiring, especially for older customers.

Chapter 1

INTRODUCTION

1.1. Overture

The major objective of this project is to make shopping in superstores more enjoyable by solving the most common problems that customers have. By using new technologies and creative ideas, the project hopes to speed up the payment process, make it easier to compare prices and keep track of a budget, and make shopping easier for everyone, including people with vision problems and older people. Radio Frequency Identification (RFID) readers would be put into the trolleys as part of the suggested solution. When a customer puts an item in the shopping cart, the RFID reader instantly reads the name, price, expiration date, and discounts for that item. This information is shown on a screen that is attached to the trolley, so customers can quickly see what they have chosen and make any changes they need to. The cart will also be made so that customers can walk with it, so they won't have to work to move it back and forth. By concentrating this method in place, the project hopes to cut down on the time-consuming manual scanning that has to be done during billing. Customers will be able to bring their shopping cart to the payment area, where it will be scanned and the information used to make a correct bill. This technology will save time for both customers and employees, making shopping go more smoothly and quickly. Also, the group knows how important it is for everyone to be able to use it. With a speaker built into the system, customers will be told about the specifics, prices, and weights of the products. People who can't see will benefit from this feature because it will help them find their way around and make smart choices while they shop. Overall, the goal of the project is to change the way people shop at super shops by using technology to make shopping less frustrating, more convenient, and more fun for everyone.

1.2. Engineering Problem Statement

The current purchasing experience in superstores is characterized by lengthy lines, inefficient billing procedures, manual calculation of purchases, and difficulty maneuvering carts with heavy loads. These obstacles result in consumer frustration and a chaotic shopping environment overall. In addition, the system lacks accessibility for those with visual impairments and the elderly. This project's objective is to create a solution that addresses these obstacles and improves the purchasing experience in superstores. The proposed system aims to integrate Radio Frequency Identification (RFID) technology into shopping carts, enabling automatic scanning of product information, such as the item's name, price, expiration date, and applicable discounts[1]. This data will be displayed on a screen attached to the shopping cart, allowing customers to easily review items and modify prices as necessary by rescanning the products. The design of carts that can travel alongside customers, eliminating the need for manual pushing, is another aspect of the solution. This feature will enhance maneuverability and reduce physical strain on customers, making purchasing more convenient. Additionally, the incorporation of a speaker into the system will facilitate product announcements, including product details, pricing, and weights, which will benefit the visually impaired. The primary engineering obstacles to be addressed in this undertaking include:

Designing an effective and efficient system that can specifically scan and retrieve product information using RFID readers integrated into the trolleys.

Real-time information display: Developing a screen dashboard that can immediately exhibit the scanned data, allowing customers to review and alter prices as needed.

Mobility and stability of trolleys: Developing a mechanism that enables trolleys to walk smoothly and securely alongside customers, assuring stability even when carrying heavy loads.

Accessibility considerations: Implementing straightforward and comprehensive product announcements through the speaker to ensure the system is accessible to individuals with visual impairments.

System reliability and scalability: Creating a system that is reliable, scalable, and able to handle a large number of consumers and products during peak hours.

The successful implementation of this project will result in a more streamlined and efficient shopping experience, reduced wait periods at the billing section, enhanced budget management, increased mobility and accessibility, and, ultimately, greater customer satisfaction in supermarkets

1.3. Related Research Works

Smart trolleys are essential for daily life and shopping. They provide convenience through features like displays, personalized recommendations, and streamlined checkout. They improve inventory management cater to special needs, and offer valuable data for retailers. Overall, smart trolleys enhance the shopping experience, making it efficient and enjoyable.

1.3.1. Earlier Research

S. J. Mane et al describes a smart shopping system that uses RFID technology to enhance supermarket payment procedures. By substituting traditional barcode scanning with RFID tags, the system enables the rapid and simultaneous display of product prices and total amount, thereby reducing wait periods and boosting customer satisfaction[2].

A. Peradath et al suggests "Smart Trolley in Mega Mall," a microcontroller-based purchasing solution. This ingenious shopping cart follows customers, displays product details when barcodes are scanned, and enables fast and effortless purchases. At the invoicing counter, it interfaces seamlessly with computers for verification and bill printing, streamlining the overall process[3].

H.-H. Chiang et al provides members with RFID-enabled membership cards with a convenient and efficient shopping experience by facilitating quick item scanning and billing. It eliminates the need for customers to wait in lines, sparing them time and increasing their satisfaction in supermarkets and hypermarkets[4].

Y. L. Ng et al proposes an RFID-enabled smart purchasing cart to improve the shopping experience. It expedites item searches, provides real-time purchase data, and enhances budget management. Positive feedback from a market survey highlights its time-saving and convenience-enhancing benefits. For widespread adoption, it is recommended to conduct additional research[5].

A. A. S. Gunawan et al Developing an RFID-based intelligent purchasing cart system for malls. Simplifies the billing procedure, shortens lines, and improves the overall purchasing experience. Automatic product scanning, real-time price display, and wireless billing data transfer. Performance that is efficient, compact, and promising[6].

1.3.2. Recent Research

The objective of the project is to create a cutting-edge autonomous shopping trolley system utilizing Arduino, RFID technology, and other parts. The goal is to simplify the shopping experience for consumers, cut down on line waiting times, and automate the purchasing process. The technique entails tagging items with RFID tags, scanning them with an RFID reader mounted on the cart, and showing the total on an LCD screen. To allow automated movement, the cart is additionally fitted with ultrasonic sensors and motors. The customer's registered mobile number is also utilized to send a message with the complete bill using a GSM module. The initiative intends to increase shopping convenience, effectiveness, and financial management[6]

This paper proposed that, by combining RFID, IoT, and a mobile application, the suggested Smart Shopping Cart transforms the shopping experience. Customers may manage their wish lists, preferences, and payments with ease using the app. RFID sensors read the product tags to provide quick information and speed up the invoicing process. This cutting-edge technology, which aims to decrease wait times and increase convenience, has the potential to significantly change the retail sector by providing consumers with a smooth and effective shopping experience[7]

M. Shahroz et al provide practical methods for improving shoppers' shopping experiences. The suggested system has components including an LCD, a microphone, a weight scanner, an RFID reader, and a camera with an ultrasonic sensor. Access to the trolley is supplied through RFID loyalty cards that are given out to customers. Customers may scan items using the camera on the device, which takes pictures and uses OpenCV to compare them to data in a database. Accurate measurements are ensured by the weight sensor, and the LCDs product information, payment information, and suggestions according to individual customer preferences. Additionally, customers may use the microphone to ask questions; the system then answers on the display. The system counts the number of consumers in the billing line using object tracking from CCTV cameras, prompting them to transfer to a rapid checkout counter if required. The research covers the functioning of the suggested smart trolley system, including screenshots of the user interface, and delivers the findings[8]

This project suggests building a smart trolley using an Arduino NANO, RFID, a barcode reader, and a Wi-Fi module. Notably during the COVID-19 epidemic, it seeks to enhance the shopping experience by minimizing crowds and lines. The trolley's ability to sync with a smartphone app enables users to keep their social distance. The technology offers effective item scanning and tracking while delivering up-to-the-minute pricing and expiry information. Users may add or remove things from their shopping list, and the data is transferred to the cloud for display on the mobile application. Customers may shop in comfort and safety with the help of the smart trolley[9]

A convenient and effective shopping experience is provided by the smart trolley, a cutting-edge gadget. It includes cutting-edge components including an Arduino UNO, a Wi-Fi module, and RFID technology. Customers may scan goods, read their data on an LCD screen, add or delete things, and produce invoices using the trolley. It offers multiple payment alternatives, both online and offline, and enables the administrator to keep track of stock information. The smart trolley is intended to solve the shortcomings of current methods and enhance the whole shopping experience[10]

A multipurpose smart trolley developed for supermarkets is called the "Follow Me" automated trolley. Advanced technologies are included, including automated parking, barcode scanning, and customer following. Customers may make purchases and provide ideas using an Android application on the system, while supermarket employees can control inventory and create invoices using a PC program. For navigation, the trolley makes use of IR sensors and a line-following algorithm. To confirm the system's correctness and usability, the research team performed unit testing and integration testing. Overall, the autonomous "Follow Me" trolley improves the shopping experience by bringing convenience and efficiency to both consumers and supermarkets[11]

1.4. Critical Engineering Specialist Knowledge

To improve the shopping experience at superstores, this project seeks to integrate RFID scanners into trolleys. The system streamlines invoicing and improves user convenience by automatically scanning items, displaying information, and adding self-propelled trolleys.

For this project, the engineering expert knowledge must include an in-depth understanding of several important areas.

The first need is to know about Radio Frequency Identification (RFID) technology. The expert should be well-versed in the fundamentals, workings, and application of RFID systems. Understanding of RFID tags, readers, antennas, and communication protocols falls under this category. They need to be able to choose the best RFID parts for the trolley system, maximize their efficiency, and guarantee their compatibility with the current infrastructure[12].

Second, a solid foundation in electronics and embedded systems is required. The expert should be able to design and create the embedded systems and electronic components that power the RFID readers and display panels in the trolleys. Circuit design, microcontrollers, sensors, and power management knowledge are needed for this. They need to be able to include these parts in the trolley's design to guarantee dependability and toughness in a retail setting.

Thirdly, the expert has to be knowledgeable about the user interface (UI) and user experience (UX) design. They need to be adept in designing a simple and approachable user interface for the trolley's display screen. Information architecture, graphic design, interaction design, and usability testing are all necessary for this. The expert should concentrate on making the information on display simple to understand, giving clear directions, and allowing changes to pricing or quantities.

Knowledge of networking and wireless communication is also essential. Data must be sent wirelessly between the trolley's RFID readers and the billing section for the trolley system to function. An expert should be able to develop a dependable and secure communication infrastructure for the system and be familiar with wireless protocols like Wi-Fi or Bluetooth.

Designing a trolley that can move independently and go alongside consumers requires knowledge of mechanical engineering and robotics. The expert should be knowledgeable in mechanical design concepts, motor systems, motion control, and sensors. They must be able to design a sturdy and effective walking system for the trolley.

To handle the RFID data gathered from the trolleys, data management, and integration capabilities are crucial. The professional should be aware of integration and data management methods. They should make sure that the data is accurately processed, stored, and integrated with the billing system. It is important to take data security, privacy, and scalability into mind.

System integration and testing should also be familiar to the professional. They should be adept in coordinating the RFID trolley system's integration with other systems already in place at the mall, such as the payment and inventory control systems. To guarantee smooth functioning and compatibility with the mall's infrastructure, testing, and troubleshooting skills are essential.

To maintain regulatory compliance, knowledge of pertinent industry standards and laws is required. The expert should be knowledgeable about the standards and laws that apply to wireless communication, electronic systems, and RFID technology. They should make sure that the created system conforms to privacy, safety, and electromagnetic interference laws.

The administration of the whole development process requires strong project management abilities. The expert should be adept at collecting requirements and designing, implementing, testing, and deploying systems. They must be able to work well with other project stakeholders to efficiently manage resources, finances, and deadlines.

The expert should also have a mentality that encourages innovation and constant progress. It's crucial to keep up with the most recent developments in RFID technology, electronics, robotics, and retail business trends. They ought to be able to spot areas where the functionality, effectiveness, and user experience of the trolley system may be improved.

1.5. Stakeholders

Stakeholders are people or organizations who are affected by a certain project or endeavor or who have a vested interest in it. They may be made up of different entities, such as people, groups, or communities. Several stakeholders may be found in the project's proposal to design a system that integrates RFID readers in trolleys for mega stores. The mega-store owners or management are the main stakeholders, to start. They are accountable for the mega shop's overall performance and operation. Their goals are to improve the shopping experience, boost operational effectiveness, and foster consumer pleasure and loyalty. The second is that actual consumers are important stakeholders. They are immediately impacted by the shopping experience and have requirements for product accessibility, convenience, and service quality. Customers significantly influence the mega shop's viability and durability. Another crucial group of stakeholders is the workers, especially those who work in the billing department. They have firsthand experience with the day-to-day operations and knowledge of the difficulties encountered in the billing process. Their productivity may be increased by enhancing their work environment and minimizing their burden. Technology suppliers, such as firms or people that offer RFID technology, software, and hardware components, are also stakeholders. They have a stake in the efficient delivery of their solutions, as well as the proper operation of the RFID readers and related systems. Regulatory agencies and organizations in the retail sector could be interested in the project. When it comes to the use of RFID technology in big-box stores, they could provide rules, recommendations, or laws. Their participation assures adherence to industry best practices and fosters the general expansion and development of the retail business. Advocates for inclusion and accessibility for people with disabilities are members of the community. By offering a more inclusive and user-friendly shopping experience, they want to ensure that the proposed system meets the requirements of a variety of consumers, including those who are blind or visually impaired. Finally, companies that compete in the retail sector might be regarded as stakeholders. They may monitor the project's execution to gauge its effectiveness and determine if comparable technology or business strategies need to be used in their organizations. By incorporating and involving various stakeholders throughout the project, it is possible to have a thorough awareness of their wants, issues, and viewpoints. It encourages cooperation and collaboration and eventually aids in the effective deployment of the RFID-enabled trolley system in superstores.

1.6. Objectives

The primary objective of this project is to improve the process consumers purchase in supermarkets by implementing RFID technology in shopping carts and making them smart. The goal is to simplify the billing process, automate the scanning of products, reduced the number of waiting times, and improve customer happiness through reducing shopping easier.

1.6.1. Primary Objectives

- Implement RFID technology for automated product detection in shopping carts.
- Streamline billing procedures in order to reduce delay times.
- Enhance overall customer satisfaction and the purchasing experience.
- Address the challenges of manual scanning and budget balancing.
- Improve operational effectiveness by optimizing resource utilization.
- Collect information on the preferences and purchasing habits of customers.
- Implement RFID to demonstrate technological progress.

These primary objectives direct the project towards enhancing the super shop's efficiency, consumer experience, and innovation.

1.6.2. Secondary Objectives

- Provide real-time product information, pricing, and discounts.
- Increase the precision of billing calculations.
- Reduce the invoicing section's need for additional human resources.
- Improve accessibility for those with disabilities.
- Reduce the amount of physical exertion required to push carts.
- Promote environmental responsibility by digitizing product information.

These secondary objectives support the principal objective of improving the shopping experience of customers in superstores.

1.7. Organization of Book Chapters

Chapter 1: This chapter discusses the significance of the project and outlines its potential advantages. It essentially includes the important aspects and overall design of the project.

Chapter 2: In this chapter, a thorough study is discussed along with the literature review. In-depth explanations are provided for the parts and techniques utilized in this project. There are more criteria as well, such as engagement from stakeholders, validity and correctness of prior and current research, and accuracy.

Chapter 3: Time scheduling, management principal modeling, and planning may be carried out effectively after the cost analysis has been completed. This project will be organized in a block diagram in this section. For this project, an attempt is made to create either a 3D or 2D model. When we've finished with project management, engineering theories and techniques will be simple.

Chapter 4: After the modeling and literature study are complete, implementing our idea will be simple. One may consider chapter four to be the project's hazy outline. This chapter includes material on coding and simulation. Our next task will be to collect the tools needed to manufacture the hardware when the code for our project's number plate detection, simulation, and database creation is complete. We'll put in the hardware piece by piece.

Chapter 5: This chapter will address the result section following implementation. The project's approved outcome for the automation of smart shopping system. Whether the product added or not is shown by display text. Also showing properties of RFID and IoT.

Chapter 6: This will be the last chapter of this project including Conclusion. This chapter will have some discussion on the overall project, limitations and improvement of the project. This chapter will also contain the survey result on the impact on the environment and society and full summary.

Chapter 2

PROJECT MANAGEMENT

2.1. Introduction

Designing and deploying an IoT-based Smart Trolley and invoicing system for a superstore is a difficult and comprehensive project that requires careful project management. During the project start, project objectives, parameters, and key stakeholders—team members, management, and external partners—are identified. A solid project charter includes the project's objectives, scope, goals, and first financial considerations. The next project planning step emphasizes accuracy. The project's scope is established, and a detailed plan with milestones, schedules, and resource allocation is created. A thorough risk assessment is done to identify and manage possible difficulties, and budgeting for hardware, and software, is emphasized. If external components are needed, a procurement plan is created. The design phase then defines the hardware, sensors, and communication protocols that support the IoT ecosystem, creating a strong system architecture. Then, user interface design ensures a seamless and user-friendly experience for customers and staff. IoT devices are selected after rigorous investigation, using the best sensors and hardware components for the project. Consumer data and system integrity are protected by comprehensive security measures and data management rules that outline data collection, processing, and storage. With a solid design, the development process begins, integrating IoT devices and sensors into the trolleys and creating the smart trolley and invoicing system software. System operation depends on trolleys, and the central system communicating well. Smart trolleys and billing systems are implemented in the superstore using deployment tactics developed throughout the project. This phase includes extensive shop personnel training to ensure new system competency. Business insights are also gained via reporting frameworks and data analytics tools that analyze sales and customer behavior data. Effective project management, including constant monitoring, control, and open communication, is necessary to keep the project on track and react to changes and problems. A final review verifies that all project goals were met after completion. Stakeholder consent is obtained, and detailed documentation is created for future use. Finally, a comprehensive maintenance strategy is created to ensure the project's sustainability. Keeping the system flexible to allow future enhancements in response to user feedback and technological advancements is crucial to enabling the IoT-based Smart Trolley and invoicing system to evolve and benefit the superstore's customers.

2.2. S.W.O.T. Analysis of the Project

An essential part of project management (SWOT analysis) is because it provides an organized framework for evaluating internal and external elements that might affect the success of a project. It supports strategic planning by emphasizing resources that may be used, areas that need improvement, business possibilities, and risks to be aware of. Resource allocation, risk assessment, and goal alignment with organizational goals are all guided by this analysis. Additionally, it promotes efficient stakeholder communication, improves flexibility in changing contexts, and supports a continuous improvement culture[13]. SWOT analysis ultimately plays a crucial part in ensuring that initiatives are well-prepared, effective, and connected with the larger aims of the organization, greatly enhancing its success.

2.2.1. Strength

Innovation is shown through the project's use of cutting-edge IoT technologies. Smart Trolley and billing system implementation might improve shopping efficiency, checkout speeds, and customer experience. Improved shopping experiences may boost consumer loyalty. Additionally, the system's ability to give vital data on consumer behavior, preferences, and purchasing habits may help the mega store modify its goods and marketing efforts. The initiative may attract tech-savvy clients who value ease and innovation as one of the first retailers to implement such technology. In addition, integration with POS (Point of Sale) and inventory management systems helps boost operational efficiency and customer service. Scalability gives the mega store the option to add features like internet shopping and reward programs, improving its products and customer loyalty.

2.2.2. Weakness

The smart shopping cart project faces several challenges, including cost constraints, technical challenges, user adoption, and the availability and reliability of supporting infrastructure. Implementing an IoT-based system requires substantial expenses, including hardware, software development, integration, and ongoing maintenance. This financial burden may be particularly challenging for smaller retailers or businesses with limited budgets.

User adoption and the learning curve are also critical concerns. Introducing a groundbreaking technology like the smart shopping cart may face resistance from traditional shoppers, making it difficult to convince them to adopt the new system. Privacy and data security concerns are paramount, as handling sensitive personal and transactional data within an IoT system raises privacy and security concerns. Regular maintenance and updates are crucial for optimal performance and security, but can be resource-intensive and logistically challenging. Integration complexity is another weakness, as integrating the smart shopping cart system with existing point-of-sale systems and retail infrastructure can be complex. Addressing these weaknesses is crucial for successful project execution, involving thorough planning, user education, robust security measures, and efficient maintenance processes.

