A MINI PROJECT REPORT ON

SMART TROLLEY

(AUTOMATED BILLING SYSTEM USING RFID TECHNOLOGY AND MOTION USING JOYSTICK IN A TROLLEY)

Submitted in partial fulfillment of the requirements for the award of

BACHELOR OF TECHNOLOGY IN ELECTRONICS AND COMMUNICATION ENGINEERING

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SMART TROLLEY

<u>CERTIFICATE</u>

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ABSTRACT

In shopping malls, a shopping trolley or a shopping cart is a necessary tool for shopping. Traditionally, it is used by customers inside the store to transport goods to the cashier during shopping and designed not to leave the store. It is an inconvenience and time wasted for customers who want to find the desired product in the store by using the traditional shopping trolley. After putting all items in the trolley we approach the counter for billing which can result in long queues at all the counters. This shopping system's improvement is the primary focus of this study.

This improvement is proposed in the form of usage of RFID technology; RFID tags representing each product attached to them, while the trolley is modified to hold an RFID reader to read the UID of RFID tags. These UIDs are assigned to the respective products, thus returning the stored information of that product from the database. This data is displayed on the LCD. The selected products can be removed by pressing the delete button and reading the RFID tags once again. The total cost is summarized by the Arduino Mega 2560 for materials stored in memory which were already sent to it. The trolley also has motors attached to each wheel controlled by a joystick. The driver module L298N regulates the joystick input to the motors and thus implements the trolley's motion.

This design of a smart trolley reduces congestion at the cashier counter and shortens the time and waste of effort during the billing process. The moving system eases the difficulty of transportation for heavy purchasers and aged customers. The smart trolley is characterized by the speed of shopping compared to conventional shopping and provides a quality service.

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CHAPTER 1

INTRODUCTION

1.1 BASIS OF OUR SELECTION

In today's fast-paced world, the demand for efficient and secure shopping systems has never been greater. Shopping malls and all types of businesses are constantly seeking innovative solutions to streamline their customer shopping experiences and their overall sales. Traditional methods of shopping are reliant on manual checking systems, and often fall short in terms of time management and satisfaction of customers. However, with the advent of advanced technologies such as RFID and DC motors, a new era of shopping with automated billing systems is inevitable.

This paper focuses on the implementation of RFID reader with RFID tags and DC motors attached to the wheels of the trolley, which is controlled by the joystick module, using the Arduino Mega 2560. Arduino Mega 2560, a low-cost project focused device offers the perfect combination of affordability and flexibility. Utilizing the capabilities of Arduino Mega 2560 alongside the simple and user-friendly, our proposed system aims to revolutionize the way shopping is managed across various domains.

At the core of our system lies the implementation of RFID technology to individualize the purchasable goods and select them to be bought. Through the deployment of RFID tags, the system can accurately detect and recognize the products within a very limited area, even under varying interferences. Additionally, the integration of motor driver and joystick module technology further eases the strain of shopping, thus simplifying the experience of the customers.

The use of Arduino Mega 2560 as the underlying device brings several key advantages for our shopping system. Its compact size and low power consumption make it ideal for deployment in diverse settings, ranging from supermarkets to shopping malls. Furthermore, the open-source nature of Arduino Mega 2560 allows for easy customization and integration with existing

infrastructure, enabling seamless adoption by users with varying technical expertise.

In summary, our proposed shopping system represents a paradigm shift in the way shopping is done, offering unparalleled comfort, mobility, and convenience through the integration of RFID detection and joystick-controlled dc motor technologies with Arduino Mega 2560. By automating the accounting process involved in shopping and eliminating the limitations of traditional methods of requiring manpower to do the same, our system empowers the institutions and organizations to optimize their operations, foster accountability, and embrace the future of smart trolley management.

CHAPTER 2

LITERATURE REVIEW

2.1 ANALYSIS

In recent years, the concept of smart trolleys has gained significant attention due to their potential to enhance shopping experiences through automation and enhanced functionality. This literature review explores various components and technologies commonly integrated into smart trolleys, with a focus on the Arduino Mega 2560 microcontroller platform.

2.1.1 Arduino Mega 2560

The Arduino Mega 2560 is a versatile microcontroller board widely used in embedded systems and DIY projects due to its large number of digital and analog I/O pins. It serves as the central processing unit for the smart trolley, coordinating input from various sensors and controlling output devices.

2.1.2 Components of the Smart Trolley

1. Push Button: A simple yet effective input device used for triggering specific actions such as starting or stopping the trolley.

2. RFID Reader and Cards: RFID technology is employed for item identification and tracking. Each product is tagged with an RFID card or label, which the reader scans to add or remove items from the trolley's inventory.

3. LCD Screen: Provides visual feedback to the user, displaying item lists, total costs, promotions, and navigation menus.

4. Buzzer: Used for auditory feedback, signaling important events such as successfully scanning an item or alerting the user to system status.

5. Driver Module and DC Motors: These components form the propulsion system of the trolley, enabling movement in specified directions based on user commands or automated navigation.

6. Joystick Module: Offers manual control over the trolley's movement in scenarios where precise navigation is required, such as crowded store aisles or narrow passages.

The integration of these components allows the smart trolley to streamline the shopping experience by automating inventory management, providing real-time feedback to users, and enhancing navigation capabilities within retail environments.

2.1.3 Conclusion

In conclusion, the smart trolley project incorporating Arduino Mega 2560 and various peripheral components represents a significant advancement in retail automation. By leveraging these technologies, the project aims to enhance user convenience, optimize inventory management, and contribute to the evolving landscape of IoT-enabled smart retail solutions.

This literature review provides a foundational understanding of the components and functionalities essential for developing a smart trolley system. By referencing the suggested literature, you can further enrich your project report with technical insights and real-world applications.

CHAPTER 3

METHODOLOGY

Project

Experiment

3.1 COMPONENTS USED

The components that are primarily used are listed below

- Arduino Mega 2560
- Push Button
- RFID Reader and Tags
- (16x2) Liquid Crystal Display
- Driver Module
- DC Motor
- Power Supply
- Buzzer
- Joystick Module

Fig. shows the block diagram of the design.