2.2.3. Opportunities

The hyperstore might become a retail pioneer by adopting these new solutions early. This early adoption could attract tech-savvy shoppers who want convenience and efficiency in their shopping experiences, drawn to IoT-based shopping's streamlined product interactions and checkout process. The project's ability to gather data on customer behavior, preferences, and buying habits enables data-driven marketing activities including personalized product suggestions, targeted promotions, and customized loyalty programs. The mega-store may increase sales, customer engagement, and loyalty by using this data. The project's scalability allows for extension and diversification, such as internet shopping and reward program refinements to encourage repeat commerce and build client loyalty[14]. The project has the potential to give the superstore a competitive edge by offering innovative and convenient shopping experiences, leveraging data-driven customer engagement strategies, and exploring growth and diversification opportunities in a dynamic market.

2.2.4. Threats

The project's success is threatened by external dangers revealed in this analysis. Due to the intricacy of IoT technology, technical issues may delay and impact customer experience. Other threats include competitors adopting comparable IoT technologies, reducing the project's distinctiveness and competitive edge. Data privacy and security rules are difficult to comply with, with legal and reputational ramifications. Cost overruns and unexpected costs are financial concerns. The project requires strong technical support, continual innovation, rigorous compliance, sensible financial management, and aggressive risk mitigation to handle these challenges[15]. Recognizing and resolving these vulnerabilities helps boost the project's resilience and success in a changing environment.

2.3. Schedule Management

To finish the project, we are keep doing regular meeting with our honorable supervisor. Before taking every action, we arrange a meeting with supervisor and discuss about our progress. All the group member strictly follows this Gantt Chart and tries to complete their task within the given time.

Table 2.1: Gantt Chart

Date	Feb'23	Feb'23	Feb'23	Feb'23	Jun'23	Jun'23	Jun'23	Sep'23	Sep'23	Sep'23	Sep'23	Sep'23
Tasks	23	23	1-14	23-24	1	15	15	1	1	7	21	28
Orientation												
Online Proposal Submission Deadline												
Chapter 1 & 2 Submission to Supervisor												
Chapter 1 & 2 Revised Submission to Supervisor												
Progress Defense												
Attend Final Defense												
Progress report submission												
Online Chapter 1 & 2 Submission												
Peer ReviewSurvey& lifelong learning report submission												
Draft Project Book Submission to Supervisor												
Draft Project Book Submission to External												
Submission of final book,poster,summery												
Final defense												

2.4. Cost Analysis

One of the most crucial tools in project management is cost analysis. This cost analysis was planned to determine the expense the expense vs the gain in the project plan.

Table 2.2: Hardware components lists

Serial	Components	Unit Cost	Unit	Expanse
1	Arduino Mega	1900	1	1900
2	Arduino Uno	800	3	2400
3	LCD Display 20×4	360	2	720
4	Ultrasonic Sensor	100	3	300
5	LM2596 DC-DC Step-Down Buck Module	100	2	200
6	Li-po Battery 11.1V 1100mAh	1400	1	1400
7	RC522 RFID Module	90	1	90
8	RC522 RFID Card	80	4	320
9	RC522 RFID Tag	40	4	160
10	GSM Module 800L	450	1	450
11	Speaker	120	1	120
12	Rpm 8403 amplifier Sound Module	40	3	120
13	Arduino MicroSD Card Module	75	1	75
14	Samsung 8gb Memory Card	250	1	250
15	300 rpm Gear Motor	1500	4	6000
16	L298N Motor Driver Module	180	1	180
17	Blue plastic Wheel	750	4	3000
18	Sim Card	50	1	50
19	Jumper wire	2.5	40	100
20	Load Cell	160	1	160
21	Switch	5	1	5
Total				18000

2.5. P.E.S.T. Analysis

Project management requires P.E.S.T analysis to understand all external elements affecting a project. Considering Political, Economic, Social, and Technological elements helps project managers understand their project's context. Understanding supports strategy planning, risk assessment, and resource allocation. It helps maintain regulatory compliance, stakeholder engagement, and project relevance in a changing environment. P.E.S.T analysis enables educated decision-making and proactive management of project success and external effects.

2.5.1. Political Analysis

P.E.S.T. political analysis studies political aspects that may affect this project's execution. Government data privacy, consumer protection, and retail technology adoption rules may be political factors. Political or regulatory developments may also influence the project. A project with global supply chains or multinational collaborations may also need political stability, international trade agreements, and diplomatic connections. Complying, mitigating risks, and maintaining a positive political climate for project success require understanding and managing these political issues.

2.5.2. Economic Analysis

The P.E.S.T framework's economic analysis of this project examines economic issues that might affect its results. Assessing the economic environment, including economic growth rates, inflation, and currency stability, may affect project costs and financial planning. The economic research also examines consumer spending and income levels, which might impact superstore demand and customer adoption of the IoT-based system. The project's budget and finance sources are also affected by financing alternatives, interest rates, and capital availability[13]. Project managers can make educated judgments, adjust to economic changes, and assure financial viability in diverse economic situations by completing a complete economic analysis.

2.5.3. Social Analysis

This project's P.E.S.T social analysis examines several factors that contribute to its effectiveness. Understanding customer behavior, including purchase choices and the demand for ease, efficiency, and personalization, is vital. Societal developments including technological dependence, sustainability, and internet transactions also have major consequences. How clients interact with the project depends on demographics like age, income, and geography. Cultural values and ethical issues like sustainability and responsible consumerism influence the project's reception. Effective communication and engagement techniques linked with these social elements are crucial for target audience resonance and project market attractiveness[16]. The social analysis emphasizes the project's integration into society and the need for adaptation and alignment with changing social values and preferences for business success.

2.5.4. Technology Analysis

Technology analysis in the P.E.S.T framework evaluates all technical elements that affect the accomplishment of this endeavor. It starts with a thorough assessment of the project's technological basis, notably its use of IoT technologies. Recognizing the shifting tech landscape, this examination evaluates the project's alignment with current technology. Rapid technical breakthroughs and disruptive inventions are also examined. Emerging technologies and their influence on project competitiveness must be monitored. Assessment of the project's compliance with industry standards and best practices assures technical relevance and compliance. Additionally, IoT talent and knowledge are crucial. Team competency in IoT infrastructure design, implementation, and maintenance is crucial to the project. Thus, project sustainability depends on possessing or developing the requisite skills. The technology study concludes that a rapidly changing technological world requires awareness and flexibility[17]. By monitoring technological trends, aligning with industry standards, encouraging innovation, and training a skilled workforce, the project can use technology to achieve its goals and stay competitive in a changing environment.

2.6. Professional Responsibilities

The IoT-based Smart Trolley and billing system project has several different professional tasks that fall under the heading of project management. They include a wide range of tasks, including establishing the project's goals and scope as well as controlling costs, managing teams, directing technical work, and making sure regulations are followed. Project managers need to interact with a range of stakeholders, assist and mentor team members, and conduct quality control procedures to achieve project requirements. In addition, they are in charge of creating training programs for both staff members and clients, managing vendors and procurement effectively and documenting project progress. A key component of the project's success is the use of data analytics for decision-making, continuous performance monitoring, and seamless interaction with current systems. To maintain the system's flexibility and long-term survival after project completion, project managers must set up maintenance procedures[18]. The IoT-based system benefits both the superstore and its consumers as a result of these obligations, which work together to ensure its successful adoption and ongoing efficacy.

2.6.1. Norms of Engineering Practice

The significance of certain rules from the IEEE Code of Ethics must be emphasized in the context of creating and implementing an IoT-based Smart Trolley and invoicing system for a superstore[19]. These rules provide engineers and project managers with a strong ethical foundation:

Code 1 (Safety and Welfare of the Public): This code acts as a continual reminder to put the welfare, health, and safety of the people first. In the context of our project, this includes ensuring that the safety measures on the smart trolleys are reliable and that consumer data is kept secure. It represents a dedication to providing a purchasing experience that doesn't jeopardize anyone's well-being.

Code 2 (Avoiding Conflicts of Interest): Transparency is essential to every project, but it's particularly important when it comes to avoiding them. Adhering to this code guarantees that all stakeholders are informed of possible conflicts, whether they relate to vendor ties or financial interests, enabling decisions to be made without hidden agendas or prejudices.

Code 3 (Honesty and Realism): Honesty is the cornerstone of trust. This code serves as a reminder to be honest in our communication of the IoT system's capabilities and limits. Setting reasonable expectations for stakeholders and being open about possible difficulties will keep everyone informed and on the same page.

Code 4 (Rejecting Bribery): Ethical procurement procedures are essential to project management. Rejecting bribes makes ensuring that choosing a vendor is done based on merit and what is best for the project, not by using unethical methods. This keeps the procurement procedure honest and ethical.

Code 7 (Honest Criticism and Acknowledgement): Continuous development is encouraged by fostering a culture where sincere feedback is appreciated. It encourages team members to provide helpful criticism, confess and fix mistakes, and appreciate one another's accomplishments. This code encourages responsibility, openness, and dedication to excellence.

Code 8 (Fair Treatment and Nondiscrimination): A key component of ethical engineering is inclusivity. Code 8 serves as a reminder to treat everyone equally and with respect, regardless of their background. This idea extends to encouraging diversity and inclusion inside the project team, making sure that everyone's viewpoints are appreciated.

Code 9 (Preventing Harm to the Environment): Environmental responsibility is becoming more and more crucial. This code promotes reducing the environmental effect of IoT systems via energy-efficient design and ethical disposal methods. It demonstrates a dedication to environmentally friendly technological solutions.

In conclusion, these particular principles from the IEEE Code of Ethics work together to provide a complete ethical framework that directs every element of the project. They make sure that everyone is treated equally, that conflicts of interest are controlled, that information is conveyed honestly, that procurement is moral, that feedback is constructive, and that the environment is preserved[20]. Adhering to these values isn't simply a question of ethics; it's a commitment to carrying out the project with responsibility, integrity, and ethical awareness.

2.6.2. Individual Responsibilities and Function as Effective Team Member

The project's success depended on the team's ability to work well together, and everyone in the team worked closely to that end. Good communication and understanding among team members tremendously aided our joint efforts. We kept up regular contact throughout the project to make sure we were constantly in touch. To guarantee the prompt and effective completion of assignments, we actively participated in talks and planned our tactics together. We successfully overcame obstacles and completed the project's objectives by pooling our skills and expertise.

Table 2.3: Team members contributions

Group Members Name	ID	Contribution
Anik Datta	20-43054-1	Topic Selection, Component Collection, Project Management, Poster Design, 2D Modeling, Summary, Hardware implementation
Nadia Hossain Riya	20-43013-1	Summary Writing, Summary of poster writing, Book Writing, Project Structure, Hardware implementation
Jagannath Bhowmik	20-43095-1	Hardware Assembly, Program Simulation, Flowchart, Bug Detection, Circuit Simulation, Result Analysis, Hardware implementation
Muntasir Sumit Anik	20-42976-1	Cost Analysis, Book Writing, Component Collection, Block Diagram, Hardware implementation, Programming

2.7. Management Principles and Economic Models

The management concepts and economic models for the project of building and implementing an Internet of Things (IoT)-based smart trolley and billing system for a superstore include several important factors, including the following:

2.7.1. Principles of Managements

Project Management: The project is managed by strong project management principles. These concepts include creating crystal clear goals, establishing project milestones, setting schedules, and efficiently allocating resources. Methodologies such as Waterfall and agile approaches are used by project managers to guarantee an organized approach to the carrying out of projects.

Collaborative Efforts within a Team: Effective collaboration is Essential. The success of the project is driven by tight collaboration between the members of the team, the promotion of open communication, and the utilization of the members' various abilities and areas of experience.

Engagement of Stakeholders: It is essential to get stakeholders involved, such as the management of the superstore, the staff, and the consumers. Their contributions and criticisms help shape project choices and ensure that those decisions are aligned with corporate goals.

Management of Risk: Reactive and proactive risk assessment and management are essential components of the project. The interruption of a project may be reduced by identifying probable problems and finding solutions to those problems.

Quality Assurance: Quality control procedures are put into place to make certain that the Internet of Things (IoT) system satisfies stringent requirements for both its level of performance and its level of protection for its users.

Management of Change: The project is aware of the need for adaptation. The concepts of change management are used to deal with alterations to the project's scope, needs, or technology.

2.7.2. Models of Economics

Cost-Benefit Analysis: A cost-benefit analysis evaluates the feasibility of the project from a financial standpoint. It does this by contrasting the expenses of development, which include things like hardware, software, labor, and continuing maintenance, with the anticipated benefits, which include things like higher levels of productivity and customer happiness.

Return on Investment (ROI): Refers to the amount of money that may be earned as a result of the capital that was put into a project. It determines if the advantages that accrue over time justify the original financial spend by analyzing the data.

Total Cost of Ownership (TCO): is a metric that takes into account all of the costs that are involved with an Internet of Things (IoT) system, such as the costs of procurement, installation, maintenance, and operating expenditures throughout its lifespan. It offers a comprehensive analysis of the economics of the project.

Economies of Scale: The project investigates the possibility of achieving economies of scale since the scalability of the IoT system enables incremental improvements and the incorporation of features such as online purchasing and loyalty programs, which together boost a company's potential for long-term profitability.

Analysis of the Market: An economic model will take into account market characteristics such as the need from customers for more convenient and technology-driven shopping experiences. It analyses the possible increase in income as well as market share that the project may bring about.

Control of Costs: Efficient methods for controlling costs are put into place to monitor and manage project expenditures. This helps to guarantee that the project stays within the allotted budget.

Revenue Models: Estimate the Potential Money Created by Better Customer Experiences Revenue models estimate the potential money created by better customer experiences greater sales and the gathering of important consumer data to enable informed decision-making.

In brief, the project uses management concepts to guarantee efficient execution and utilizes economic models to analyze financial sustainability, measure return on investment, and investigate revenue possibilities. The use of these guiding principles and models jointly directs the project towards effective implementation and long-term sustainability in the setting of the supermarket.

2.8. Summary

This project aims to revolutionize the shopping experience by implementing an IoT-based smart trolley and invoicing system for a superstore. The project involves a collaborative teamwork framework, stakeholder involvement, and risk management measures to ensure seamless communication and efficient task execution. Quality assurance methods are being executed, including comprehensive testing and validation procedures for the IoT devices, software components, and overall system. Change management concepts are used to enhance flexibility in response to changing requirements and new possibilities. Economic models are used to investigate the project's financial feasibility, ensuring long-term profitability. The project also investigates scalability and income potential, attracting tech-savvy clients who value convenience and innovation. Market analysis and tight cost control systems are used for financial decision-making. The project exemplifies effective project management practices, supported by an advanced economic framework, to deliver an innovative IoT solution that maximizes efficiency and customer satisfaction, contributing to the superstore's sustained financial growth.

Chapter 3

METHODOLOGY AND MODELING

3.1. Introduction

This project uses plans and designs to make a new IoT-based smart shopping cart and billing system. Methodology guides the step-by-step process, and modeling shows how it will work. It can change our conventional shopping environment, benefiting both customers and stores. However, due to their limited applicability and formal structures, existing strategies often face opposition. There is a growing need for alternative approaches that consider human and organizational factors. Method tailoring or customization is a potential area of study in this context. In the current accelerated change environment, IoT-based applications are rapidly transforming industries, particularly in the business sector. This chapter examines the methodology and design of an IoT-based project, which uses cutting-edge components like sonar, RFID readers, weight sensors, and proximity sensors to collect data on product positioning in a trolley. Actuators, controlled by sonar sensors, facilitate autonomous trolley movement. Wireless protocols like GSM module are used for billing and customer communication. Power management is based on a 12V LiPo battery. The operation of the system is explained using a net-meter concept, including block diagrams, flowcharts, and hardware setups.

After studying this chapter, you will have a clearer understanding.

3.2. Block Diagram and Working Principle

In figure 3.1 Here, the provided block diagram presents a simplified representation of the primary hardware components and modules employed in the smart shopping cart project. Each individual block inside the diagram symbolizes a distinct hardware component or module, while the arrows serve to denote the various connections or interactions that exist between them. The initial version of the Control Board, also known as the 1st UNO, establishes connections with servo motors, a motor driver, and ultrasonic sensors. The Ultrasonic Sonar Sensors are connected to the Ultrasonic Sensors block, and so on. The GSM Module establishes a connection with the RFID & Audio Processing Board, which in turn establishes a connection with the Ultrasonic Sensors.

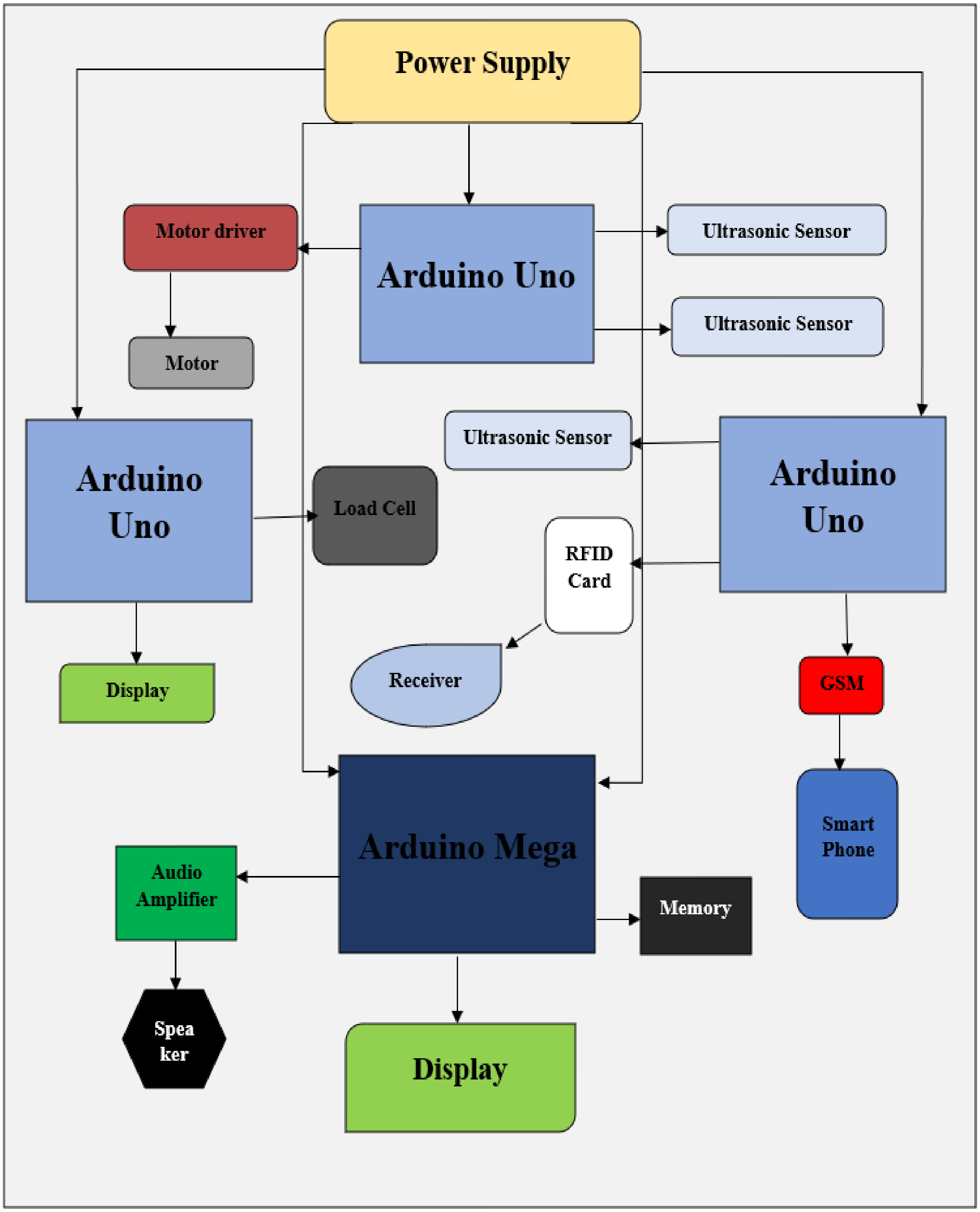

Figure 3.1: Block diagram

The interconnection between the Display, Power Management, and Battery blocks is evident. This document offers a comprehensive summary of the hardware configuration employed in the project.