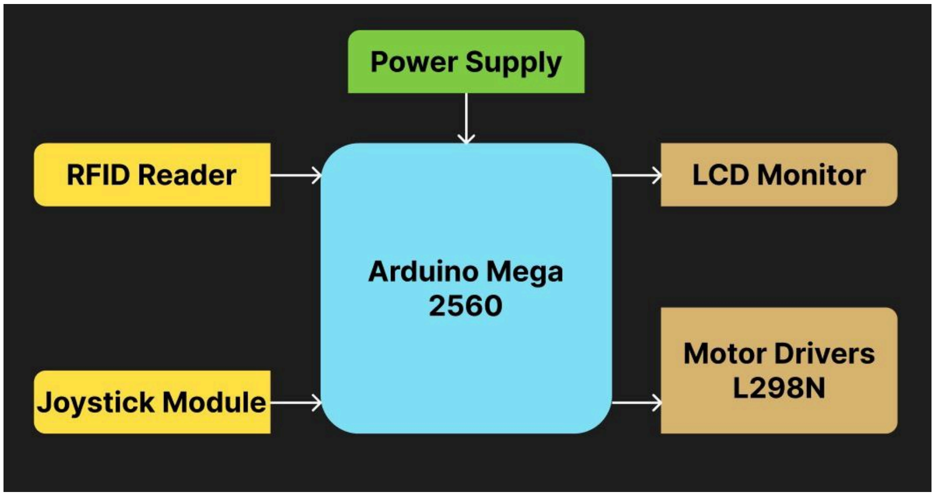

Fig.3.1 Block diagram of a Smart Trolley.

3.1.1 Arduino Mega 2560

The Arduino Mega 2560 stands as a beacon of innovation and creativity within the realm of

electronic prototyping. Serving as the flagship microcontroller board in the Arduino lineup, the Mega 2560 embodies a robust blend of features and capabilities tailored to meet the diverse needs of developers and enthusiasts worldwide. Fig. shows the image of an Arduino Mega 2560.

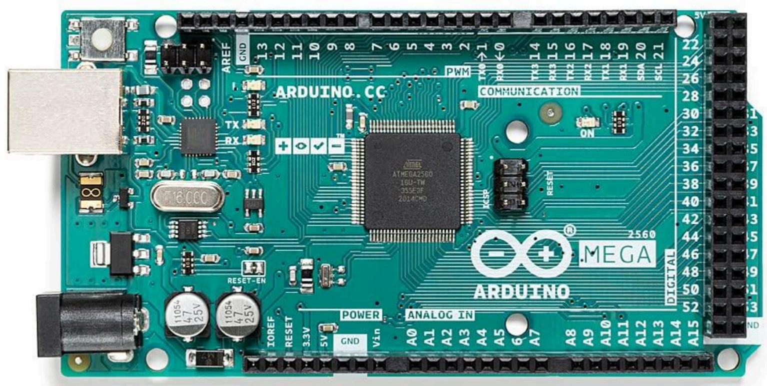

Fig.3.2 Arduino Mega 2560

At the heart of the Arduino Mega 2560 lies the ATmega2560 microcontroller, a powerful yet versatile chip that forms the backbone of countless electronic projects. Boasting an impressive array of 54 digital input/output pins and 16 analog inputs, the Mega 2560 offers unparalleled flexibility for interfacing with a myriad of sensors, actuators, and peripheral devices. This abundance of I/O options empowers developers to create projects ranging from simple LED blinkers to sophisticated robotic systems with ease. Fig. shows the layout of the pins in an Arduino Mega 2560.

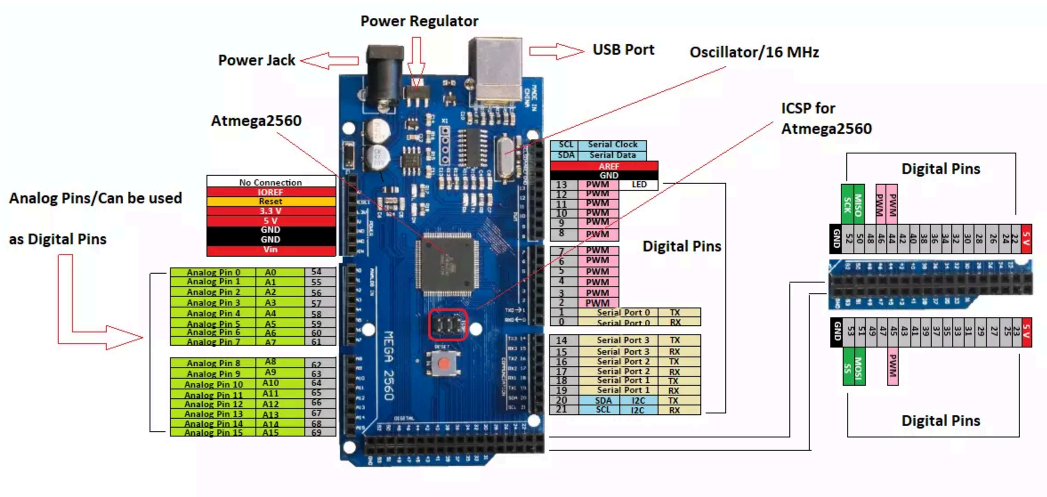

Fig.3.3 Arduino Mega 2560 Pin Diagram

Furthermore, with 256 KB of flash memory and 8 KB of SRAM, the Mega 2560 provides ample space for storing program code and data. This generous memory allocation enables developers to implement complex algorithms, handle large datasets, and execute diverse functionalities without compromising performance. Whether it's data logging, signal processing, or real-time control, the Mega 2560 rises to the occasion, facilitating the realization of ambitious project ideas.

Moreover, the Mega 2560's seamless integration with the Arduino software ecosystem streamlines the development process, allowing users to harness the power of an extensive library of pre-written code and libraries. From beginner-friendly tutorials to advanced programming techniques, the Arduino community offers a wealth of resources to support developers at every stage of their journey. Additionally, the Mega 2560's compatibility with a wide range of shields and expansion modules further enhances its versatility, enabling developers to extend its capabilities and tailor it to their specific project requirements.