3.2.1. Working Principle

In figure 3.2 The revolutionary Smart Trolly project combines automation, RFID, ultrasonic sensors, auditory feedback, and GSM networking to improve shopping. A microprocessor and sensor network creates an intelligent, user-friendly shopping assistant in the prototype. The operation relies on three Arduino boards for automated cart movement, obstacle detection, RFID item tracking, audio assistance, that's customized advertising.

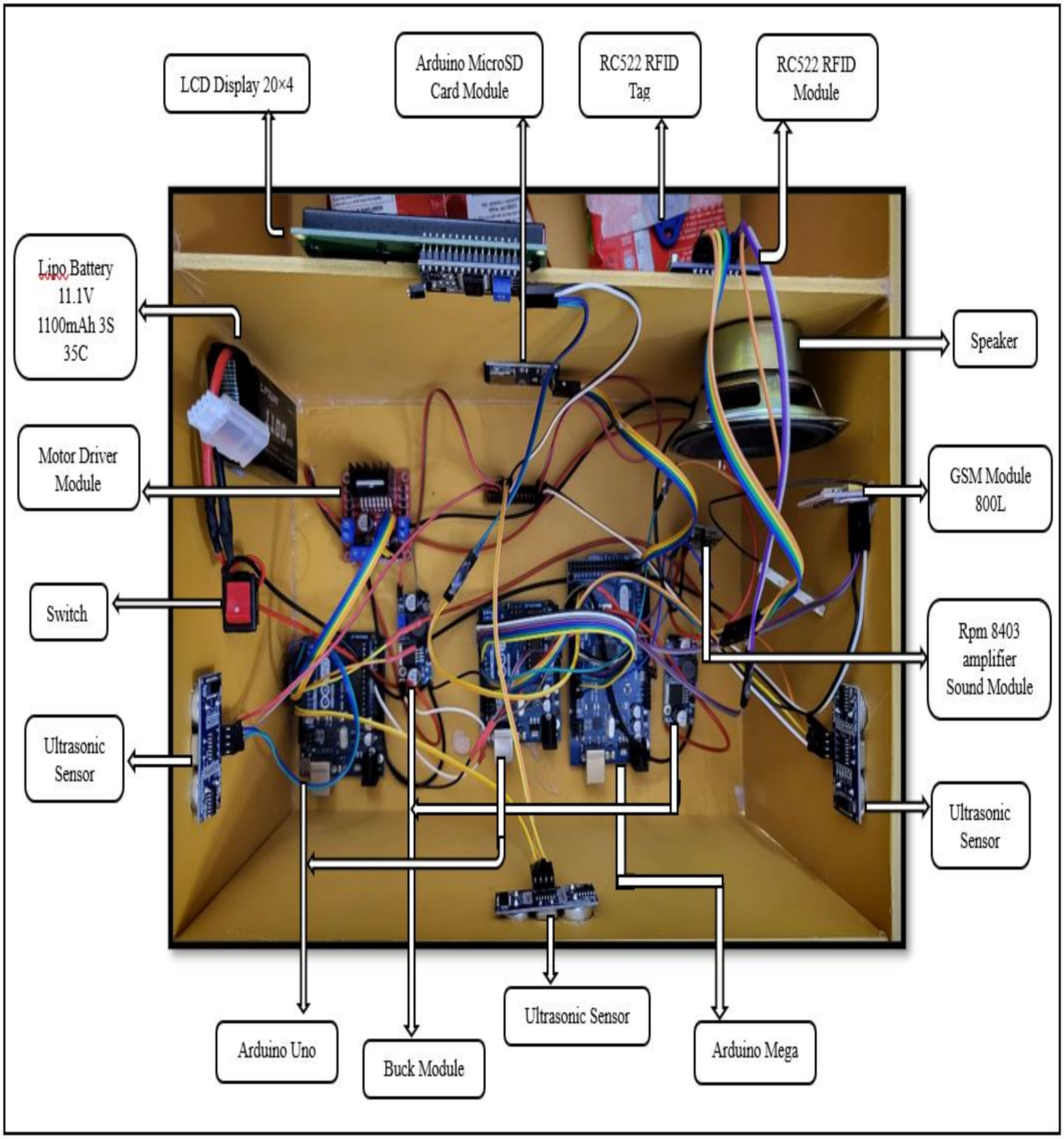

Figure 3.2: Hardware Model Component

This project aims to improve retail navigation, shopping, product management, sustainability, diversity, and data security. The project prepares for future generations that could use AI, AR, and IoT to make shopping smarter and more personalized.

A simulation model assessed project performance and suggested improvements. The simulation proved the smart shopping cart concept's practicality by showing that RFID technology guides and tracks items, voice feedback and communication work well, and data is displayed on an LCD screen. User interface is easy and power management is smooth.

The smart shopping cart system is a coherent, multipurpose solution with several interconnected parts. The control board (1st UNO) uses servo motors to propel the cart while Ultrasonic Sonar Sensors detect obstructions and calculate distances for safe travel. RFID readers track cart items in real time by identifying unique tags and maintaining an inventory list.

The interface displays cart status, contents, advertising messages, and notifications on a 20x4 inch LCD display. Powered by a 1100mAh Li-po battery and DC-DC buck modules, the system is mobile and independent.

3.2.2. Flow chart

In figure 3.4 The IoT-enabled smart trolley system described here utilizes ultrasonic sensors to consistently monitor the immediate environment surrounding the cart. The acquired data is subsequently processed by an Arduino Uno microcontroller, which promptly triggers a response whenever a user's hand is detected within a proximity of 10 cm from any of the front, left, or right sensors. Consequently, the cart is appropriately propelled in the desired direction. RFID technology is employed for the purpose of scanning products, whereby payment is facilitated through the utilization of a card, and subsequently, the collected data is transmitted to an Arduino Mega for analytical purposes. The Mega system is responsible for managing product information, user data, and cart management. It is designed to display detailed product information and audibly notify the user when a product is scanned. Furthermore, in the event that the identical product is scanned once more, it is afterwards eliminated from the shopping cart, so facilitating an interactive and streamlined purchasing encounter.

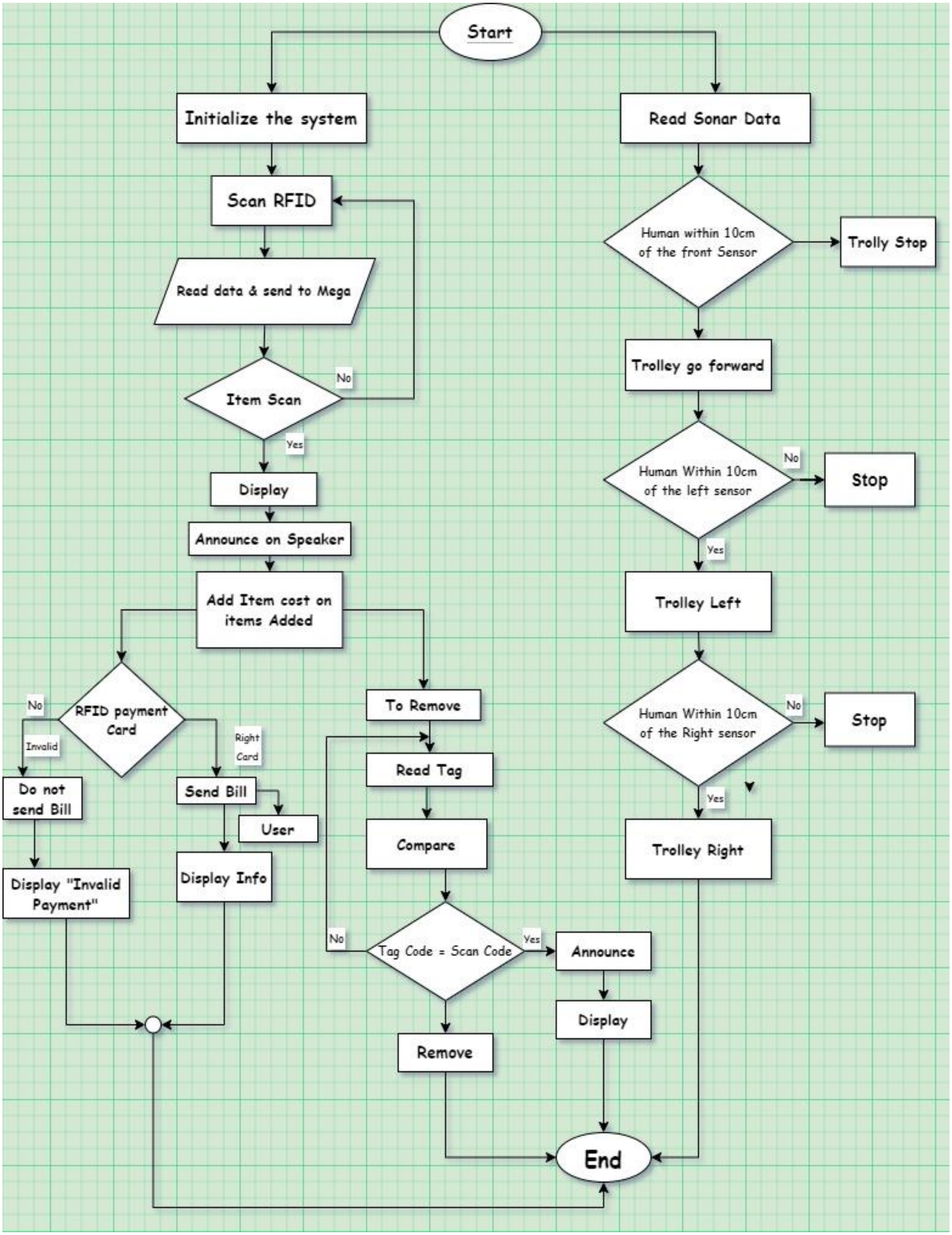

Figure 3.4: Flow Chart showing sequence of operations

3.3. Modeling

The smart trolley is equipped with essential components strategically placed for optimal functionality. At its base, gear motors powered and regulated by the DC-DC Buck Converter propel the cart. Microcontrollers (Uno and Mega Boards) positioned above manage diverse functions like obstacle detection, navigation, and audio processing based on inputs from sensors. Integrated with the microcontrollers, the GSM module enables crucial communication with users or the store. Positioned at the cart's front, sonar sensors use ultrasonic waves for obstacle detection and navigation.

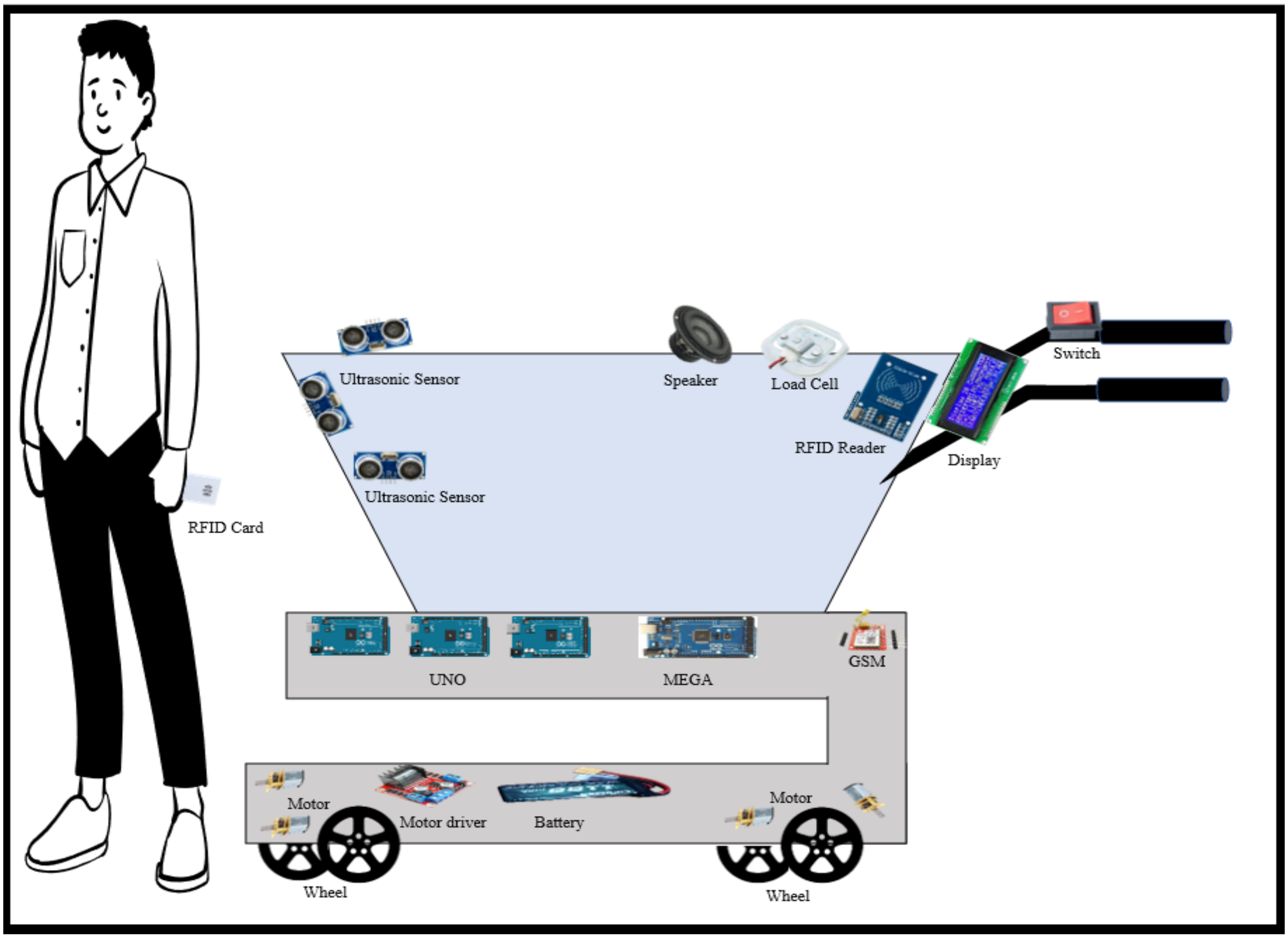

Figure 3.5: 2D Model

The RFID reader, placed in the handle area, facilitates efficient item identification and inventory management. A speaker, situated close to the sensors, provides informative audio feedback to the user. At the top, a display imparts essential information, while a weight scale aids in item tracking and checkout. This thoughtful arrangement of components augments the shopping experience by ensuring seamless navigation, precise item identification, and meaningful user interaction.

3.4. Summary

The smart shopping trolley project is a novel integration of automation, RFID technology, ultrasonic sensors, auditory feedback mechanisms and GSM networking, hence revolutionizing the traditional shopping encounter. The hardware system includes essential components such as ultrasonic sonar sensors, GSM modules, and microprocessors, as depicted in a comprehensive block diagram. This enterprise places a strong emphasis on improving the navigation experience in retail settings and promoting sustainability. Furthermore, it paves the way for potential future developments such as artificial intelligence (AI), augmented reality (AR), and the Internet of Things (IoT) in the realm of shopping. The utilization of simulation plays a crucial role in evaluating and enhancing the performance of a project. In its whole, the incorporation of state-of-the-art technology in this project serves as a demonstration of its capacity to transform the retail industry through the provision of a streamlined and engaging shopping encounter.

Chapter 4

PROJECT IMPLEMENTATION

4.1. Introduction

The Smart Trolly project is a revolutionary use of technology that combines robotics, RFID, ultrasonic sensing, audio feedback, and GSM connection to improve the shopping experience. The project is a prototype that is based on technology. It uses a network of microcontrollers and sensors to make a shopping assistance that is smart, user-friendly, and effective. The project operates by three Arduino boards, which make it possible for the cart to move on its own, identify obstacles, track items using RFID, give audio feedback, and show personalized ads. The goal of the project is to make it simpler to find your way around, make shopping easier, improve how products are managed, and think about sustainability, diversity, and data security. AI, AR, IoT, and other new technologies could be used in future versions to make shopping even smarter and more personalized.

4.2. Required Tools and Components

In this section, the required tools for system design, testing, and implementation are discussed.

Hardware Components

1. Arduino Mega
2. Arduino Uno
3. LCD Display 20×4
4. Ultrasonic Sensor
5. LM2596 DC-DC Step-Down Buck Module
6. Lipo Battery 11.1V 1100mAh 3S 35C
7. RC522 RFID Module
8. RC522 RFID Card
9. RC522 RFID Tag
10. GSM Module 800L
11. Speaker
12. Rpm 8403 amplifier Sound Module

13. Micro SD Card Module
14. Samsung 8gb Memory Card
15. 300 rpm Gear Motor
16. L298N Motor Driver Module
17. Yellow plastic Wheel
18. Sim card
19. Jumper wire
20. Load Cell
21. Switch

4.2.1. Hardware Components

4.2.1.1. Arduino Mega

Figure 4.1: Arduino Mega 2560

It controls all the main things of the project. It is also connected with Node MCU, buzzer, GPS module, display etc. The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It offers an extensive range of digital and analog input/output pins, making it ideal for complex projects. The board provides 54 digital input/output pins, 16 analog inputs, and a larger memory size compared to other Arduino boards. It supports various communication protocols such as UART, I2C, and SPI, allowing for seamless interaction with other devices. With its powerful features, the Arduino Mega 2560 is commonly used in robotics, automation, and projects requiring a higher number of I/O pins and memory capacity.

4.2.1.2. Arduino Uno

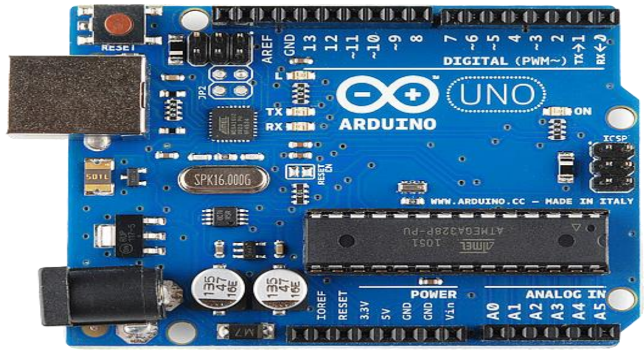

Figure 4.2: Arduino Uno

The Arduino Uno is a microcontroller board that is built upon the ATmega328P microcontroller, as specified in its datasheet. The device is equipped with a total of 14 digital input/output pins, out of which 6 have the capability to function as Pulse Width Modulation (PWM) outputs. Additionally, it offers 6 analogue inputs. The device incorporates a 16 MHz ceramic resonator (CSTCE16M0V53-R0) for frequency stability. It also features a USB connection, a power connector, an ICSP header, and a reset button.