The Arduino Mega 2560 stands as a testament to the spirit of innovation and exploration in the field of electronics. With its unparalleled combination of robust hardware, ample memory resources, and user-friendly development environment, the Mega 2560 empowers individuals of all skill levels to turn their creative visions into tangible reality. Whether it's in the hands of hobbyists, students, or seasoned professionals, the Mega 2560 continues to inspire and drive innovation, fostering a vibrant community of makers and innovators worldwide.

3.1.2 Push Button

The humble push button, despite its simplistic appearance, holds a profound significance in the world of electronics and human-computer interaction. Consisting of a simple mechanism that completes an electrical circuit when pressed, the push button serves as a fundamental interface component in countless electronic devices, from appliances and gadgets to industrial machinery and consumer electronics. Fig. shows the image of a Push Button.

Fig.3.4 Push Button

The push button embodies the principle of user input, allowing individuals to initiate actions or trigger events with a simple press. This intuitive interaction mechanism has become ingrained in our daily lives, serving as the primary means of control for everything from turning on lights to launching spacecraft. Whether it's the satisfying click of a mechanical button or the silent actuation of a capacitive touch sensor, the push button offers a tactile and reliable means of communication between humans and machines.

In addition to its role as a user interface element, the push button also plays a crucial role in safety and emergency systems. Emergency stop buttons, for example, provide a fail-safe mechanism for halting machinery in hazardous situations, helping to prevent accidents and protect lives. Similarly, reset buttons offer a means of restoring devices to a functional state after encountering errors or malfunctions, enhancing reliability and usability.

Furthermore, the push button's versatility extends beyond simple on/off control. Through the use of various signaling techniques such as momentary, latching, or toggle action, push buttons can facilitate a wide range of functions and interactions. For instance, a momentary push button may be used to trigger a temporary action, such as taking a photo or initiating a keyboard shortcut, while a latching button can be used to toggle between different states, such as switching between audio modes or locking/unlocking a device.

Moreover, the push button's adaptability makes it an ideal component for prototyping and experimentation in electronics projects. Whether it's interfacing with microcontrollers, integrating into custom circuits, or incorporating into interactive installations, push buttons offer a straightforward and versatile means of user input that can be easily tailored to suit specific project requirements.

3.1.3 RFID Reader and Tags

Radio-frequency identification (RFID) technology has revolutionized numerous industries by enabling efficient and accurate tracking, identification, and management of assets, products, and inventory. At the core of RFID systems are RFID readers and tags, which work in tandem to transmit and receive data wirelessly using radio waves. Fig. shows the image of an RFID Reader, Tag and Card.

Fig.3.5 RFID Reader, Card and Tag

RFID readers serve as the central component of an RFID system, responsible for emitting radio waves and capturing data from RFID tags within their vicinity. These readers can be stationary or mobile and come in various form factors to suit different applications. They typically consist of an antenna, a transceiver, and a microcontroller, which processes the incoming data and communicates with the host system. RFID readers emit electromagnetic waves at specific frequencies, which activate RFID tags within their range and prompt them to transmit their unique identification information.

RFID tags, also known as transponders or RFID chips, are small electronic devices that contain a microchip and an antenna. These tags come in various shapes and sizes and can be either passive, active, or semi-passive. Passive RFID tags do not have an internal power source and rely on the energy emitted by the RFID reader to transmit data. Active RFID tags, on the other hand, have their own power source (e.g., battery) and can transmit data over longer distances. Semi-passive tags have a battery for powering the microchip but rely on the RFID reader for communication.

The RFID tag stores unique identification data, which can include serial numbers, product codes, or other relevant information. When an RFID reader emits radio waves, the tag's antenna receives the signal, which induces a current in the tag's microchip, powering it temporarily. The microchip then modulates the radio waves and reflects them back to the reader, transmitting the stored data. The reader captures this information and forwards it to the host system for processing and analysis.

RFID technology offers numerous advantages over traditional barcode systems, including faster data capture, non-line-of-sight operation, and the ability to read multiple tags simultaneously. This makes RFID ideal for applications such as inventory management, asset tracking, access control, and supply chain optimization. Additionally, RFID tags can be embedded in various materials, including plastics, paper, and fabrics, enabling seamless integration into existing products and processes.

Despite its numerous benefits, RFID technology also poses certain challenges, including concerns about privacy and security. Because RFID tags can be read remotely and without direct user interaction, there are potential risks associated with unauthorized access to sensitive information. However, advancements in encryption and authentication protocols help mitigate these risks and ensure the secure operation of RFID systems.

In conclusion, RFID readers and tags form the backbone of RFID systems, enabling seamless identification, tracking, and management of assets and inventory across a wide range of industries. With their ability to provide real-time visibility and actionable insights, RFID technology continues to drive efficiency, productivity, and innovation in diverse applications, from retail and logistics to healthcare and beyond. As technology continues to evolve, RFID is poised to play an increasingly vital role in shaping the future of the Internet of Things (IoT) and smart connected systems.

3.1.4 Liquid Crystal Display Screen

The 16x2 LCD display is a ubiquitous and versatile component in the realm of electronics, renowned for its simplicity, compact size, and functionality. With its ability to showcase 16 characters per line across 2 lines, this display module offers a clear and concise medium for presenting textual information in various projects. Equipped with a backlit feature, it ensures readability even in low-light conditions, making it suitable for a wide array of applications, from home automation systems to industrial control panels. Fig. shows the image of a 16x2 LCD Screen.