4.2.1.3. LCD Display 20×4

Figure 4.3: Liquid Crystal Display 20×4

In this display all the result of our project like fault type and fault distance are shown. It is connected with the Arduino Mega 2560. (LCD) 20x4 is a type of alphanumeric display commonly used in electronic devices for displaying text and simple graphics. The "20x4" notation refers to the size of the display, indicating that it can display 20 characters per line and has a total of 4 lines. The display consists of 20-character positions arranged in 4 rows. Each position can display a character using a predefined set of characters, including letters, numbers, symbols, and some special characters. The LCD 20x4 is widely used in various electronic devices, including consumer electronics, industrial equipment, instrumentation, robotics, and embedded systems. It provides a simple and cost-effective way to display information such as messages, measurements, status indicators, and menus.

4.2.1.4. Ultrasonic Sensor

Figure 4.4: Ultrasonic Sensor

The Ultrasonic Sensor is a device utilized for the purpose of measuring the distance to an item by means of ultrasonic sound waves. An ultrasonic sensor employs a transducer to emit and receive ultrasonic pulses, which subsequently provide data regarding the distance between the sensor and an item.

4.2.1.5. LM2596 DC-DC Step-Down Buck Module

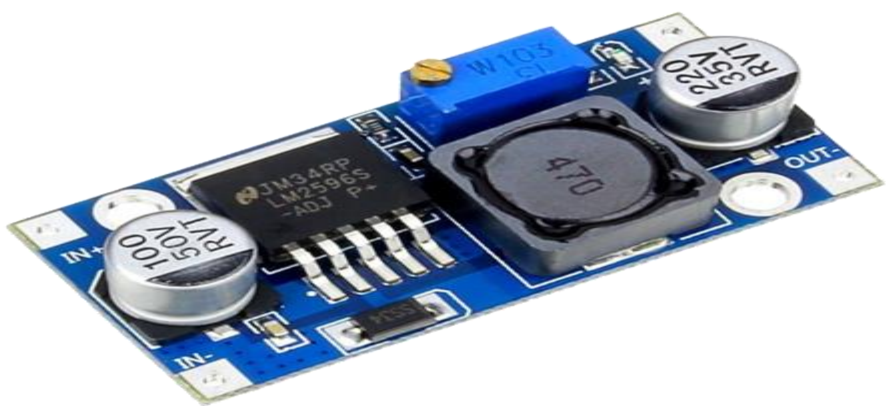

Figure 4.5: LM2596 DC-DC Step-Down Buck Module

The DC-DC Buck Converter Step Down Module LM2596 Power Supply is a type of step-down switching regulator that has the ability to drive a load of 3 amps while maintaining excellent line and load regulation. The aforementioned devices are offered with fixed output voltages of 3.3 V, 5 V, 12 V, as well as an adjustable output variant.

4.2.1.6. Li-po Battery 11.1V 1100mAh 3S 35C

Figure 4.5: Li-po Battery 11.1V 1100mAh 3S 35C

A rechargeable battery utilizing lithium-ion technology and employing a polymer electrolyte in lieu of a liquid electrolyte is commonly referred to as a lithium polymer battery, or more accurately, a lithium-ion polymer battery (abbreviated as LiPo, LIP, Li-poly, lithium-poly, among other variations).

4.2.1.7. RC522 RFID Reader Module

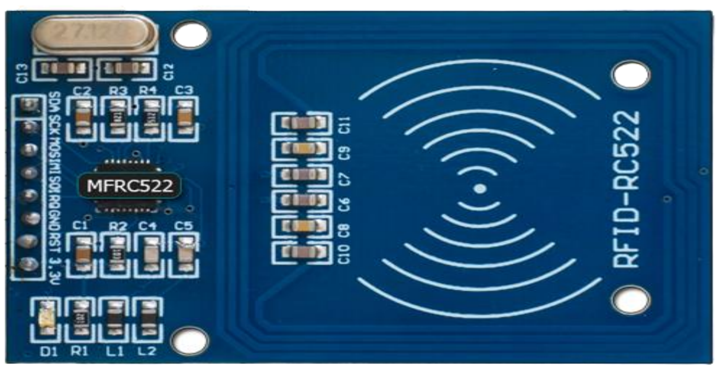

Figure 4.6: RC522 RFID Reader Module

The RC522 module is a type of radio-frequency identification (RFID) module operating at a frequency of 13.56MHz. It utilizes the MFRC522 controller developed by NXP semiconductors as its core component. The module has the capability to support I2C, SPI, and UART communication protocols. Typically, it is packaged with an RFID card and key fob. The utilization of this technology is prevalent in attendance systems and various other applications involving the identification of individuals or objects.

4.2.1.8. RC522 RFID Card

Figure 4.7: RC522 RFID Card

The RC522 is a tiny and cost-effective RFID card reader developed by NXP. It operates on a non-contact 13.56MHz communication protocol and is known for its low power consumption. Due to these features, it is often regarded as the optimal solution for the development of smart metres and portable hand-held devices.

4.2.1.9. RC522 RFID Tag

Figure 4.8: RC522 RFID Tag

RFID tags represent a form of tracking technology that employs intelligent barcodes to ascertain the identity of various goods. RFID, an abbreviation for "radio frequency identification," employs radio frequency technology in the functioning of RFID tags.

4.2.1.10. GSM Module 800L

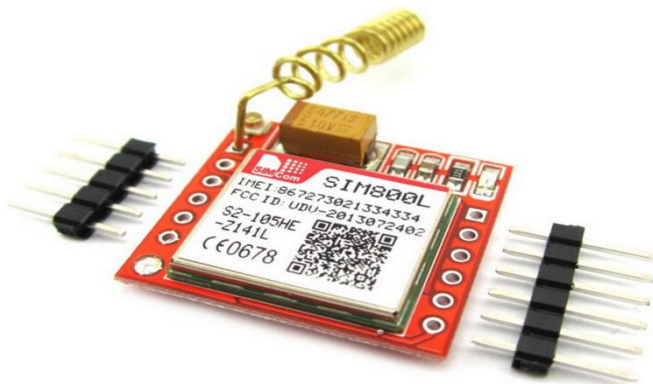

Figure 4.9: GSM Module 800L

The SIM800L Module is a compact cellular GSM/GPRS breakout board designed for facilitating GPRS transmission, message exchange, and call functionality. This module is compatible with quad-band GSM/GPRS networks, enabling the transfer of GPRS and SMS data remotely.

4.2.1.11. Rpm 8403 amplifier Sound Module

Figure 4.10: Rpm 8403 amplifier Sound Module

The PAM8403 is a type of amplifier board that is capable of being powered by a standard 5V input. It has the ability to drive a pair of stereo speakers, each with a power output of 3W + 3W. The selection of a Class-D stereo audio amplifier in a compact board size is highly commendable. The utilization of this Amplifier enables users to attain superior audio reproduction from a stereo input. Moreover, this device possesses a distinctive attribute, namely, its capability to directly power speakers through its output.

4.2.1.12. Arduino MicroSD Card Module

Figure 4.11: Arduino MicroSD Card Module

Incorporate memory into your Arduino project to store data, media files, and other relevant information. The Micro SD Adaptor, or Card Reader Module, is designed to work with dual 1/0 voltages. Data transfer to and from a normal SD card is easy with the Module. Pinout is compatible. The chart below shows the system's Arduino and other microcontroller compatibility. The Micro SD Card Reader Module's SPI interface works with all SD cards. It runs on 5V or 3.3V, making it Arduino UNO/Mega compatible. Data logging, audio processing, video playback, and graphics rendering are all possible with the SD module.

The device has six pins: GND, VCC, MISO, MOSI, SCK, and CS. GND grounds, whereas VCC powers. CS is the chip select signal pin, whereas MISO, MOSI, and SCK are SPI bus pins. A low-dropout (LDO) regulator generates 3.3V, which powers the Micro SD card and the level converter chip in the 3.3V regulator circuit. A common AVR microcontroller can read signals with this Module. A Miniature Circuit Breaker (MCB) is an electrical switching device designed to protect electrical circuits from over currents and short circuits. It is a crucial component of electrical distribution systems in residential, commercial, and industrial buildings. It helps us to protect the power system. We can also call it safety measure.

4.2.1.13. Samsung 8gb Memory Card

Figure 4.12: Samsung 8gb Memory Card

Support for the UHS-1 Ultra-High-Speed bus reading speeds of 50 MB per second Sufficient to meet the high-speed connectivity needs of smart phones, tablets, and vehicle recorders.8GB Micro Card Class 10/UHS-1 storage. Up to 95MB/s read speed and 35MB/s write performance.

Ideal for the Apple iPhone 4/4S/5, tablets, and digital cameras. The contents of the box: 8GB Micro, premium 200s Class 10 UHS-1, SDHC10 card from Transcend with adapter. SD Card Speed Test Using a USB 3.0 Card Reader and Crystal Disc Mark.

4.2.1.14. 300 rpm Gear Motor

Figure 4.13: 300 rpm Gear Motor

The N20 Micro Gear 12V 300 RPM DC Motor (High Torque) is characterized by its lightweight design, high torque output, and low rotational speed. The use of a gearbox assembly serves to augment the motor's torque. The cross-sectional dimensions of the object under consideration are measured to be 10 × 12 mm. Additionally, the output shaft of the gearbox exhibits a D-shaped configuration, with a length of 9 mm and a diameter of 3 mm.

4.2.1.15. L298N Motor Driver Module

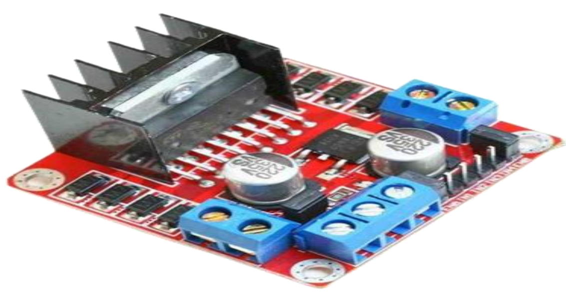

Figure 4.14: L298N Motor Driver Module

The L298N Motor Driver Module is a motor driver module with high power capabilities designed for the purpose of driving both DC and Stepper Motors. The module is comprised of an L298 motor driver integrated circuit (IC) and a 78M05 5V regulator. The L298N Module has the capability to regulate the movement of either four direct current (DC) motors or two DC motors with the ability to manage both their direction and speed.

4.2.1.16. Blue plastic Wheel

Figure 4.15: Blue plastic Wheel

The wheel is composed of a superior-grade rubber material that provides optimal traction during operation. The wheel exhibits robustness and durability due to the incorporation of a rim made of nylon-reinforced plastic. These high-quality wheels have the capability to be connected to BO type motors. By using coupling mechanisms, it is possible to enhance the functionality of a robot. Coupling mechanisms can improve the robot's balance by providing a stronger grip and facilitating smoother and more precise motion.

4.2.1.17. Speaker

Figure 4.16: Speaker

Speakers are transducers that convert electromagnetic waves into sound waves. The speakers receive audio from a computer or receiver. This input can be analogue or digital. Analogue speakers amplify electromagnetic waves into sound. Digital speakers convert the digital input to an analogue signal before generating sound waves. Speakers create sound with frequency and loudness. Frequency determines sound pitch. Soprano singers produce high-frequency sound waves, whereas bass guitars and kick drums provide low-frequency noises. How well a speaker system reproduces sound frequencies indicates audio clarity. Many speakers use numerous speaker cones for different frequency bands to generate more realistic sounds. Tweeters and mid-range speakers are typical of two-way speakers, while three-way speakers have a tweeter, mid-range, and subwoofer.

4.2.1.18. Sim Card

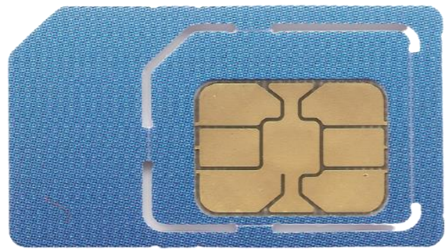

Figure 4.17: Sim Card

A Subscriber Identity Module (SIM card), also known as a Subscriber Identification Module, is an integrated circuit designed to securely store an international mobile subscriber identity (IMSI) number and its associated key. These components are utilized to identify and authenticate subscribers on mobile telephony devices, including mobile phones and laptops.

4.2.1.19. Jumper wire

Figure 4.18: Jumper wire

Jumper wires are a type of electrical wiring that has connection pins at both ends. They are employed for the purpose of establishing a connection between two places inside an electrical circuit without the need for soldering. Jumper wires are a versatile tool that can be employed for circuit modification or troubleshooting purposes.

4.2.2.20 Load Cell

Figure 4.19: Load Cell

The load cell under consideration is an internal 1000Ohm half-bridge strain gauge load cell with a load range of 50kg. It is designed with a half-bridge structure. Commonly employed in hopper scales, platform scales, platform balance, belt scales, and various other electronic weighing apparatus. The half-bridge load sensor is a commonly employed component in weight scales.

4.2.2.21 Switch

Figure 4.20: Switch

A switch is an electrical device that has the capability to either establish or break the conducting pathway inside an electrical circuit, so either halting the flow of electric current or redirecting it from one conductor to another.

4.2.2. Software Requirements

4.2.2.1. Proteus

Proteus is a widely used software suite primarily used for designing and simulating electronic circuits. It is developed by La Center Electronics Ltd. Proteus provides a comprehensive set of tools for schematic capture, PCB (Printed Circuit Board) design, and circuit simulation. In proteus we simulate our main simulation of fault detection. The simulation is given in next chapter.

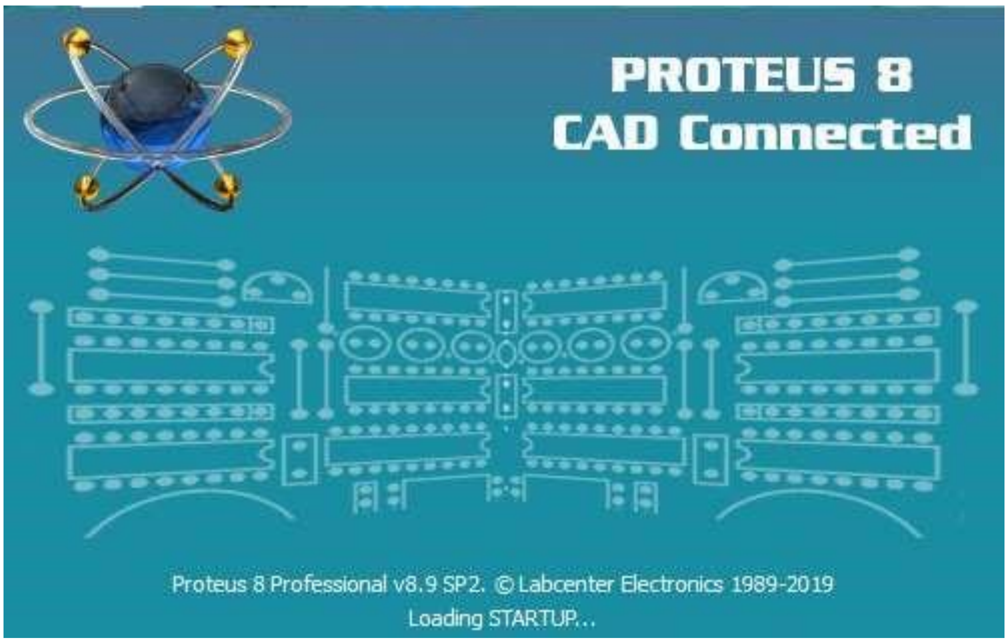

Figure 4.21: GUI of Proteus Software

4.2.2.2. Arduino IDE

We run our Arduino code in this software. Arduino Uno, when paired with the Arduino IDE, can be used to develop a wide range of projects and applications. Here are some examples of the work that can be done using Arduino Uno software: Arduino Uno is commonly used for electronics prototyping, allowing you to connect and control various electronic components such as sensors, LEDs, motors, displays, and more. The Arduino IDE provides a simple interface for writing code to interact with these components. With the help of Arduino Uno and the Arduino IDE, you can create IoT projects by connecting your board to the internet. Arduino Uno can communicate with web servers, cloud platforms, and other devices, enabling you to build applications such as home automation systems, weather stations, and remote monitoring systems.

Figure 4.22: Arduino IDE

4.3. Implemented Models

This project implementation is done in two ways, simulation model and hardware model. The simulation model combines the logical and mathematical ideas and uses computer software to try to replicate a real-world system. Contrastingly hardware model consists of the circuit designed to perform the referred operation.

4.3.1. Simulation Model

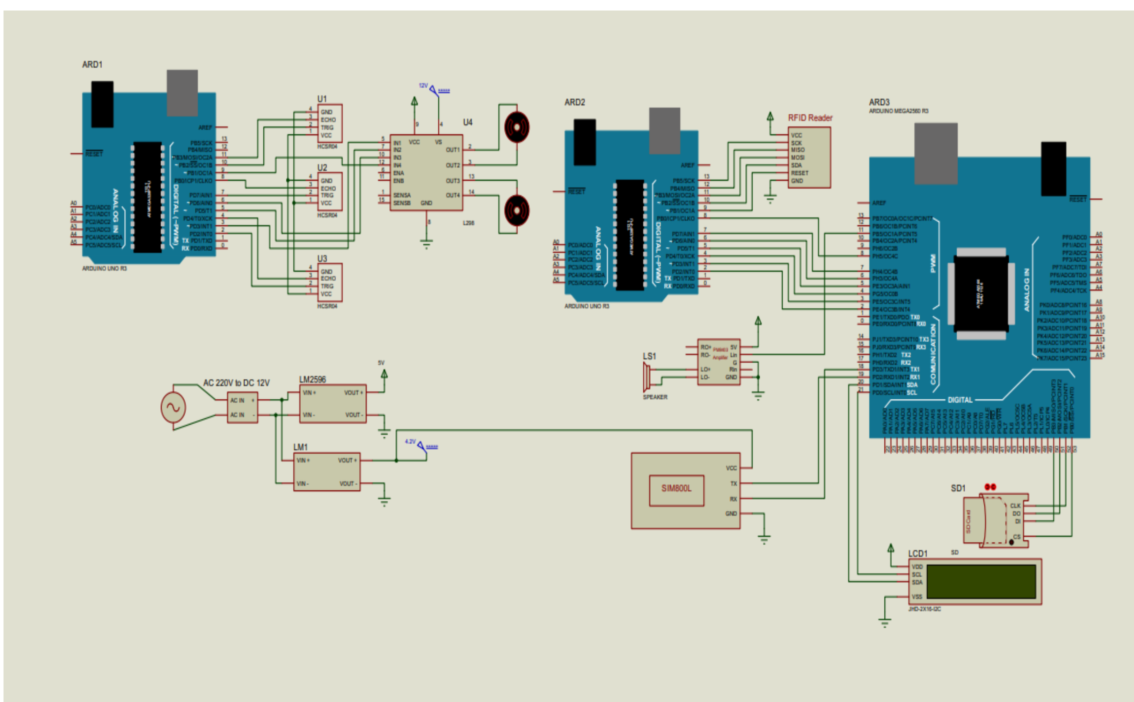

Figure 4.23: Simulated Model Designed in Proteus

The simulation model in Fig. 4.23 Analysis of simulation results is important for improving the project, finding places where it could be better, and making sure that the hardware parts and how they work together are in line with the project's goals and objectives. It helps confirm the idea, figure out problems, and improve the method before it is put into action. The simulation showed that the smart shopping cart idea could work out well. Using RFID, the cart was able to find its way, avoid obstacles, and keep track of its things. Feedback and communication through audio were quick and interesting. The information was displayed smoothly on the LCD screen. Power control made sure that things ran smoothly. The way the user interacted with the system was fine, and contact between the different parts was easy. Integration of hardware showed that it was possible, and it was clear that it could be scaled up for future improvements. Overall, the program proved that the project could be done technically and gave a solid foundation for doing it in the real world.