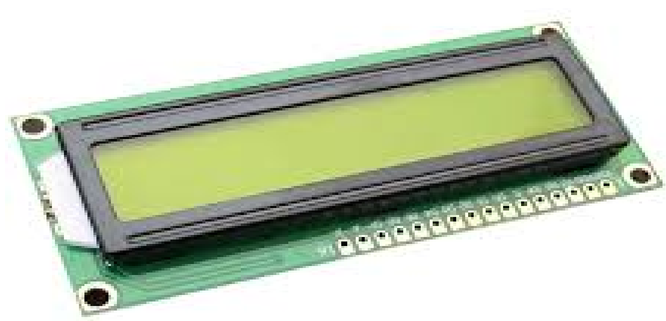

Fig.3.6 LCD Screen

In the design, the 16x2 LCD serves as an invaluable tool for introducing customers and sellers to the fundamentals of microcontroller interfacing and programming. Its straightforward interface and compatibility with popular microcontrollers like Arduino and Raspberry Pi make it accessible to beginners while providing ample opportunities for advanced experimentation and learning. Additionally, the adjustable contrast feature allows users to fine-tune the display to optimize visibility, enhancing the educational experience.

Beyond the shopping malls, the 16x2 LCD finds extensive use in DIY electronics projects and embedded systems. Whether it's displaying real-time data from sensors in a weather station or presenting status updates in a home security system, this display module excels in conveying critical information with clarity and precision.

3.1.5 Driver Module

A motor driver is a vital component in robotics, automation, and many other electromechanical systems, serving as the intermediary between a microcontroller or other control system and the motor itself. Its primary function is to regulate the electrical power supplied to the motor, controlling its speed, direction, and torque. Fig. shows the image of a Driver Module.

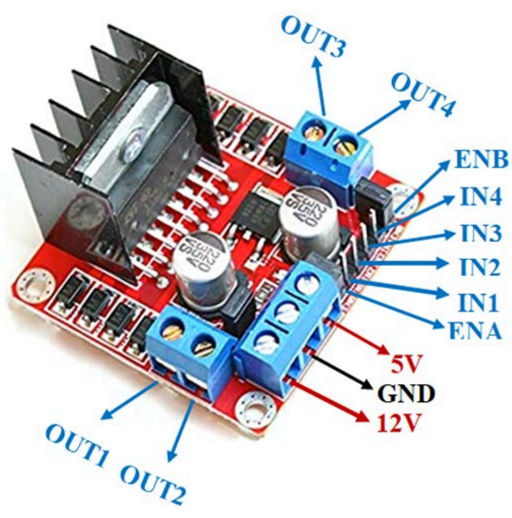

Fig.3.7 L298N Driver module with Pin Layout.

At its core, a motor driver typically consists of power transistors or MOSFETs (Metal-Oxide-Semiconductor Field-Effect Transistors) arranged in an H-bridge configuration.

This arrangement allows the motor driver to reverse the polarity of the voltage applied to the motor, enabling bidirectional control. By selectively turning these transistors on and off in specific patterns, the motor driver can vary the speed and direction of the motor's rotation with precision.

Motor drivers come in various types and configurations to accommodate different motor types, sizes, and operating conditions. For instance, brushed DC motors, stepper motors, and brushless DC motors each have unique characteristics that require specialized motor drivers tailored to their specific needs. Additionally, motor drivers vary in terms of voltage and current ratings, with some capable of handling high-power motors commonly found in industrial applications.

One of the key considerations when selecting a motor driver is its control interface. Motor drivers may feature analog inputs, PWM (Pulse Width Modulation) inputs, or digital communication protocols such as UART, SPI, or I2C, allowing them to interface with a wide range of microcontrollers, PLCs (Programmable Logic Controllers), and other control devices.

Beyond basic motor control, many motor drivers incorporate additional features to enhance performance and protect the motor and driver circuitry. These features may include overcurrent protection, thermal shutdown, stall detection, and fault diagnostics, safeguarding the system against potential damage and ensuring reliable operation in various operating conditions.

In recent years, advancements in motor driver technology have led to the development of integrated solutions that combine motor control, sensing, and communication capabilities into a single device. These integrated motor drivers simplify system design, reduce component count, and offer enhanced functionality, making them ideal for compact, cost-effective applications such as consumer electronics, automotive systems, and home automation.

In summary, motor drivers play a crucial role in controlling the speed, direction, and torque of electric motors in a wide range of applications. By providing the necessary interface between control systems and motors, motor drivers enable precise and efficient motor control, contributing to the performance, reliability, and versatility of electromechanical systems across various industries.

3.1.6 DC Motor

Direct current (DC) motors represent a cornerstone technology in the realm of electromechanical systems, powering a myriad of devices and machinery across various industries. At their core, DC motors convert electrical energy into mechanical motion through the interaction of magnetic fields within the motor. This fundamental principle underpins their operation and versatility in applications ranging from automotive systems and industrial machinery to consumer electronics and robotics. Fig. shows the image of a DC Motor.

Fig.3.8 DC Motors

One of the defining characteristics of DC motors is their simplicity in design and operation. Consisting of a stationary part called the stator and a rotating part known as the rotor, DC motors rely on the attraction and repulsion of magnetic fields to generate rotational motion. By applying a DC voltage to the stator windings, a magnetic field is created, which interacts with the magnetic field produced by the rotor. This interaction causes the rotor to rotate, thereby converting electrical energy into mechanical work.

DC motors offer several advantages that contribute to their widespread adoption in various applications. One notable advantage is their ability to provide high torque at low speeds, making them well-suited for tasks requiring precise control and starting capabilities. Additionally, DC motors exhibit linear speed-torque characteristics, meaning their speed can be easily controlled by adjusting the input voltage or current. This inherent controllability makes DC motors highly versatile and adaptable to a wide range of operating conditions and load requirements.

Furthermore, DC motors are renowned for their reliability, durability, and ease of maintenance. With fewer moving parts compared to their AC counterparts, DC motors typically experience less wear and tear over time, resulting in extended service life and reduced maintenance costs. Additionally, the modular nature of DC motors facilitates easy replacement of components, minimizing downtime and maximizing operational efficiency in industrial settings.

In recent years, advancements in motor design and control technologies have further enhanced the performance and efficiency of DC motors. Brushless DC (BLDC) motors, for example, eliminate the need for mechanical brushes and commutators, resulting in improved reliability, reduced maintenance, and higher efficiency. Moreover, the integration of electronic speed controllers (ESCs) and advanced control algorithms enables precise speed and position control, opening up new possibilities for applications requiring high performance and responsiveness.

In conclusion, DC motors represent a cornerstone technology with a rich history of innovation and evolution. From their simple yet robust design to their versatility and controllability, DC motors continue to play a vital role in powering a wide range of electromechanical systems and devices. As technology continues to advance, the legacy of DC motors persists, driving progress and innovation across diverse industries and applications.

3.1.7 Power Supply

The power supply serves as a critical component in any electronic device, ensuring reliable operation and user-friendly functionality. Whether it's a small handheld gadget or a complex industrial system, the efficiency and control provided by these elements are paramount to the overall user experience and performance. Fig. shows the image of a Power Supply.

Fig.3.9 Power Supply Adapter.

The power supply unit (PSU) is responsible for converting external electrical power into a form suitable for the device's operation. In the context of the Arduino Mega 2560 and similar electronic projects, the power supply may come from a variety of sources, including batteries, wall adapters, or USB connections. The choice of power supply depends on factors such as portability, voltage requirements, and available power outlets. Additionally, the power supply must provide sufficient current capacity to meet the demands of the connected components while maintaining stable voltage levels to prevent damage or erratic behavior.

3.1.8 Buzzer

The buzzer is a fundamental component in the world of electronics, prized for its simplicity and versatility in generating audible alerts and notifications. Consisting of a piezoelectric element housed within a compact enclosure, the buzzer produces sound when an electrical signal is applied to it. This distinctive sound can range from a simple tone to a more complex series of beeps or melodies, depending on the design and configuration of the buzzer. Fig. shows the image of a Buzzer.

Fig.3.10 Buzzer

One of the primary applications of buzzers is in alarm systems, where they serve as an effective means of alerting users to potential threats or emergencies. From smoke detectors and security alarms to countdown timers and doorbells, buzzers play a crucial role in ensuring the safety and security of both residential and commercial spaces. Their loud and attention-grabbing sound makes them ideal for drawing immediate attention to critical situations.

In addition to alarm systems, buzzers find widespread use in electronic devices and appliances as indicators and feedback mechanisms. For example, they are commonly employed in kitchen appliances like microwave ovens and coffee makers to signal the completion of cooking cycles or brewing processes. Similarly, they are integrated into consumer electronics such as mobile phones and computers to provide audible alerts for incoming calls, messages, and notifications.

3.1.9 Joystick Module

The joystick module is a versatile input device widely used in electronic projects to control motion and direction. Consisting of two potentiometers—one for each axis—and a tactile switch, the joystick module enables users to manipulate objects or interfaces in both two-dimensional and three-dimensional space with precision and ease. Its compact form factor and intuitive operation make it an ideal choice for applications ranging from remote-controlled vehicles and robotic arms to gaming consoles and virtual reality systems. Fig. shows the image of a Joystick Module.

Fig.3.11 Joystick Module

One of the key features of the joystick module is its dual-axis control, which allows users to independently adjust the position along the X and Y axes. This enables nuanced control over the movement of connected devices, whether it's steering a vehicle, aiming a camera, or navigating a virtual environment. Additionally, the joystick's analog output provides continuous positional feedback, enabling smooth and fluid motion control with fine-grained accuracy.

In addition to its analog control capabilities, the joystick module typically includes a built-in tactile switch, commonly referred to as the "click" function. This switch serves as a convenient means of triggering actions or functions within a project, such as initiating a firing sequence in a game or toggling between different operating modes. Its tactile feedback enhances user interaction and adds a tactile dimension to the control experience.

The versatility of the joystick module extends beyond its hardware capabilities to its seamless integration with microcontroller platforms such as Arduino and Raspberry Pi. By connecting the joystick module to an appropriate microcontroller board and utilizing the corresponding libraries and code examples, developers can quickly incorporate joystick functionality into their projects with minimal effort. This plug-and-play compatibility streamlines the development process and empowers users to focus on implementing their desired functionality without getting bogged down by low-level hardware details.

Moreover, the joystick module's modular design and standardized interface make it easy to interface with other electronic components and peripherals. Whether it's integrating additional sensors, displays, or communication modules, the joystick module serves as a central control interface that can be expanded and customized to suit specific project requirements. This versatility enables developers to create highly tailored solutions that meet the unique needs of their applications, from interactive installations and educational tools to industrial automation systems and beyond.

Furthermore, the affordability and accessibility of joystick modules make them widely available to hobbyists, students, and professionals alike. With a modest investment, individuals can acquire multiple joystick modules for experimentation, prototyping, and learning purposes. This democratization of access to advanced input devices fosters a culture of innovation and collaboration within the maker community, where knowledge sharing and collective problem-solving thrive.

The joystick module represents a powerful yet accessible tool for motion control and user interaction in electronic projects. Its dual-axis analog control, tactile feedback, and seamless integration with microcontroller platforms make it an indispensable component for a wide range of applications. Whether it's steering a robot, flying a drone, or piloting a virtual spacecraft, the joystick module empowers users to unleash their creativity and bring their ideas to life with precision and control.

3.2 PROGRAMMING

The Arduino Mega 2560 is programmed using the Arduino IDE.

3.2.1 Arduino IDE

Arduino Integrated Development Environment (IDE) serves as the cornerstone for developing projects based on Arduino microcontroller boards like the Arduino Mega 2560, central to the smart trolley project. The significance and functionality of Arduino IDE, pivotal in programming and deploying code into Arduino-based systems. The key features and capabilities include:

1. Cross-Platform Compatibility: Arduino IDE is compatible with major operating systems including Windows, macOS, and Linux, ensuring accessibility for developers across different platforms.
2. Simplified Programming: Its user-friendly interface simplifies the process of writing, compiling, and uploading code to Arduino boards. This is crucial for integrating components such as RFID readers, LCD screens, and motor drivers into the smart trolley system.
3. Integrated Libraries: Arduino IDE includes a vast library of pre-written functions and examples, facilitating rapid prototyping and implementation of complex functionalities like RFID communication protocols or motor control algorithms.
4. Serial Monitor: The built-in Serial Monitor enables real-time debugging and communication between the Arduino board and connected peripherals, aiding in troubleshooting and data visualization during development.
5. Extensibility: Arduino IDE supports the integration of third-party libraries and additional hardware platforms, expanding its functionality beyond the core Arduino boards. This versatility is beneficial for incorporating advanced sensors or communication modules into the smart trolley.
6. Community Support: With a large and active community of developers and enthusiasts, Arduino IDE benefits from extensive online resources, forums, and tutorials. This ecosystem provides invaluable assistance in overcoming challenges and discovering new possibilities for project enhancement.