4.3.2. Hardware Model

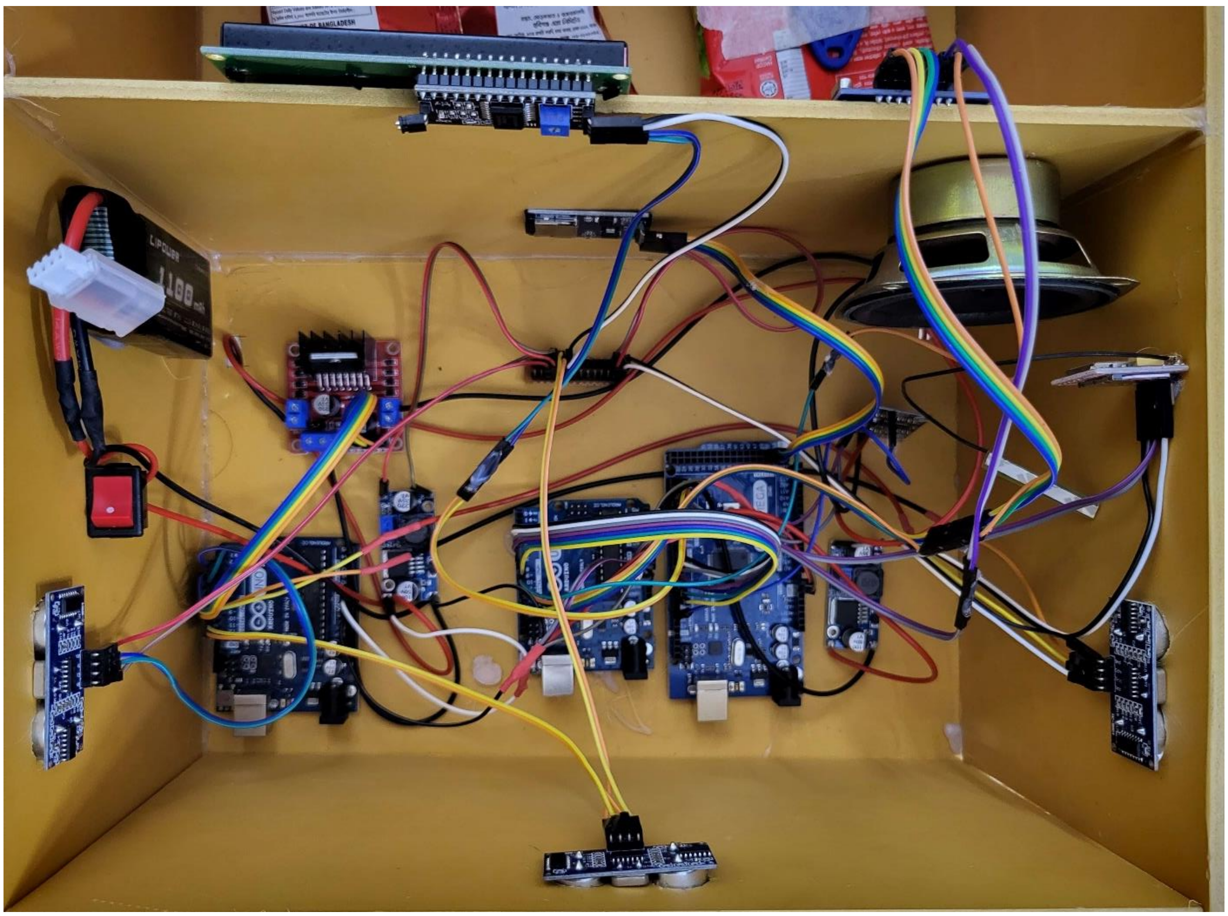

Figure 4.24: Top view of the hardware model

4.4. Engineering Solution in accordance with professional practices

The smart Trolly project is built using engineering standard methods that put a priority on quality, safety, and efficiency. The process starts with a detailed study and specification of the requirements. This makes sure that there is a clear plan for development. For future improvements, a strong system framework is made with a focus on modularity and scalability. Safety and dependability are important, which is why there are emergency stop buttons and thorough risk assessments. Regulatory compliance is very important, as is meeting legal and industry norms. The system's powers are tested through prototyping and thorough testing, and best practices are used when making software. User-centered design principles are used to make the interface easy to use, and strong data security measures are put in place to keep user information safe. Integrating energy economy and sustainability helps people use resources in a responsible way. Documentation and reports keep things open, and project management methods and quality assurance processes make sure that goals are met. Fair data handling, human interactions, and system behavior are all driven by ethics. Iterative development is a way of making changes based on comments from users.

4.5. Summary

This project represents an innovative integration of automation, RFID technology, ultrasonic detection, auditory assistance, and GSM connectivity with the aim of enhancing the shopping experience. The prototype utilizes a network comprising microcontrollers and sensors to develop an intelligent and user-friendly shopping assistant. The system comprises three Arduino boards, facilitating self-directed cart forwarding, identification of obstacles, tracking of items using RFID technology, provision of acoustic feedback, and display of tailored advertisements. The primary objective of the project is to facilitate navigation, optimize the shopping process, improve product management, and prioritize sustainability, variety, and data security. Subsequent iterations possess the potential to integrate sophisticated technologies such as artificial intelligence (AI), augmented reality (AR), and the Internet of Things (IoT) in order to enhance the shopping experience by imbuing it with greater intelligence and personalization. The project's performance was assessed, areas for improvement were identified, and the alignment of hardware components with the project's goals was ensured through the utilization of a simulation model. The simulation model provided validation for the viability of the smart shopping cart concept, illustrating the efficacy of RFID technology in several aspects such as navigation, item tracking, audio assistance, and data presentation. The project's technical feasibility and potential for future expansion are supported by the effective integration of hardware components.

Chapter 5

RESULTS ANALYSIS & CRITICAL DESIGN REVIEW

5.1. Introduction

The development of the smart Trolly involved a thorough evaluation of crucial issues. Significant importance was given to the task of ensuring that the cart possessed the capability to intelligently traverse and effortlessly maneuver across different places, while skillfully evading obstacles. The prioritization of precision in the association of RFID tags with products and the maintenance of an up-to-date inventory was emphasized. The audio system was subjected to meticulous calibration in order to provide accurate and valuable auditory information during interactions with the cart. The design of the cart's display was carefully planned to ensure maximum clarity in a variety of lighting settings. The primary areas of emphasis were optimizing power efficiency and ensuring a consistent power provision. The prioritization of user-friendliness led to the iterative improvement of the interface, which was informed by feedback received. Comprehensive examinations were carried out to ensure smooth integration of communication between components. The comprehensive assessment has substantiated the affirmation that our intelligent shopping cart effectively achieves its stated objective of streamlining and augmenting the shopping process.

5.1.1. Circuit Diagram of the system

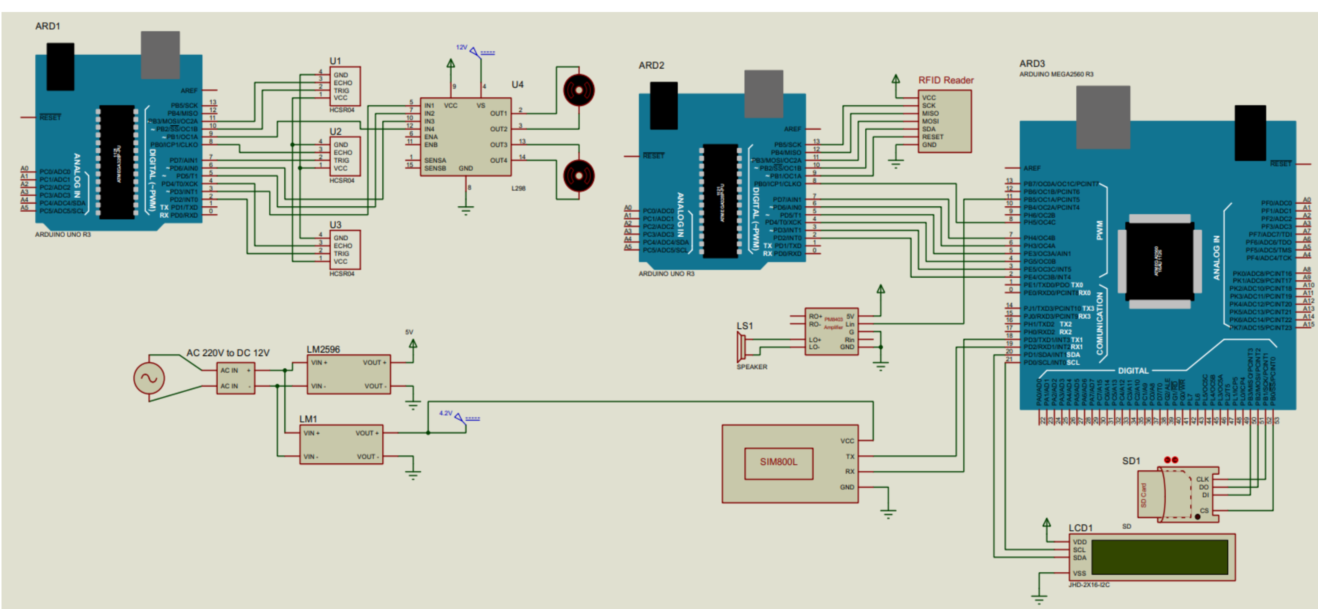

Fig 5.1: Circuit diagram of the system

5.2. Results Analysis

In this innovative smart trolley solution, numerous sophisticated features were effortlessly incorporated and rigorously assessed. The resultant model distinguishes itself due to its high level of accessibility and user-friendliness, as it does not necessitate any specialized training and prioritizes convenience as a fundamental aspect. One notable benefit is the decrease in necessary personnel and the consequent decrease in the amount of time users spend waiting in billing queues. This technological advancement enables the simultaneous participation of several people, providing significant advantages for both merchants and consumers.

The performance of the ultrasonic sensors in the system was excellent, as they demonstrated accurate detection of obstructions and enabled seamless navigation without any collisions. In addition, the RFID item tracking system demonstrated a high level of accuracy by effectively linking each scanned RFID tag to a particular product, resulting in improved efficiency in inventory management. The inclusion of an audio feedback system greatly enhanced the user experience by delivering timely and relevant information.

Furthermore, the LCD display fulfilled its intended function commendably by efficiently conveying information regarding the status of the cart and promotional messages with a notable level of clarity and accuracy. The implementation of efficient power management techniques facilitated the maintenance of a reliable and steady power provision by utilizing both the Li-po battery and DC-DC buck modules. In addition, we have also integrated a weight machine for manual weight measurements. This additional weight machine, equipped with a strain gauge, accurately displays the weight of loose produce items and vegetables. It enables customers to confirm the weight of the substance. The way users interacted with the Users will find it easy and smooth to use the project because the interface is carefully designed for them.

The project demonstrated exceptional proficiency in the areas of communication and synchronization across Arduino boards, facilitating coordinated activities and ensuring dependable data exchange. The seamless incorporation of these hardware components highlights the project's effective operational capabilities, laying a solid groundwork for expandability and prospective improvements. This project demonstrates significant potential in integrating sophisticated features and technologies, highlighting its notable flexibility in meeting future requirements and the dynamic nature of technological progress.

5.2.1. Simulated Results

5.2.1.1. Initiation of the System

This figure below shows when shopping curt ready to shopping.