In the context of the smart trolley project, Arduino IDE plays a pivotal role in programming the Arduino Mega 2560 microcontroller. Developers can utilize its intuitive interface to configure inputs from components such as push buttons and RFID readers, manage outputs to LCD screens and buzzers, and control motor movements via driver modules and joystick inputs.

Arduino IDE stands as an indispensable tool in the development journey of the smart trolley project. Its robust features, ease of use, and extensive support ecosystem empower developers to efficiently prototype, iterate, and deploy innovative solutions that enhance user interaction and operational efficiency in retail environments.

By leveraging Arduino IDE, the smart trolley project can achieve seamless integration of hardware components, ensuring a reliable and scalable solution that meets the evolving demands of modern retail environments.

3.2.2 Programming Code of the Design

```
#include <SPI.h>
#include <MFRC522.h>
#include <LiquidCrystal.h> // Include the LiquidCrystal library

#define SS_PIN 10      // SS pin for MFRC522 RFID reader
#define RST_PIN 5      // RST pin for MFRC522 RFID reader
#define BUTTON_PIN 2   // Pin for the push button
#define BUZZER_PIN 4   // Pin for the buzzer

// Define LCD pin connections
#define LCD_RS 8
#define LCD_EN 9
#define LCD_D4 11
#define LCD_D5 12
#define LCD_D6 13
#define LCD_D7 14
#define LCD_COLUMNS 16
#define LCD_ROWS 2

LiquidCrystal lcd(LCD_RS, LCD_EN, LCD_D4, LCD_D5, LCD_D6, LCD_D7); // Initialize the
LCD

MFRC522 mfrc522(SS_PIN, RST_PIN);
```

```
// Define product details
struct Product {
  String name;
  float price;
};

Product products[] = {
  {"Biscuit", 10.00},
  {"Tea", 20.00},
  {"Coffee", 30.00},
  {"Ice Cream", 40.00}
};

// Define array to map RFID UIDs to products
String productUIDs[] = {
  "cdbc1c3a",
  "8666b206",
  "1d91f306",
  "1d91f339"
};

float totalAmount = 0.0;
int productsAdded = 1;
bool buttonPressed = false;

// Motor control pins
#define ENA 3
#define IN1 22
#define IN2 23
#define ENB 6
```

```
#define IN3 24
#define IN4 25

// Joystick pins
#define VRX_PIN A0
#define VRY_PIN A1

void setup() {
  Serial.begin(9600);
  SPI.begin();
  mfrc522.PCD_Init();
  pinMode(BUTTON_PIN, INPUT_PULLUP);
  pinMode(BUZZER_PIN, OUTPUT);

  // Initialize the LCD
  lcd.begin(LCD_COLUMNS, LCD_ROWS);

  // Initialize motor control pins
  pinMode(ENA, OUTPUT);
  pinMode(IN1, OUTPUT);
  pinMode(IN2, OUTPUT);
  pinMode(ENB, OUTPUT);
  pinMode(IN3, OUTPUT);
  pinMode(IN4, OUTPUT);
}

void loop() {
  // Check for button press
  if (digitalRead(BUTTON_PIN) == LOW) {
    buttonPressed = !buttonPressed; // Toggle button state
    if (buttonPressed) {
```

```
      displayBillAmount(); // Print total amount when button is pressed
      totalAmount = 0.0; // Reset total amount
      productsAdded = 1; // Reset total product count
    }
    delay(250); // Debounce delay
  }

  // Read RFID card if button is not pressed
  if (!buttonPressed && mfrc522.PICC_IsNewCardPresent() && mfrc522.PICC_ReadCardSerial()) {
    String tagUID = "";
    for (byte i = 0; i < mfrc522.uid.size; i++) {
      tagUID += (mfrc522.uid.uidByte[i] < 0x10 ? "0" : "");
      tagUID += String(mfrc522.uid.uidByte[i], HEX);
    }
    mfrc522.PICC_HaltA();

    // Beep the buzzer
    beep();

    // Search for product details based on RFID tag UID
    int productIndex = -1;
    for (int i = 0; i < sizeof(productUIDs) / sizeof(productUIDs[0]); i++) {
      if (tagUID == productUIDs[i]) {
        productIndex = i;
        break;
      }
    }

    // If product found, add to the total amount and display
    if (productIndex != -1) {
```

```
      totalAmount += products[productIndex].price;
      displayProductDetails(productIndex);
      productsAdded++;
    } else {
      Serial.println("Product not found");
    }
  }

  // Control motors based on joystick input
  controlMotors();
}

// Function to control the buzzer
void beep() {
  digitalWrite(BUZZER_PIN, HIGH); // Turn on the buzzer
  delay(100); // Beep duration
  digitalWrite(BUZZER_PIN, LOW); // Turn off the buzzer
}

// Function to display product details on LCD
void displayProductDetails(int index) {
  lcd.clear(); // Clear the LCD
  lcd.setCursor(0, 0);
  lcd.print("Product: ");
  lcd.print(products[index].name);
  lcd.setCursor(0, 1);
  lcd.print("Price: Rs");
  lcd.print(products[index].price);
}

// Function to display bill amount on LCD
```

```
void displayBillAmount() {
  lcd.clear(); // Clear the LCD
  lcd.setCursor(0, 0);
  lcd.print("Total Amount: Rs");
  lcd.print(totalAmount);
  lcd.setCursor(0, 1);
  lcd.print("Total Products: ");
  lcd.print(productsAdded - 1);
}

// Function to control motors based on joystick input
void controlMotors() {
  int xValue = analogRead(VRX_PIN);
  int yValue = analogRead(VRY_PIN);

  int motorSpeedA = map(abs(yValue - 512), 0, 512, 0, 255);
  int motorSpeedB = map(abs(xValue - 512), 0, 512, 0, 255);
  if (yValue < 512) { // Forward
    digitalWrite(IN1, HIGH);
    digitalWrite(IN2, LOW);
    analogWrite(ENA, motorSpeedA);
  } else if (yValue > 512) { // Backward
    digitalWrite(IN1, LOW);
    digitalWrite(IN2, HIGH);
    analogWrite(ENA, motorSpeedA);
  } else {
    analogWrite(ENA, 0);
  }

  if (xValue < 512) { // Left
    digitalWrite(IN3, HIGH);
```

```
    digitalWrite(IN4, LOW);
    analogWrite(ENB, motorSpeedB);
  } else if (xValue > 512) { // Right
    digitalWrite(IN3, LOW);
    digitalWrite(IN4, HIGH);
    analogWrite(ENB, motorSpeedB);
  } else {
    analogWrite(ENB, 0);
}
}
```

3.3 DESIGN

Fig. shows the internal structure of the design, including the connections between the pins.

3.3.1 Component Selection and Pin Configuration

1. RFID Reader (MFRC522): Connected to SPI pins (SS_PIN and RST_PIN) for reading RFID tags.
2. Push Button and Buzzer: Configured on digital pins (BUTTON_PIN and BUZZER_PIN) for user interaction and feedback.
3. LCD Display: Utilizes digital pins (LCD_RS, LCD_EN, LCD_D4, LCD_D5, LCD_D6, LCD_D7) for displaying product details and total amounts.
4. DC Motors and Joystick: Motor control pins (ENA, IN1, IN2, ENB, IN3, IN4) set up to drive trolley movement based on joystick inputs (VRX_PIN and VRY_PIN).

3.3.2 Software Development

1. Arduino IDE Setup: Install necessary libraries (SPI, MFRC522, LiquidCrystal) to support RFID communication and LCD display.
2. Initialization: In the `setup()` function, initialize SPI communication, RFID reader, LCD display, motor control pins, and configure input/output pin modes.
3. Main Loop Logic: The `loop()` function continuously monitors:

- Button Press: Detects button press to toggle between displaying total amount and resetting counters (`displayBillAmount()` function).
- RFID Tag Detection: Uses the MFRC522 library to detect and read RFID tags/cards (`mfrc522.PICC_IsNewCardPresent()` and `mfrc522.PICC_ReadCardSerial()`).
- Product Identification: Compares RFID tag UID with predefined UIDs (`productUIDs[]`) to identify products and accumulate total amount (`totalAmount`).
- LCD Display: Updates LCD with product details (`displayProductDetails()` function) and total amount (`displayBillAmount()` function).
- Motor Control: Adjusts motor speeds (`controlMotors()` function) based on joystick inputs to maneuver the trolley.

3.3.3 Testing and Integration:

1. Hardware Testing: Validate individual component functionalities (RFID reader, LCD display, motors) and their integration with Arduino Mega 2560.
2. Software Testing: Verify RFID tag detection, LCD display accuracy, button functionality, and motor responsiveness to joystick inputs.
3. Integration Testing: Ensure seamless interaction between hardware components and correct operation of the entire smart trolley system.

3.3.4 Documentation and Deployment:

1. Project Documentation: Compile detailed documentation including circuit diagrams, pin configurations, Arduino sketch (`*.ino` file), and component datasheets.
2. User Manual: Provide instructions on operating the smart trolley, including RFID tag placement, button functions, and joystick control.
3. Appendices: Include appendices for code snippets, library references, and additional technical details relevant to the project.

3.3.5 Optimization and Refinement:

1. Performance Optimization: Fine-tune motor control algorithms and RFID tag detection thresholds for optimal system performance.
2. User Interface Refinement: Enhance LCD display layouts and user prompts for improved usability in retail settings.
3. Feedback Incorporation: Consider user feedback from testing phases to implement enhancements and address any identified issues.

3.4 EXPLANATION AND WORKING

The automated billing system using RFID technology and a joystick controlled movement system with an Arduino Mega 2560, has the following functions:

3.4.1 System Integration

1. Shopping Starts: Press the push button set aside to mark the beginning of a shopping session.
2. Movement: After initializing, the joystick can be used by the user to move the trolley.
3. Product Selection: Utilize RFID Reader to read the RFID Tags assigned to the different products. The deciphered UID is matched with the database to obtain the information of the respective products. Ringing of the buzzer signals the entry of the product into the shopping list.
4. Product Deletion: Scanning of the already selected product once again deletes the product from the shopping list. Ringing of the buzzer signals the deletion of the product from the shopping list.
5. Shopping Ends: Pressing the push button once again marks the end of the shopping session, thus initiating a calculation of grand total and displaying the shopping list to the user.
6. Feedback Mechanisms : Use the LCD and buzzer for real-time feedback .

3.5 ADVANTAGES

The Smart Trolley has various advantages including:

1. Efficient Shopping Experience: With RFID-enabled smart trolleys, customers can simply place tagged items into their trolley, and the RFID reader automatically registers each item. This streamlines the checkout process, reducing waiting times and enhancing the overall shopping experience.
2. Inventory Management: RFID tags attached to products enable real-time tracking of inventory levels as items are removed from shelves and placed into smart trolleys. This provides retailers with accurate and up-to-date inventory information, minimizing stockouts and overstock situations.
3. Loss Prevention: RFID technology helps prevent theft and unauthorized removal of items from stores. If a tagged item is removed from the premises without being properly scanned and paid for, the RFID system can trigger alarms or notify store personnel, deterring theft and reducing shrinkage.
4. Personalized Marketing: By collecting data on customers' shopping habits and preferences through RFID tags, retailers can offer personalized promotions and recommendations based on past purchases. This targeted marketing approach enhances customer engagement and loyalty.
5. Enhanced Accessibility: RFID-enabled smart trolleys can assist shoppers with disabilities or mobility issues by providing navigation assistance within the store. For example, the system can guide users to specific products or aisles based on their preferences or shopping lists.
6. Analytics and Insights: The data collected from RFID tags can be analyzed to gain valuable insights into customer behavior, product popularity, and store layout effectiveness. Retailers can use this information to optimize store layouts, inventory placement, and marketing strategies for improved sales and customer satisfaction.
7. Scalability and Flexibility: The Arduino Mega 2560 provides a scalable platform for building RFID-enabled smart trolleys that can be easily customized and expanded to suit different store sizes and layouts. Its ample I/O capabilities allow for integration with additional sensors, displays, or communication modules as needed.
8. Cost-Effectiveness: Arduino-based solutions offer a cost-effective alternative to proprietary RFID systems, allowing retailers to implement RFID technology without significant upfront investment. Additionally, the open-source nature of Arduino facilitates community collaboration and support, reducing development costs and accelerating time to market.