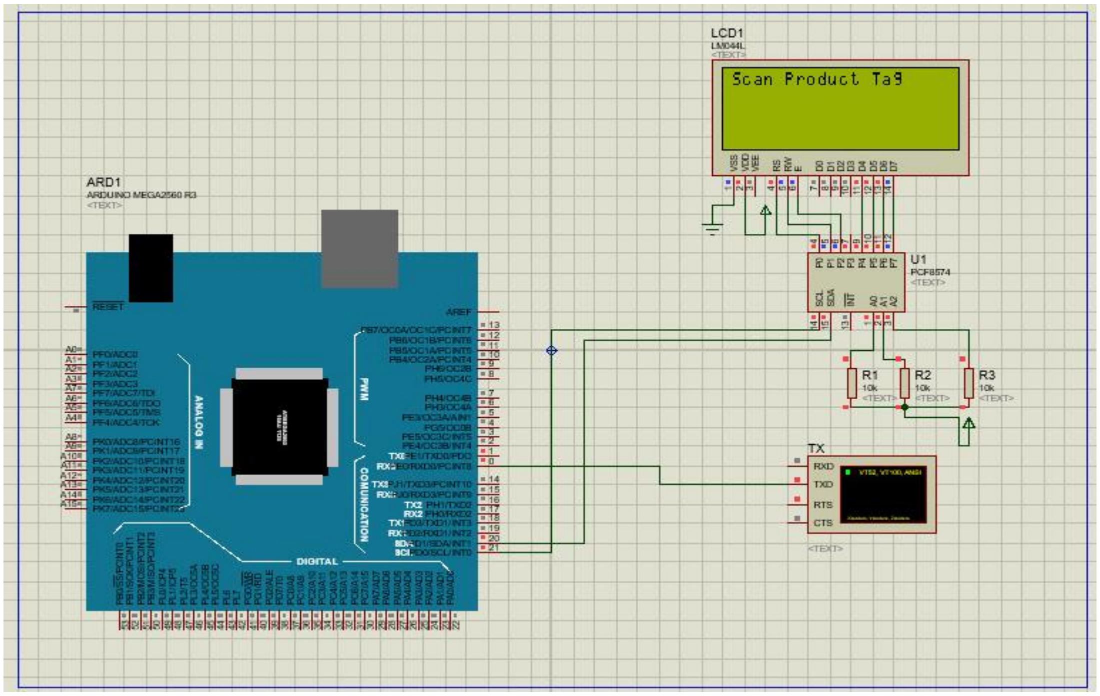

Fig 5.2: Begging of the system

5.2.1.2. Items addition in the cart

This figure below shows result when item added

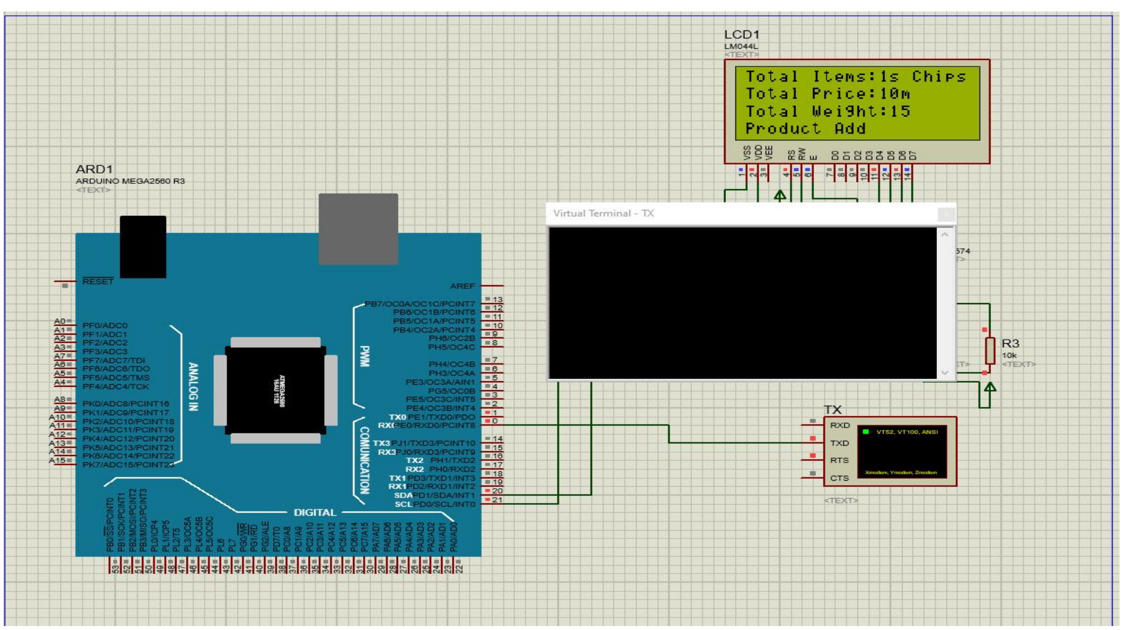

Fig 5.3: Item added result

5.2.1.3. Total items addition in the cart

This figure shows result of total items added

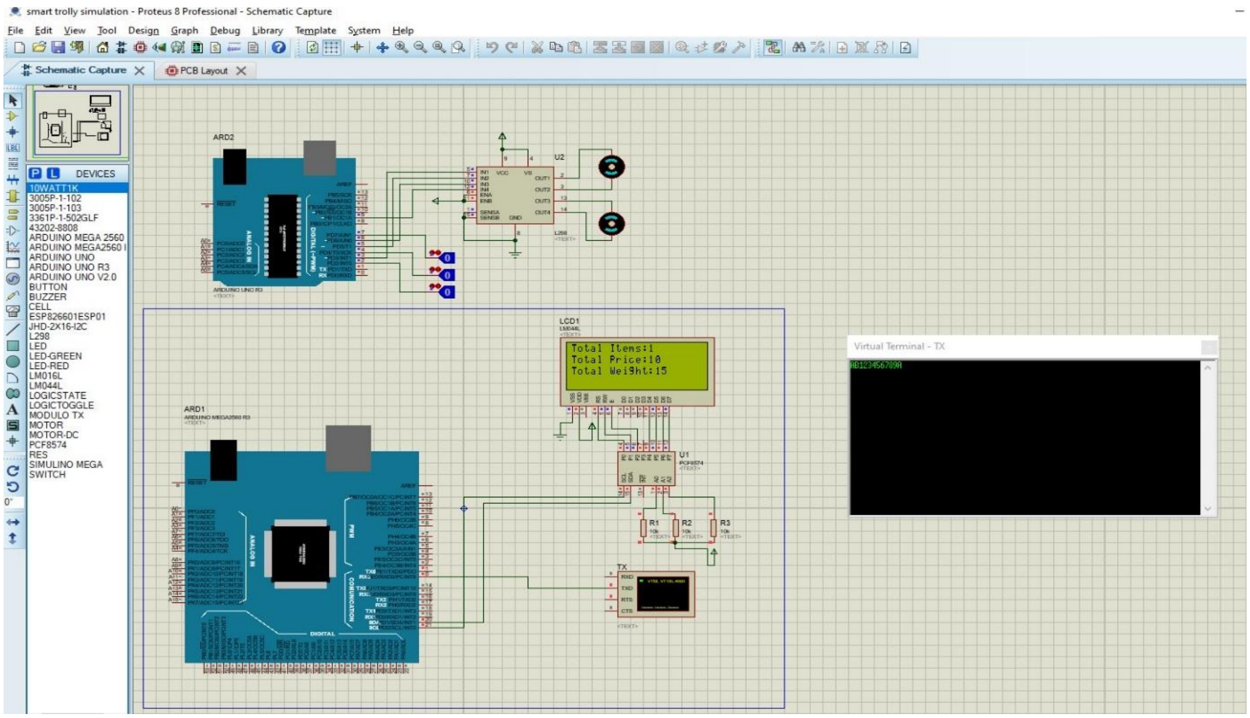

Fig 5.4: Total items added system

5.2.1.4. Billing system

This figure show result of billing system

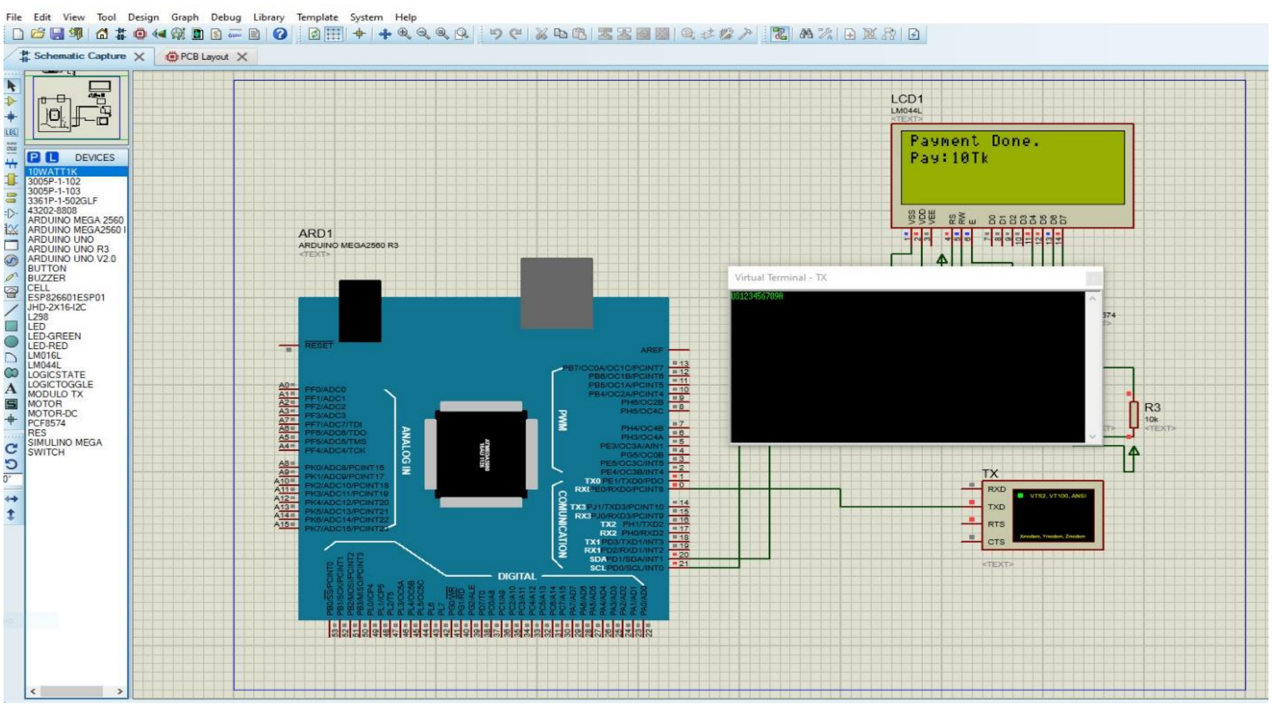

Fig 5.5: Billing system result

5.2.2. Hardware Results

The ultrasonic sensors in the system performed exceptionally well, displaying precise impediment detection and enabling collision-free navigation. Additionally, the RFID item tracking system proved to be highly accurate by successfully associating each scanned RFID tag with a specific product, leading to increased inventory management effectiveness. By providing timely and pertinent information, an audio feedback system substantially improved the user experience. Additionally, the LCD display successfully carried out its intended purpose by accurately and effectively relaying information regarding the status of the cart and advertising messages. Utilizing both the Li-po battery and the DC-DC buck modules, effective power management strategies made it easier to provide a dependable and consistent power supply. A weight machine for manual weight measurements has also been added. The weight of loose produce products and vegetables is accurately displayed by this extra weight machine, which has a strain gauge. Customers can verify the substance's weight thanks to it. Due to the presence of a painstakingly designed, user-centric interface, the project's user interaction component demonstrated an impressive level of intuitiveness and seamlessness.

5.2.2.1. Test Result

After scanning a specific product, the display will show the product name, weight, and price, as depicted in the provided picture.

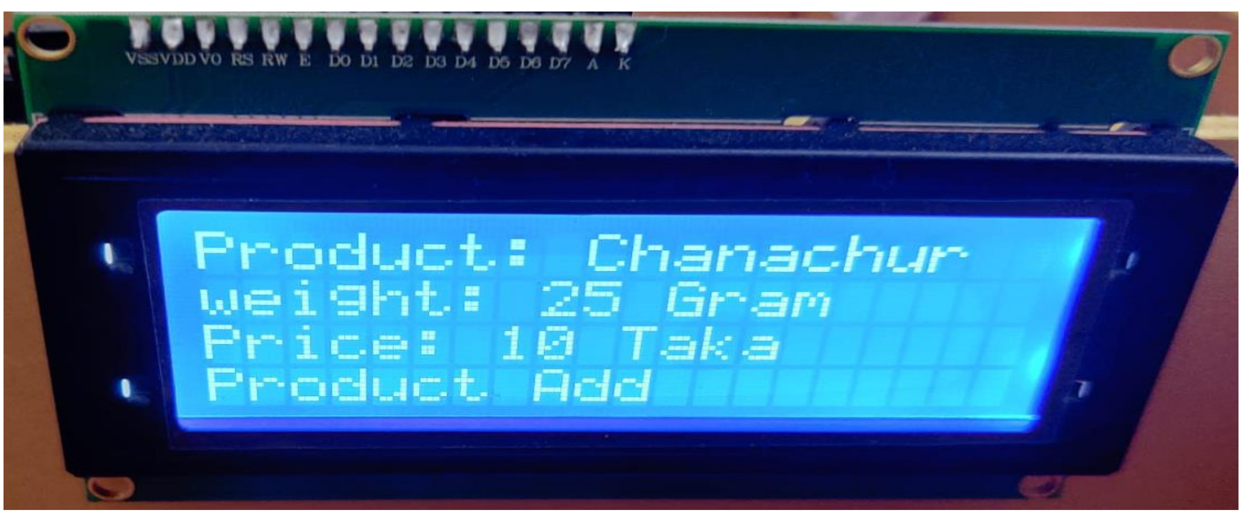

Fig 5.6: Details of a single product

After adding each product, the display will show the total number of products, total weight, and total price for each item, along with the overall totals, as given below.

Fig 5.7: Details of total product

When weight is measured using the weight cell, it shows the result. This manual method is mainly used for measuring the weight of retail goods.

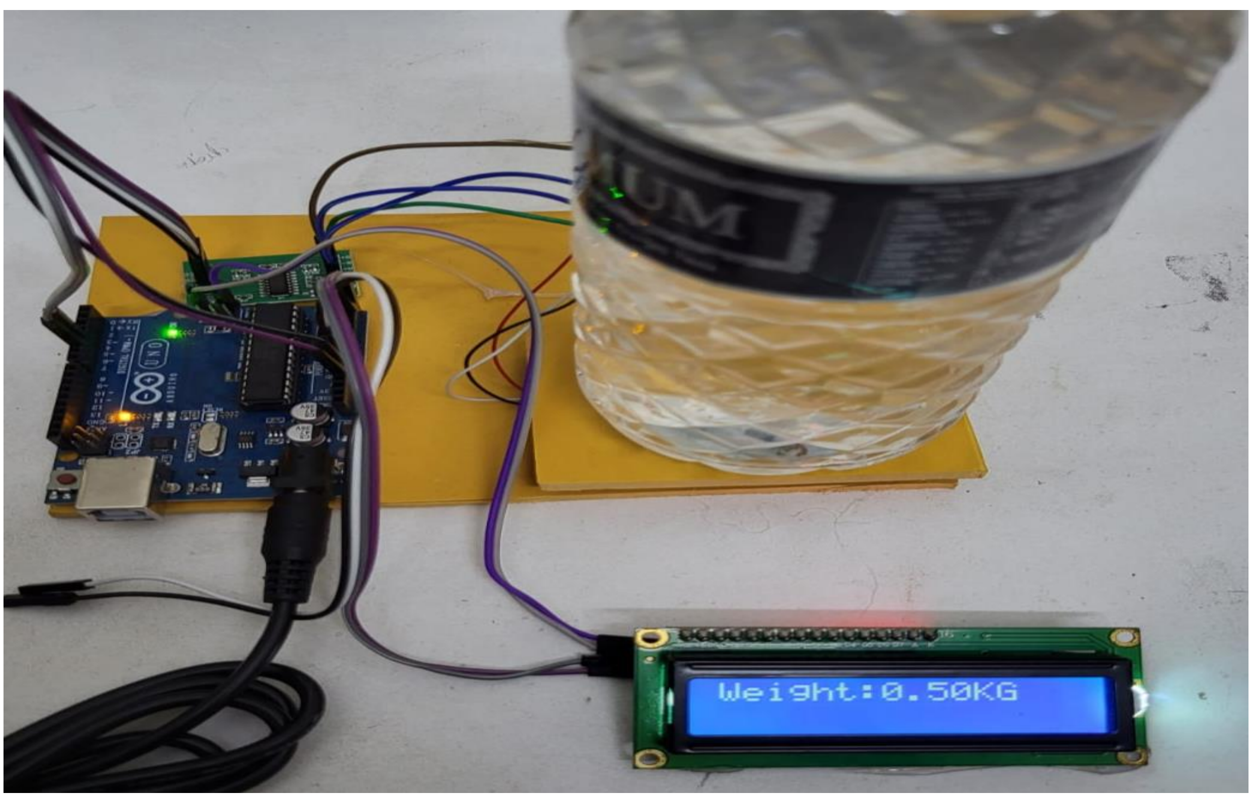

Fig 5.8: Weight measurements using Load Cell

After the bill is paid, customers will receive an SMS on their phones, as shown in the given picture.

Fig 5.9: Payment completion

The provided picture will display the payment completion message for all products added during the entire shopping process.

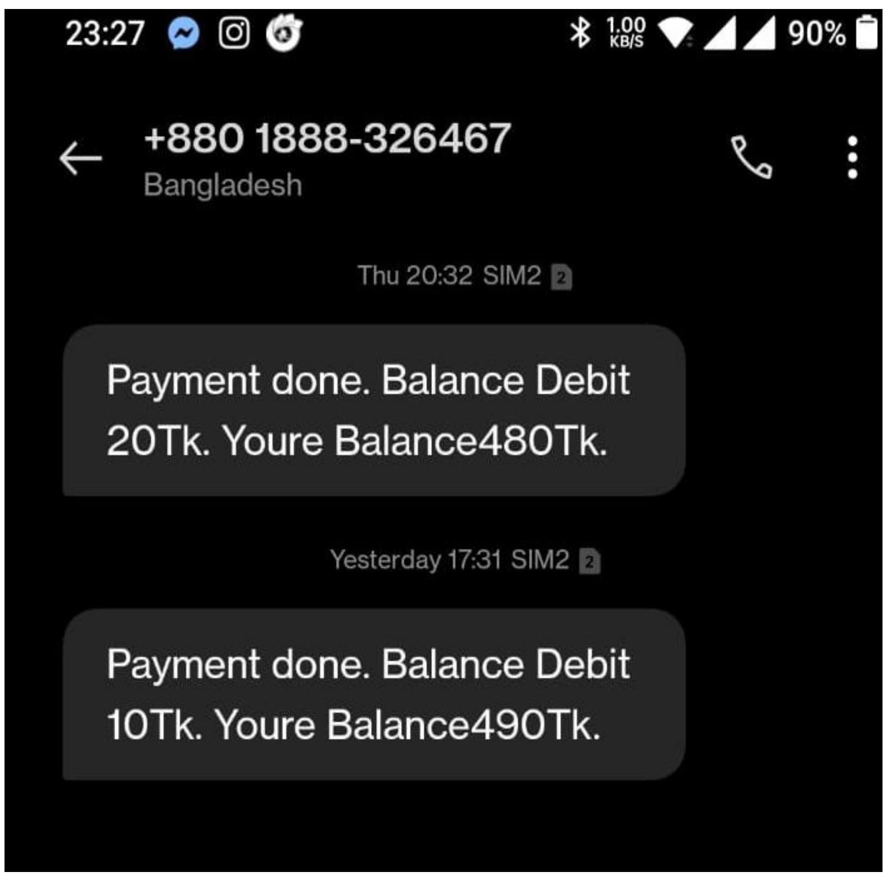

Fig 5.10: Confirmation of Payment Completion through SMS

5.3. Comparison of Results

The comparison of simulation and hardware results is a crucial step in validating the accuracy and reliability of simulations in their ability to predict real-world outcomes. Simulations, although highly effective in predicting the functions of systems, need to be consistent with the real-world performance of hardware in order to be practically applicable. This thorough comparison not only shows how accurate systems are but also shows where they could be improved, which boosts dependability in design and analysis methods.

The closer look of RFID Item Tracking, specifically in the context of hardware and simulation, revealed major differences. The simulation showcased a high level of accuracy in RFID tracking, exhibiting a notably increased frequency and enhanced processing speed in comparison to the hardware implementation, mostly due to the implementation of direct tag code. The simulation's improved performance indicates that enhancing it might lead to better monitoring in real-life situations. The performance of the hardware is comparatively inferior to that of the simulation. Nevertheless, in order to establish unwavering trust in the system's efficacy, it is important to conduct thorough validation of the hardware.

Simulation RFID tag read time: 4 tag per second

Hardware RFID tag read rate: 2 tags per second

Simulation RFID tag association accuracy: 97%

Hardware RFID tag association accuracy: 92%

The simulated load cell model was developed based on theoretical calculations and load cell requirements. The model utilized in the simulation provided projections for the anticipated levels of accuracy, sensitivity, and linearity of the weight sensor. On the other hand, the hardware implementation yielded essential empirical data regarding real-world performance. The strain gauge exhibits imperfect accuracy in displaying the measured values. The data is subject to fluctuations and is continuously updated to reflect the most recent information available. Weight measures were almost exact in the simulation. However, the real-time hardware results showed that there were very tiny differences since the weight sensor was crafted manually. The hardware findings exhibited higher levels of hysteresis and noise in comparison to the simulation results, as anticipated due to the inherent limitations imposed by the construction of a manually crafted weight sensor.

Simulated weight sensor accuracy: +/- 0.05 kg of the actual weight

Hardware weight sensor accuracy: +/- 0.2kg of the actual weight

In addition, the simulations made predictions on the clarity and readability of the information presented on the display, taking into account the design and algorithms employed. On the other hand, the hardware outcomes yielded empirical data regarding the efficacy of the physical display in presenting information across different lighting circumstances.

Simulation display luminance variation: 10%

Hardware display luminance variation: 15%

In the same way, simulations were employed to predict power consumption and efficiency by the utilization of theoretical models and algorithms. On the other hand, hardware results provided concrete, real-world observations on power usage, stability, and efficiency of the power management system. The powerhouse has a standing duration of up to one week or longer.

Simulation power stability: +/- 0.1 V

Hardware power stability: +/- 0.15 V

Simulation power efficiency: 95%

Hardware power efficiency: 85%

This thoroughly comparison of simulation results and hardware results gave us important information about how accurate and reliable the simulation model was. These insights will help people make smart choices about changes and improvements, which will improve the simulation's ability to predict future projects or versions.

5.4. Summary

The comparison of simulation and hardware results is crucial for validating the accuracy and reliability of simulations in predicting real-world outcomes. Simulations are effective in predicting system functions but need to be consistent with real-world hardware performance for practical application. A closer look at RFID Item Tracking revealed major differences between the two, with the simulation showing higher accuracy in RFID tracking due to direct tag code implementation. This suggests the possibility of improving tracking capabilities in real-world scenarios through optimization. The simulated load cell model was developed based on theoretical calculations and load cell requirements, providing projections for the anticipated levels of accuracy, sensitivity, and linearity of the weight sensor. However, the hardware implementation yielded empirical data regarding real-world performance. The strain gauge displayed imperfect accuracy in displaying measured values, and the simulation displayed almost correct weight measurement sect. Real-time hardware findings showed minor variations due to the weight sensor's handmade construction, leading to higher levels of hysteresis and noise. Simulations also predicted the clarity and readability of information presented on the display, considering the design and algorithms employed. Hardware results provided empirical data on the efficacy of the physical display in presenting information across different lighting circumstances. Simulate was used to predict the power consumption and efficiency of theoretical models and algorithms, while hardware results provided concrete, real-world observations on power usage, stability, and efficiency of the power management system.

Chapter 6

CONCLUSION

6.1. Summary of Findings

An IoT-based smart trolley and billing system for a supermarket has been designed and put into operation as part of this project. With the increasing shift towards digital technology, the primary motivation for choosing this issue was to improve the shopping experience, operational effectiveness, and use of IoT-based technologies. Across the world, common activities like shopping, using shopping carts, and waiting in long billing lines are common issues. Technology-enhanced purchasing may greatly improve our everyday lives in the digital age. The shopping experience is improved by allowing the trolley to follow consumers on its own, eliminating the need to push it back and forth which may help senior citizens. The RFID scanner will automatically scan products if they are maintained. As the goods are scanned, their names, weights, and prices are broadcast through the speaker, providing an additional benefit. For those without vision, this audio input is very useful. Cards make it simple to make payments, and the system will notify you if the cards don't have enough balance. In addition, if a customer chooses the incorrect item, they may return it and the price will be corrected instantly. Overall, various sorts of individuals may utilize these intelligent trolleys easily and conveniently. In conclusion, the installation of a smart trolley using IoT technology promises to convert the conventional shopping experience into a simplified, effective, and customized one, thereby enhancing consumer happiness and perhaps increasing revenues for the retailer.

6.2. Novelty of the work

The inefficiency of the traditional method of shopping was the primary inspiration for the development of the Internet of Things-based smart trolley and billing system. When using a typical method, the whole act of shopping is a distracting experience, beginning with the selection of items and ending with the settlement of the bill. It is also difficult for those with mobility issues to push the trolley back and forth, and the traditional method takes a lot of time, particularly when there is a sale or it is the weekend; hence, the model of the trolley that has been offered may in some way assist with the inconveniences that are caused by these two factors. There are several innovative elements that, when combined, have the potential to dramatically improve the overall quality of the shopping experience for consumers and the operational efficiency of the store. The integration of the Internet of Things into the billing system, automation, and management of the shopping cart and its contents is the primary focus of this article. This integration enables a shopping experience that is streamlined and effective. Because this is an Internet of Things-based trolley, we included a variety of sensors in its design, including RFID readers and RFID tags, weight sensors, and Sonic sensors. In a convenient shopping system, it takes a lot of time to wait in line for manual scanning, which also requires a lot of manpower. These sensors make the shopping experience simpler because, when putting the chosen items, they immediately get added to the virtual cart. This saves a lot of time since, in a comfortable shopping system, it takes a lot of time to stand in line for manual scanning. Customers can breeze through the checkout process and avoid waiting in huge lines if they scan their items. The final bill will be generated automatically and sent to the customer's mobile device, and the payment method will be in cards, such as on a digital platform, which will decrease the need for cash transactions. In addition to this, the system will gather data that the owners of supermarkets may use to improve their inventory management and marketing efforts. The forward-thinking approach that this project is taking also incorporates adaptive error correction, which will ensure that transactions are accurate. Importantly, the inclusiveness of the project is highlighted by giving top priority to user-friendliness, particularly for those who are visually impaired, via the use of product detail announcements and interfaces that are easy to understand. The fact that clients of any age or level of technical expertise can utilize this product without any additional effort is yet another advantage of our project. In general, the originality of this concept is in its capacity to transform the shopping experience via the use of IoT technologies, automation, and an automated billing process in the model of a typical supermarket, therefore increasing both consumer pleasure and operational efficiency[22].