3.6 DISADVANTAGES

The design of the Smart Trolley, although with the usage of various technology can improve the User Experience, it also has some drawbacks:

1. Cost: Implementing RFID technology, along with the necessary hardware like antennas and RFID tags, can add significant costs to the production of smart trolleys. This might lead to higher retail prices, potentially deterring budget-conscious customers.
2. Complexity: Integrating RFID technology with the Arduino Mega 2560 requires a certain level of technical expertise. Setting up the RFID reader, configuring the Arduino, and managing the communication between the components can be complex and time-consuming, especially for those unfamiliar with electronics and programming.
3. Maintenance: Smart trolleys rely on a network of sensors and electronic components, which are prone to wear and tear over time. Regular maintenance and troubleshooting may be required to ensure the proper functioning of the RFID reader, tags, and associated hardware, adding to operational costs and complexity.
4. Security Concerns: RFID technology, while convenient, can raise concerns about data privacy and security. Without adequate encryption and authentication measures, there is a risk of unauthorized access to sensitive customer information stored on RFID tags, such as purchase history or personal details.
5. Interference: RFID signals can be susceptible to interference from nearby electronic devices or environmental factors like metal surfaces and electromagnetic fields. This interference can affect the reliability and accuracy of RFID readings, leading to potential errors in inventory tracking or checkout processes.
6. Limited Range: RFID readers typically have a limited range within which they can detect RFID tags. This means that items placed in the trolley may need to be positioned within close proximity to the RFID reader to ensure accurate identification, potentially causing inconvenience for users.
7. Compatibility Issues: RFID technology may not be universally compatible with all products and packaging materials. Certain items, such as metal or liquid containers, may interfere with RFID signals or prevent accurate tag detection, leading to challenges in implementing a seamless checkout experience for all customers.

CHAPTER 4

RESULT

4.1 FINAL RESULT

The Smart Trolley, an automated shopping system using RFID Technology and Joystick controlled motor system is functioning successfully and the response is displayed on the LCD Screen. This will be a major step in the evolutionary change in the traditional way of shopping.

CHAPTER 5

CONCLUSION

5.1 IMPROVING THE DAILY LIFE

Integrating the Arduino Mega 2560 with an RFID reader and tags presents an innovative solution for developing a smart trolley system that enhances functionality and efficiency. The Mega 2560's robust processing power and extensive I/O capabilities, combined with the data capture abilities of RFID technology, promise a seamless and intuitive shopping experience for consumers while offering valuable insights and management tools for retailers.

The Arduino Mega 2560 serves as the central control unit in this system, orchestrating interactions between the RFID reader, tags, and other peripheral devices. With its ample memory and processing capacity, it efficiently manages data, user interfaces, and real-time feedback, ensuring smooth and responsive operation.

Moreover, the RFID reader and tags contribute intelligence to the trolley system, enabling automatic item identification and tracking as items are added or removed. This automation streamlines checkout processes, eliminates manual scanning, and reduces the risk of inventory errors, enhancing operational efficiency and customer satisfaction.

REFERENCES

1. Garfinkel, Simon, and Beth Rosenberg. *RFID: Applications, security, and privacy*. Pearson Education India, 2006.
2. Valvano, Jonathan W. *Embedded systems: introduction to ARM® Cortex (TM)-M microcontrollers*. Jonathan W. Valvano, 2014.
3.
4. **Simson Garfinkel and Beth Rosenberg** (Garfinkel & Rosenberg, 2006), RFID Applications, Security, and Privacy Issues.

5. **Jonathan Valvano** (Valvano, 2014) Embedded Systems: Introduction to ARM Cortex-M Microcontrollers. .

6. **Banzi, M., & Shiloh, M.** (2014). *Getting Started with Arduino: The Open Source Electronics Prototyping Platform* (3rd ed.). Maker Media, Inc.

7. **Blum, J.** (2013). *Exploring Arduino: Tools and Techniques for Engineering Wizardry*. Wiley.

8. **Finkenzeller, K**. (2010). *RFID Handbook: Fundamentals and Applications in Contactless Smart Cards, Radio Frequency Identification and Near-Field Communication* (3rd ed.). Wiley.

9. **Lahiri, S**. (2005). *RFID Sourcebook*. IBM Press.

10. **Axelson, J.** (2008). *USB Complete: The Developer's Guide* (4th ed.). Lakeview Research LLC.

11. **Monk, S.** (2017). *Programming Arduino: Getting Started with Sketches* (2nd ed.). McGraw-Hill Education.

12. **Iovine, J.** (2004). *PIC Microcontroller Project Book*. McGraw-Hill.

13. **Margolis, M.** (2011). *Arduino Cookbook*. O'Reilly Media.

14. **Chiasson, J. N.** (2005). *Modeling and High-Performance Control of Electric Machines*. Wiley-IEEE Press.

15. **Feng, L., & Wang, J.** (2019). *A Smart Shopping Trolley System Using RFID and IOT*. In *Proceedings of the 2019 International Conference on Internet of Things (iThings)*. IEEE.

16. **Patel, H., & Patel, P.** (2017). *Automated Shopping Trolley for Super Market Billing System*. In *International Journal of Scientific Research in Science and Technology*, 3(2), 270-275.