6.3. Cultural and Societal Factors and Impacts

Cultural and social variables include a group's common views, attitudes, values, conventions, and lifestyles and larger societal impacts on individuals. Traditions, languages, art, activities, religion, family, and social roles comprise culture[23]. It greatly affects how people think, behave, and interact. The social environment, relationships, educational institutions, economic situations, demography, and societal structures are social variables. Their influence on attitudes, actions, and lifestyles is significant. In business, healthcare, education, and technology design, understanding these characteristics helps adjust tactics, goods, and services to particular target groups or cultures[23].

The conception and execution of an IoT-based smart trolley and billing system are susceptible to the impact of cultural and social elements, which, in turn, have substantial repercussions for society and culture as a whole. The capacity to adapt to other cultures is one of the most important concerns. The degree of ease and familiarity that various cultures display while interacting with cutting-edge technology varies greatly from one another. Accessibility and usability of the system may thus be significantly improved across a wide range of cultural contexts by modifying the design of the system to meet a variety of cultural preferences and by offering user interfaces in several different languages. Cultural standards regarding the protection of private information and the distribution of data are another critical aspect. These standards may have a significant impact on the degree to which people accept and trust Internet of Things devices that gather data while they are shopping. For this reason, establishing clear data collecting and use policies and matching them with cultural expectations surrounding privacy becomes essential to cultivate confidence and acceptability within the user base. Furthermore, the attitudes of society regarding automation and its possible influence on employment play a significant part in influencing the adoption of an IoT-based system that automates components of the shopping process. These views play a role in determining the adoption of a system that automates aspects of the shopping process[24]. To address this problem, it is necessary to raise awareness and educate the general public about how automation may supplement human labor, improve efficiency, and generate new possibilities without eliminating employment. Inclusion in the financial sector is another aspect that is shaped by the dynamics of society. Different cultures have diverse degrees of financial inclusion, which might lead to different reactions from individuals to digital payment systems that are incorporated into IoT-based invoicing. As a consequence of this, providing several payment alternatives and ensuring that the system is easy to use for both digital and conventional payment methods is crucial for fostering inclusion and boosting adoption across a wide variety of socioeconomic subgroups. In addition, the design of the system has to take into account factors regarding inclusion as well as accessibility. Those of all ages and abilities, as well as those with disabilities, are often part of the population of a society, which might result in special accessibility requirements. Inclusion can be ensured and societal ideals of equality and equal access to services can be upheld when a system is designed from the ground up to be user-friendly for people of all different levels of physical ability. In conclusion, a comprehensive awareness of cultural and social variables is required for the design and implementation of an IoT-based smart trolley and billing system. This understanding is necessary because of the interplay between the two systems. By addressing these aspects throughout the design and implementation phase of the technology's development, it is ensured that the technology will fit with the values, requirements, and expectations of the local community. This, in turn, will eventually improve the technology's acceptability and efficacy among a variety of cultures and civilizations.

6.4. Limitations of the Work

The project of implementing an IoT-based Smart trolley with an automatic billing system is innovative and promising, but it has certain limitations that need to be acknowledged. The first thing that comes to mind while implementing anything is the cost, as it is an IoT-based technology that also has an RFID system, a sensor, and a GSM; all of these are expensive. Handling all these components, connecting them all together, and ensuring seamless integration and functionality can be challenging. There are some issues with the frequencies of RFID cards that require us to hold the payment card more closely, so it's taking some time. Some sounds are coming from speakers, which is also a disturbance. Another important factor is the privacy of customers. Striking a balance between collecting useful data and respecting customers' privacy is a delicate task. Internet connectivity and battery backup issues are also concerns. User acceptance is also one of the concerns, as not everyone is familiar with these technologies. Individuals without access to smartphones may find it difficult to use. These are the overall limitations and acknowledging limitations enhances the overall effectiveness and sustainability of the project.

6.5. Future Scopes

Local and international standards, accompanied by professional codes of ethics, outline the expected conduct and performance for individuals within their respective domains. These guidelines ensure adherence to established norms, responsible behavior, and maintenance of high professional standards. The project is fundamentally rooted in adhering to these rules and guidelines set by local and global communities. It emphasizes ethical and responsible actions, aiming to benefit all stakeholders by doing what is right and in the best possible manner.

The smart shopping cart project has significant potential for future improvements and enhancements to provide an even better shopping experience. Here are some future scope areas for betterment:

- Use smart technology to suggest products that match what customers like, in real-time.
- Incorporate features that allow customers to view and engage with products through their phones or a screen.
- Make it easy for customers to pay for things right from their cart, so they can finish quickly.
- Help customers find their way around the store using special sensors that understand where they are.
- Keep people's private information safe and follow the rules about how we handle data.
- Let customers talk to the cart and ask questions, making shopping easier and friendlier.
- Try out new and clean energy sources, like solar power, to make the cart better for the environment and last longer.

- Allow people to switch from shopping in the store to shopping online without any hassle.
- Utilize technology to analyze sales trends and assist stores in better organization.
- Make the cart work well for everyone around the world, no matter what language they speak or money they use.
- Build the cart so it's easy to add new stuff or make it better without starting from scratch.
- Ask people what they think and keep improving the cart based on what they say and what we learn from using it.
- Care for the planet by using less energy and materials that are good for the environment.
- Work together with stores to make sure the cart is just what they need and fits into their store.
- Help local communities and do good things, like showing how to shop in a way that helps the Earth and helping out those who need it.

6.6. Social, Economic, Cultural and Environmental Aspects

6.6.1. Sustainability

The Sustainable Development Goals (SDGs) set forth by the United Nations align with the objectives of the smart tram initiative, as both aim to tackle community and environmental challenges. This project contributes to the global agenda of sustainability while simultaneously addressing substantial engineering obstacles. Its focus is on optimizing the shopping experience in an eco-friendly manner[27].

Firstly, it matches with Sustainable Cities and Communities (SDG 11), aiming to create cities and communities that last sustainably by making shopping in stores more efficient. SDG 11's objective of sustainable and inclusive urban development.

It also links with Responsible Consumption and Production (SDG 12), encouraging responsible shopping and reducing waste through smart shopping and easy billing. Using advanced IoT tech in stores is a step towards progress with Industry, Innovation, and Infrastructure (SDG 9), and building a sustainable industry.

Regarding Climate Action (SDG 13), The project helps by improving how stores work and using less paper. This supports responsible use of resources and less waste.

Also, involving different groups in the retail world mirrors forming good partnerships (SDG 17), to get the smart shopping cart used widely.

On the engineering side, the project deals well with key challenges. It focuses on using resources wisely, blending different technologies smoothly, creating a design that people find easy to use, and ensuring strong security for data. By overcoming these challenges, the project isn't just in line with the SDGs but also offers a sustainable and user-friendly way to shop, benefiting both people and the planet.

6.6.2. Economic and Cultural Factors

In our smart shopping cart project, several aspects demonstrate our adherence to professional codes of ethics, safety considerations, and a focus on economic, cultural, and sustainability factors:

- Adhere to ISO 13482:2014 and ensure safe cart movement using ultrasonic sensors, aligning with safety requirements for personal care robots and human interaction.
- Comply with ISO 14001:2015 and ISO 50001, optimizing power consumption through efficient power management with Li-po batteries and DC-DC buck modules for sustainable technology integration.
- Follow GDPR and relevant local data protection laws, especially concerning the RFID item tracking system and customer data management, to ensure ethical data handling, privacy, and security.
- Align the project with IEEE Code of Ethics and NSPE Code of Ethics, emphasizing public safety, sustainability through efficient power usage (IEEE 1680), economic efficiency, cultural inclusivity, and adherence to ethical practices.
- Implement ACM Code of Ethics principles, emphasizing public welfare, avoiding harm, and maintaining honesty and accuracy, particularly in data processing components of the smart shopping cart.
- Ensure safe cart movement with ultrasonic sensors, aligning with safety standards for personal care robots.
- Optimize power consumption using Li-po batteries and DC-DC buck modules, aligning with environmental and energy management standards.
- Handle data ethically, following GDPR and local data protection laws, especially with RFID item tracking and customer data management.
- Prioritize public safety, sustainability, and ethical engineering practices as per the IEEE Code of Ethics.
- Uphold public welfare, honesty, and accuracy, especially in data processing components, in alignment with the ACM Code of Ethics. These aspects collectively underscore our dedication to

adhering to professional codes of ethics, ensuring public safety, and considering economic, cultural, and sustainability factors throughout the project.

6.7. Conclusion

The main objective of the project "Design and Implementation of an IoT-based Smart Trolley and Billing System" was to revolutionize the conventional shopping experience. The initiative aims to improve shopping efficiency, streamline checkout operations, and increase overall customer satisfaction in supermarkets by using cutting-edge IoT technologies. The innovative concept of a smart trolley that automatically scans products and allows for seamless invoicing has the potential to simplify the whole shopping experience for customers. The conventional shopping approach required a significant amount of time. The project successfully demonstrated the potential of IoT in the retail sector by using different hardware and software components such as RFID scanners, Sonic sensors, weight scales, and motor driver batteries. Customers have the option to put a product in front of the RFID scanner, which triggers an announcement over the speaker with information about the product's name, price, and weight. Notably, the trolley follows the user automatically, using automation. Payment is made through cards, where clients just insert their cards and the payment procedure is completed in seconds. However, this initiative, like any other, has constraints, including expense and technological complexity. However, there is plenty of space for future advancements, such as using machine learning for individualized suggestions, offering expanded product information, and applying sophisticated navigation systems. This project illustrates the potential of IoT in transforming ordinary experiences. The potential for improving retail experiences with technology is limitless, and this initiative is an encouraging step toward a future in which shopping is fast, convenient, and pleasurable for everybody.

.

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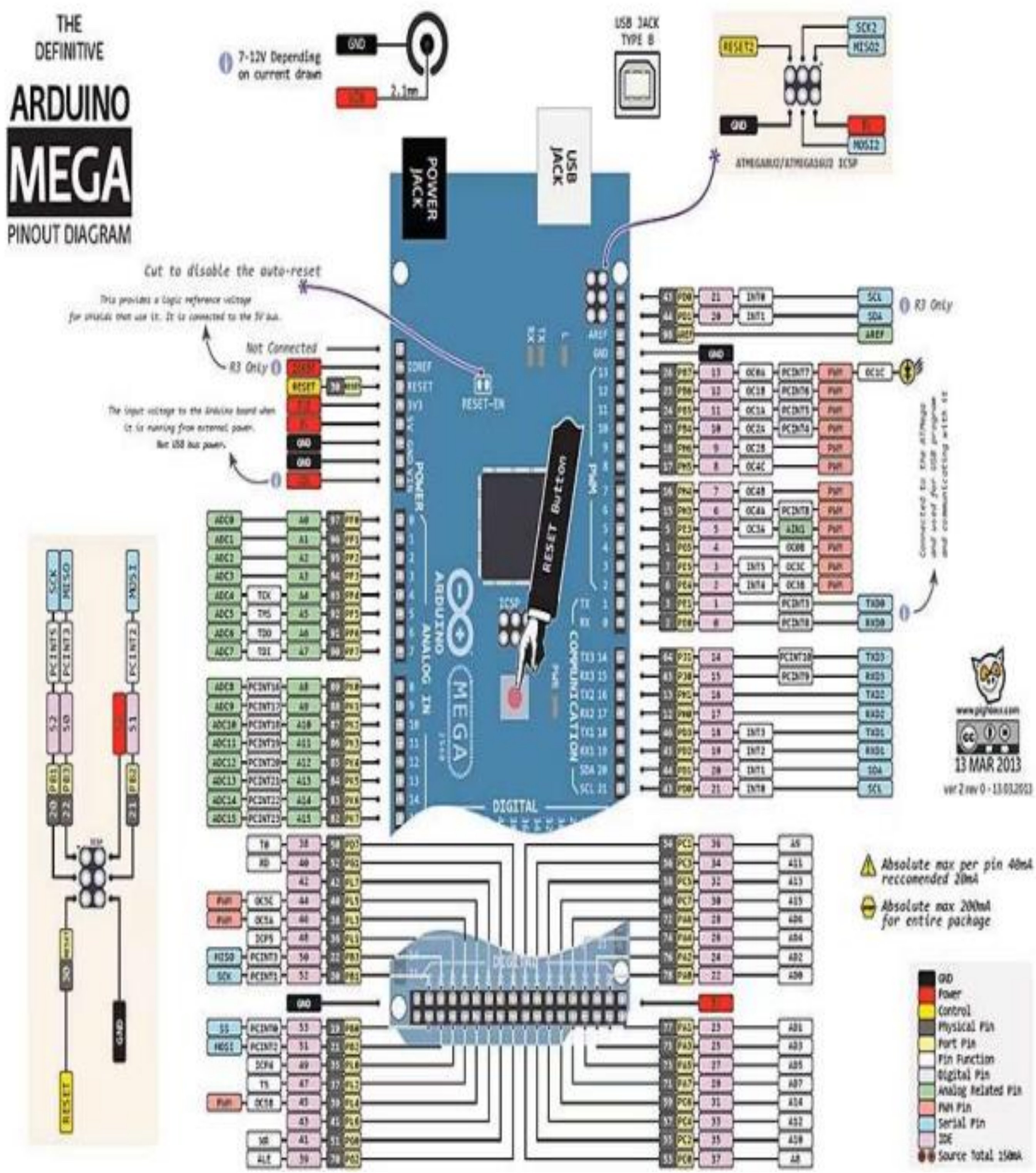
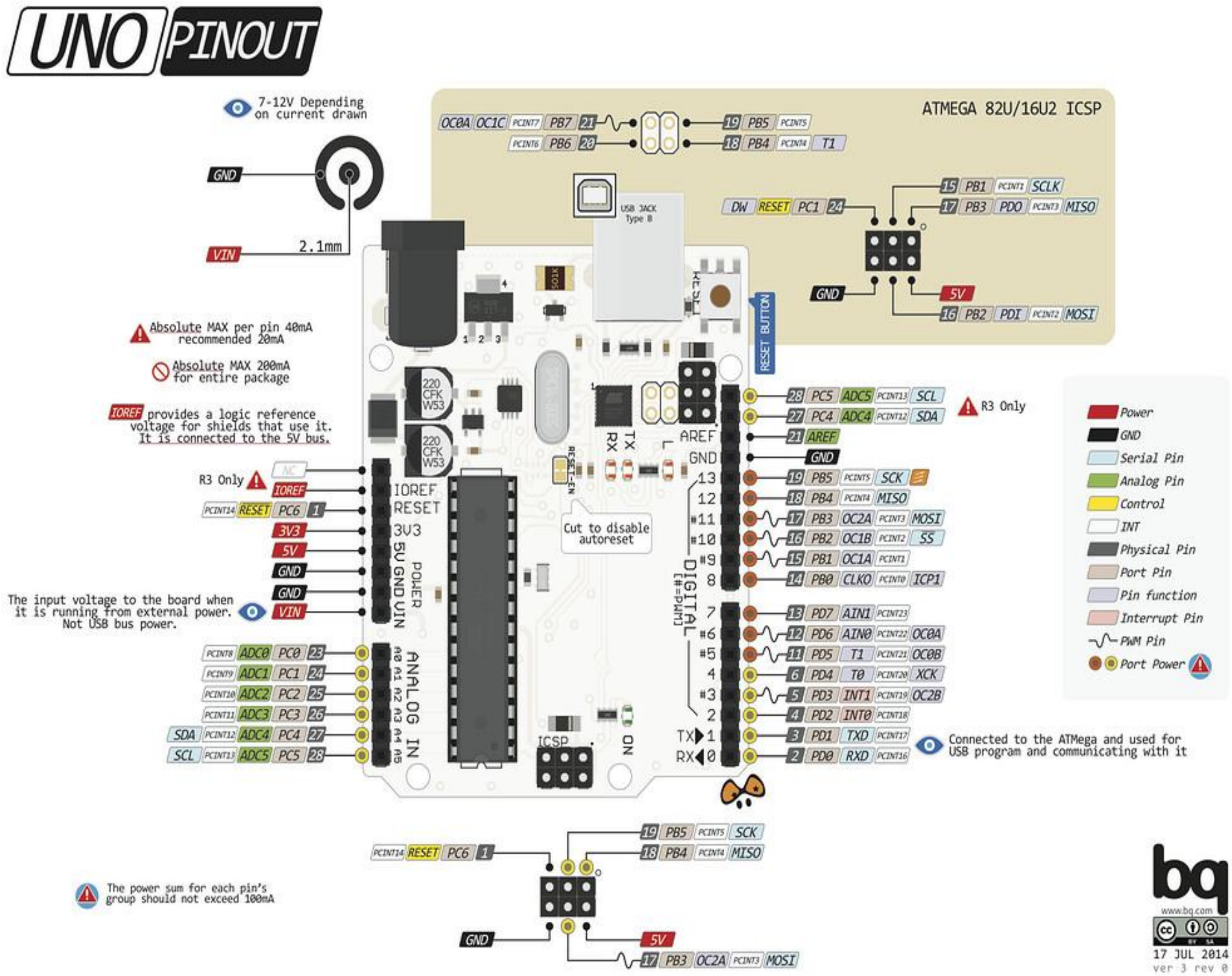
Appendix A

Datasheet of the ICs used

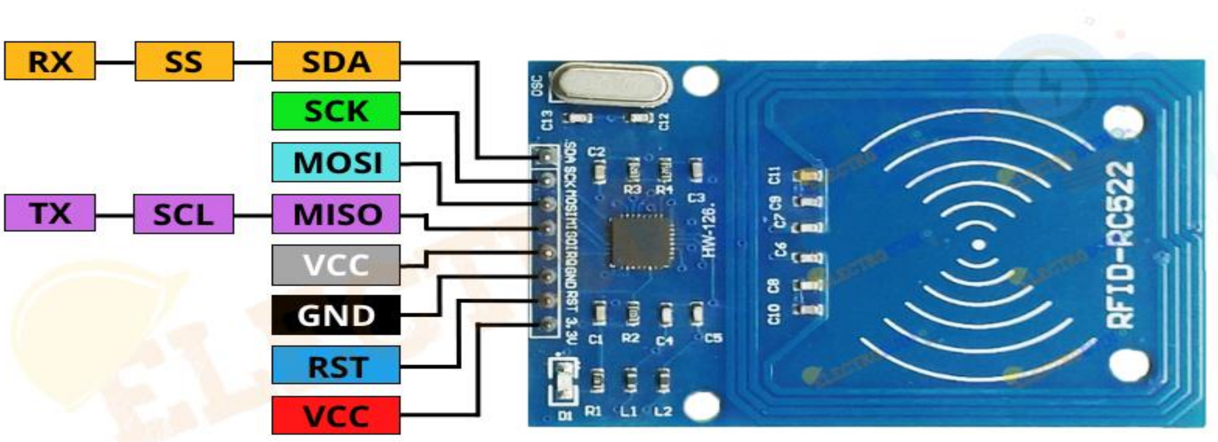
Arduino Mega:



Arduino Uno:



RFID Module:



Technical Specifications of Arduino Mega are given below

Micro controller	AT mega 2560
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	16
Digital I/O Pins	54
DC Current on I/O Pins	40mA
DC Current on 3.3V Pin	50mA
Flash Memory	256KB
SRAM	8KB
EEPROM	4KB
Frequency (Clock Speed)	16MHz
Power Jack	Yes
USB Connection	Yes

LCD 20*4" Display

Dimensions

Item	Dimensions	Unit
LCD Size	98 x 60	mm
Viewing Area	77 x 25.2	mm
Dot Size	0.55 x 0.55	mm
Dot Pitch	0.60 x 0.60	mm
Character Size	2.96 x 4.75	mm
Character Pitch	3.55 x 5.35	mm
LCD Thickness	8.8	mm

LCD Display Pin Connections

Pin No	Symbol	Level	Function
1	Vss		GND(0V)
2	Vdd		Vcc (+5V±5%)
3	Vo		Contrast Adjust
4	RS	H/L	Register Select
5	R/W	H/L	Read/Write
6	E	H/L	Enable Signal
7	DB0	H/L	Data Bit 0
8	DB1	H/L	Data Bit 1
9	DB2	H/L	Data Bit 2
10	DB3	H/L	Data Bit 3
11	DB4	H/L	Data Bit 4
12	DB5	H/L	Data Bit 5
13	DB6	H/L	Data Bit 6
14	DB7	H/L	Data Bit 7
15	NC		Not Connected
16	NC		Not Connected

Arduino UNO Specifications

- IC: Microchip ATmega328P (8-bit AVR core)
- Clock Speed: 16 MHz on Uno board, though IC is capable of 20 MHz maximum at 5 Volts
- Flash Memory: 32 KB, of which 0.5 KB used by the bootloader
- SRAM: 2 KB
- EEPROM: 1 KB

- USART peripherals: 1 (Arduino software default configures USART as a 8N1 UART)
- SPI peripherals: 1
- I²C peripherals: 1
- Operating Voltage: 5 Volts

Arduino Mega Specifications

- The ATmega2560 is a Microcontroller
- The operating voltage of this microcontroller is 5volts
- The recommended Input Voltage will range from 7volts to 12volts
- The input voltage will range from 6volts to 20volts
- The digital input/output pins are 54 where 15 of these pins will supply PWM o/p.
- Analog Input Pins are 16
- DC Current for each input/output pin is 40 mA
- DC Current used for 3.3V Pin is 50 mA
- Flash Memory like 256 KB where 8 KB of flash memory is used with the help of bootloader
- The static random-access memory (SRAM) is 8 KB

GSM Module Specification

- Standard AT commands
- Item Weight: 4.54 g
- Package Dimensions: 12.1 x 10.6 x 0.2 cm
- Adjustable serial baud-rate from 1200 to 115200 bps
- Single supply voltage: 3.4V – 4.5V
- Power saving mode: Typical power consumption in SLEEP mode is 1.5mA
- Frequency bands: SIM900A Dual-band: EGSM900, DCS1800. The SIM900A can search the two frequency bands automatically. The frequency bands also can be set by AT command.
- GSM class: Small MS
- GPRS connectivity: GPRS multi-slot class 10 (default) , GPRS multi-slot class 8 (option)
- Transmitting power: Class 4 (2W) at EGSM 900, Class 1 (1W) at DCS 1800

RC522 RFID Module specifications

- 13.56MHz RFID module
- Operating voltage: 2.5V to 3.3V
- Communication: SPI, I2C protocol, UART
- Maximum Data Rate: 10Mbps
- Read Range: 5cm
- Current Consumption: 13-26mA
- Power down mode consumption: 10uA (min)

LM2596 DC-DC step down buck Module specifications

- Module property: non-isolation buck
- Rectification mode: non-synchronous rectification
- Type: LM2596 Adjustable Power Supply Module
- Short Circuit Protection: Current limiting, since the recovery
- Input Voltage: DC 4V-35V
- Output Voltage: DC 1.23V-30V
- Output Current:3A (Maximum)
- Conversion Efficiency:92%(Highest)
- Output Ripple:30mv (Maximum)

RMP 8403 amplifier Module specifications

- 2 channels 3 W PAM8403 audio amplifier
- Output Power: 3 W + 3 W (at 4 ohm)
- Working Voltage: 2.5 to 5.5 V
- Board Size: 24 x 15 mm
- High amplification efficiency 85%
- Unique without LC filter class D digital power board
- Can use computer USB power supply directly

l298n motor driver module specifications

- Double H Bridge Drive Chip: L298N
- Logical Voltage: 5V
- Drive Voltage: 5V-35V
- Logical Current: 0-36mA
- Drive current: 2A (MAX single bridge)
- Max Power: 25W
- Dimensions: 43 x 43 x 26mm
- Weight: 26g

Software Codes:

Human flow code

```
const int trigPin = 10;
const int echoPin = 11;
long duration;
int distance;
const int trigPin1 = 7;
const int echoPin1 = 8;
long duration1;
int distance1;
const int trigPin2 = 2;
const int echoPin2 = 4;
long duration2;
int distance2;
int motorR1 = 3;
int motorR2 = 5;
int motorL1 = 6;
int motorL2 = 9;
void setup () {
  pinMode(trigPin, OUTPUT);  // Sets the trigPin as an Output
  pinMode(echoPin, INPUT);   // Sets the echoPin as an Input
  pinMode(trigPin1, OUTPUT);  // Sets the trigPin as an Output
  pinMode(echoPin1, INPUT);   // Sets the echoPin as an Input
  pinMode(trigPin2, OUTPUT);  // Sets the trigPin as an Output
  pinMode(echoPin2, INPUT);   // Sets the echoPin as an Input
  pinMode(motorR1, OUTPUT);
  pinMode(motorR2, OUTPUT);
```

```
  pinMode(motorL1, OUTPUT);

  pinMode(motorL2, OUTPUT);

  Serial.begin(9600);

}

void loop () {

  // sensor Font

  digitalWrite(trigPin, LOW);

  delayMicroseconds(2);

  // Sets the trigPin on HIGH state for 10 micro seconds

  digitalWrite(trigPin, HIGH);

  delayMicroseconds(10);

  digitalWrite(trigPin, LOW);

  // Prints the distance on the Serial Monitor

  Serial.print("Distance: ");

  Serial.println(distance);


  //Sensor right

  digitalWrite(trigPin1, LOW);

  delayMicroseconds(2);

  // Sets the trigPin on HIGH state for 10 micro seconds

  digitalWrite(trigPin1, HIGH);

  delayMicroseconds(10);

  digitalWrite(trigPin1, LOW);

  // Prints the distance on the Serial Monitor

  Serial.print("Distance1: ");

  Serial.println(distance1);

  //sensor left

  digitalWrite(trigPin2, LOW);
```

```
delayMicroseconds(2);
// Sets the trigPin on HIGH state for 10 micro seconds
digitalWrite(trigPin2, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin2, LOW);
// Prints the distance on the Serial Monitor
Serial.print("Distance2: ");
Serial.println(distance2);
Serial.println("");
if (distance < 10) //forward
{
  analogWrite(motorR1, 80);
  analogWrite(motorR2, 0);
  analogWrite(motorL1, 80);
  analogWrite(motorL2, 0);
}
else if (distance2 < 10) //Left
{
  analogWrite(motorR1, 0);
  analogWrite(motorR2, 150);
  analogWrite(motorL1, 150);
  analogWrite(motorL2, 0);
}
else if (distance1 < 10) //Right
{
  analogWrite(motorR1, 150);
  analogWrite(motorR2, 0);
  analogWrite(motorL1, 0);
```

```
    analogWrite(motorL2, 150);
  }
  else if (distance > 10 && distance1 > 10 & distance2 > 10) //stop
  {
    analogWrite(motorR1, 0);
    analogWrite(motorR2, 0);
    analogWrite(motorL1, 0);
    analogWrite(motorL2, 0);
  }
  //command = 's';
  delay (200);
}
```

RFID data read code

```
#include <SPI.h>
#include <MFRC522.h>
//For rfid
#define RST_PIN 9                  // Configurable, see typical pin layout above
#define SS_PIN 10                  // Configurable, see typical pin layout above
MFRC522 mfrc522(SS_PIN, RST_PIN); // Create MFRC522 instance
String content = "";
String content1 = "";
int product1 = 2;
int product2 = 3;
int product3 = 4;
int user1 = 5;
int user2 = 6;
int user3 = 7;
int user4 = 8;
```

```
void setup () {
 // put your setup code here, to run once:
 Serial.begin(9600);
 pinMode(product1, OUTPUT);
 pinMode(product2, OUTPUT);
 pinMode(product3, OUTPUT);
 pinMode(user1, OUTPUT);
 pinMode(user2, OUTPUT);
 pinMode(user3, OUTPUT);
 pinMode(user4, OUTPUT);
 digitalWrite(product1, LOW);
 digitalWrite(product2, LOW);
 digitalWrite(product3, LOW);
 digitalWrite(user1, LOW);
 digitalWrite(user2, LOW);
 digitalWrite(user3, LOW);
 digitalWrite(user4, LOW);
 // myserial.begin(9600);
 //for rfid
 SPI.begin(); // Init SPI bus
 mfrc522.PCD_Init (); // Init MFRC522
 mfrc522.PCD_DumpVersionToSerial (); // Show details of PCD - MFRC522 productd Reader details
 Serial.println(F ("Scan PICC to see UID, SAK, type, and data blocks..."));
}
void loop () {
 delay (1000); // read RFID
 content = " ";
 if (! mfrc522.PICC_IsNewCardPresent ()) {
```

```
    return;
  }// Select one of the cards
  if (! mfrc522.PICC_ReadCardSerial ()) {
    return;
  }
  for (byte i = 0; i < mfrc522.uid.size; i++) {
    Serial.print(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " ");
    Serial.print(mfrc522.uid.uidByte[i], HEX);
  }
content1 = content.substring(1);
  if (content.substring(1) == " ba 67 07 0b") {
    digitalWrite(user1, HIGH);
  }
  if (content.substring(1) == " ba 88 12 0b") {
 digitalWrite(user2, HIGH);
  }
if (content.substring(1) == " 03 82 db fc") {
 digitalWrite(user3, HIGH);
  }
 if (content.substring(1) == " 33 ee eb fc") {
 digitalWrite(user4, HIGH);
  }
 if (content.substring(1) == " 53 30 8d 0d") {
digitalWrite(product1, HIGH);
  }
 if (content.substring(1) == " b3 67 e2 0b") {
digitalWrite(product2, HIGH);
  }
```

```
 if (content.substring(1) == " 63 00 e4 12") {
    digitalWrite(product3, HIGH);
  }
}
```

Product information code

```
#include <SPI.h>
#include <SD.h>
#include "TMRpcm.h"
#include <LiquidCrystal_I2C.h>
// SoftwareSerial myserial(7, 8);
LiquidCrystal_I2C lcd(0x27, 20, 4);
int product1 = 2;
int product1_data;
int product2 = 3;
int product2_data;
int product3 = 4;
int product3_data;
int user1 = 5;
int user1_data;

int user2 = 6;
int user2_data;
int user3 = 7;
int user3_data;
int erruser = 8;
int erruser_data;
int flag1 = 0;
int flag2 = 0;
```

```
int flag3 = 0;

int flag4 = 0;

int flag5 = 0;

int flag6 = 0;

int flag7 = 0;

int product_price;

int product_weight;

int item_count;

int user1_balence = 500;

int user2_balence = 500;

int user3_balence = 500;


File myFile;

TMRpcm tmrpcm; // create an object for use in this sketch

void setup () {

  pinMode(product1, INPUT);

  pinMode(product2, INPUT);

  pinMode(product3, INPUT);

  pinMode(user1, INPUT);

  pinMode(user2, INPUT);

  pinMode(user3, INPUT);

  pinMode(erruser, INPUT);

  lcd.init();

  lcd.backlight();

  tmrpcm.speakerPin = 11;  //5,6,11 or 46 on Mega, 9 on Uno, Nano, etc

  // Open serial communications and wait for port to open:

  Serial.begin(9600);

  Serial.print("Initializing SD card...");
```

```
  Serial.println("initialization done.");
  tmrpcm.setVolume(5);
  Serial1.begin(19200);
  delay (20000) ;// give time to log on to network.
}
void loop () {
  user1_data = digitalRead(user1);
  user2_data = digitalRead(user2);
  user3_data = digitalRead(user3);
  erruser_data = digitalRead(erruser);
  product1_data = digitalRead(product1);
  product2_data = digitalRead(product2);
  product3_data = digitalRead(product3);
    lcd.setCursor(0, 0);
    lcd.print("Scan Product Tag");
  // Product 1
  if (digitalRead(product1) == 1) {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Product: Zeros Chips");
    lcd.setCursor(0, 1);
    lcd.print("weight: 15 Gram");
    lcd.setCursor(0, 2);
    lcd.print("Price: 10 Taka");
    lcd.setCursor(0, 3);
    lcd.print("Product Add");
    tmrpcm.play("zeros.wav");
    product1_data = 0;
```

```
  delay (5000);
  product_price =+ 10;
  product_weight =+ 15;
  item_count =+ 1;
 }
 if (digitalRead(product1) == 1) {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Product: Zeros Chips");
  lcd.setCursor(0, 1);
  lcd.print("weight: 15 Gram");
  lcd.setCursor(0, 2);
  lcd.print("Price: 10 Taka");
  lcd.setCursor(0, 3);
  lcd.print("Product Remove");
  tmrpcm.play("zeros.wav");
  delay (5000);
  product_price =- 10;
  product_weight =- 15;
  item_count =- 1;
 }
 // product 2;
 if (digitalRead(product2) == 1) {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Product: Chanachur");
  // lcd.noAutoscroll("Ruchi Chanachur");
  lcd.setCursor(0, 1);
```

```
  lcd.print("weight: 25 Gram");
  lcd.setCursor(0, 2);
  lcd.print("Price: 10 Taka");
  lcd.setCursor(0, 3);
  lcd.print("Product Add");
  tmrpcm.play("ruchi.wav");
  delay (5000);
  product_price =+ 10;
  product_weight =+ 25;
  item_count =+ 1;
 }
 if (digitalRead(product2) == 1) {
  lcd.clear();
  lcd.setCursor(0, 0);
  // lcd.noAutoscroll("Ruchi Chanachur");
  lcd.print("Product: Chanachur");
  lcd.setCursor(0, 1);
  lcd.print("weight: 25 Gram");
  lcd.setCursor(0, 2);
  lcd.print("Price: 10 Taka");
  lcd.setCursor(0, 3);
  lcd.print("Product Remove");
  tmrpcm.play("ruchi.wav");
  delay(5000);
  product_price =- 10;
  product_weight =- 25;
  item_count =- 1;
 }
```

```
// product 3;
if (digitalRead(product3) == 1) {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Product: Mr.Noodles");
  // lcd.noAutoscroll("Ruchi Chanachur");
  lcd.setCursor(0, 1);
  lcd.print("weight: 25 Gram");
  lcd.setCursor(0, 2);
  lcd.print("Price: 10 Taka");
  lcd.setCursor(0, 3);
  lcd.print("Product Add");
  tmrpcm.play("Noodles.wav");
  delay(5000);
  product_price =+ 10;
  product_weight =+ 30;
  item_count =+ 1;
}
if (digitalRead(product3) == 1) {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Product: Mr.Noodles");
  // lcd.noAutoscroll("Ruchi Chanachur");
  lcd.setCursor(0, 1);
  lcd.print("weight: 25 Gram");
  lcd.setCursor(0, 2);
  lcd.print("Price: 10 Taka");
  lcd.setCursor(0, 3);
```

```
  lcd.print("Product Remove");
  tmrpcm.play("Noodles.wav");
  delay(5000);
  product_price =- 10;
  product_weight =- 30;
  item_count =- 1;
 }
 if (user1_data == 1) {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Payment Done.");
  lcd.setCursor(0, 1);
  lcd.print("Pay:");
  lcd.print(product_price);
  lcd.print("Tk");
  user1_balence =- product_price;
  if (product_price == 10) {
   tmrpcm.play("10.wav");
  }
  if (product_price == 20) {
   tmrpcm.play("20.wav");
  }
  if (product_price == 30) {
   tmrpcm.play("30.wav");
  }
  userpayment();
 }
 if (user2_data == 1) {
```

```
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Payment Done.");
  lcd.setCursor(0, 1);
  lcd.print("Pay:");
  lcd.print(product_price);
  lcd.print("Tk");
  user2_balence =- product_price;
  if (product_price == 10) {
    tmrpcm.play("10.wav");
  }
  if (product_price == 20) {
    tmrpcm.play("20.wav");
  }
  if (product_price == 30) {
    tmrpcm.play("30.wav");
  }
  userpayment1();
}
if (user3_data == 1) {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Payment Done.");
  lcd.setCursor(0, 1);
  lcd.print("Pay:");
  lcd.print(product_price);
  lcd.print("Tk");
  user3_balence =- product_price;
```

```
    if (product_price == 10) {
      tmrpcm.play("10.wav");
    }
    if (product_price == 20) {
      tmrpcm.play("20.wav");
    }
    if (product_price == 30) {
      tmrpcm.play("30.wav");
    }
    userpayment2();
  }
  //error payment
  if (erruser_data == 1) {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Error Payment.");
    lcd.setCursor(0, 1);
    lcd.print("Use Another Card");
    delay (2000);
  }
  delay (1000);
  lcd.clear();
}
void user payment () {
  Serial1.println("AT+CMGS=\"+8801732281215\""); // +8801843513352 recipient's mobile number, in international format
  delay (1000);
  Serial1.println("Payment done. Balance Debit ");
```

```
  Serial1.print(product price);

  Serial1.print("Tk. Your Balance");

  Serial1.print(user1_balence);

  Serial1.print("Tk.");

  delay (1000);

  Serial1.println((char)26); // End AT command with a ^Z, ASCII code 26

  delay (5000);

  Serial1.println();

  delay (1000);

}

void userpayment1() {

  Serial1.println("AT+CMGS=\"+8801776509106\""); // +8801843513352 recipient's mobile number, in
international format

  delay (1000);

  Serial1.println("Payment done. Balance Debit ");

  Serial1.print(product price);

  Serial1.print("Tk. Your Balance");

  Serial1.print(user2_balence);

  Serial1.print("Tk.");

  delay (1000);

  Serial1.println((char)26); // End AT command with a ^Z, ASCII code 26

  delay (5000);

  Serial1.println();

  delay (1000);

}

void userpayment2() {

  Serial1.println("AT+CMGS=\"+8801521575420\""); // +8801843513352 recipient's mobile number, in
international format

  delay (1000);
```

```
 Serial1.println("Payment done. Balance Debit ");
 Serial1.print(product price);
 Serial1.print("Tk. Your Balance");
 Serial1.print(user3_balence);
 Serial1.print("Tk.");
 delay (1000);
 Serial1.println((char)26); // End AT command with a ^Z, ASCII code 26
 delay (5000);
 Serial1.println();
 delay (1000);
}
```

Appendix B

iThenticate Plagiarism Report

Smart Trolley

ORIGINALITY REPORT

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