A

Project Report

on

DESIGN AND FABRICATION OF ROBOTIC STORAGE AND RETRIEVAL SYSTEM FOR FOOTWEAR

submitted to

Sant Gadge Baba Amravati University,
Amravati (M.S.) 444 602

in partial fulfillment of the requirement

for the degree of

BACHELOR OF ENGINEERING
in
MECHANICAL ENGINEERING

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2022 - 2023

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Acknowledgement

It is our utmost duty and desire to express gratitude to various people who have rendered valuable guidance during our project work. We would have never succeeded in completing our task without the cooperation, encouragement and help provided to us by then. There are a number of people who deserve recognition for their unwavering support and guidance throughout this report.

We are highly indebted to our guide **Dr. N. H. Khandare** for his guidance and constant supervision as well as for providing necessary information from time to time. We would like to take this opportunity to express our sincere thanks, for his esteemed guidance and encouragement. His suggestions broaden our vision and guided us to succeed in this work.

We are sincerely thankful to **Dr. S P Trikal** (HOD, Mechanical Department, SSGMCE, Shegaon), and to **Dr. S B Somani** (Principal, SSGMCE, Shegaon) who always has been kind to extend their support and help whenever needed.

We would like to thank all teaching and non-teaching staff of the department for their cooperation and help. Our deepest thank to our parents and friends who have consistently assitted us towards successful completion of our work.

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Abstract

The efficient management of footwear inventory presents a significant challenge for places with so many crowds. Traditional manual methods of organizing and retrieving footwear can be time-consuming, error-prone, and hinder operational efficiency. This report introduces an innovative solution: the Robotic Storage and Retrieval System for Footwear Management. Leveraging advanced technologies streamlines the process of storing and retrieving footwear. In this, a prototype is designed and fabricated to arrange the footwear in crowded places. This system can be implemented in various places such as temples, hospitals, malls, and various places where a hygienic and clean environment is needed. This system uses various processors, sensors, and mechanisms such as Arduino, RFID, lead screw, and stepper motor by using this an efficient system is designed which saves human efforts and saves time and also takes less time than an individual to store and retrieve. In conclusion, the Robotic Storage and Retrieval System for Footwear Management represents a breakthrough solution in the realm of footwear inventory management. By automating the storage and retrieval process, it offers substantial advantages in terms of organization, accessibility, and overall operational efficiency. This report serves as a comprehensive resource for places such as temples, malls, and hospitals seeking to enhance their footwear management practices through the adoption of advanced automation technologies.

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List of Abbreviations and Symbols

Symbol/Abbreviation	Name
IoT	Internet of Things
RFID	Radio Frequency IDentification
ASRS	Automated Storage and Retrieval System
mm	millimeter
NEMA	National Electrical Manufacturers Association

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CHAPTER 1

INTRODUCTION

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INTRODUCTION

1.1 Overview

This introduction provides an overview of the integration of RFID technology within ASRS, highlighting its potential benefits and applications. We explore the fundamental principles of RFID technology, its components, and its working mechanism. Furthermore, we delve into the advantages of combining RFID technology with ASRS, including streamlined inventory control, improved asset tracking, reduced manual errors, and enhanced supply chain visibility.

RFID technology operates through the use of tags, which are small electronic devices capable of storing and transmitting data wirelessly. These tags consist of a microchip that stores unique identification information and an antenna for communication with RFID readers. ASRS, on the other hand, is a highly automated system that utilizes robotics and advanced machinery to handle the storage and retrieval of goods in warehouses, distribution centers, and other storage facilities.

The integration of RFID technology with ASRS allows for seamless and accurate tracking of inventory items throughout the supply chain. As goods pass through various stages, RFID tags attached to the items are detected and read by RFID readers strategically placed within the ASRS infrastructure. This enables real-time data capture, updating the inventory management system, and providing up-to-date information on the location and status of each item.

1.2 Motivation

There is a temple that we have visited, In that temple daily thousands of devotees come to the temple to take blessings from the god. So it becomes the responsibility of the organization of the temple to keep the place clean and the organization is also doing a great job they handle their crowd very efficiently and keep the place clean, As it is a temple footwears are not allowed inside the temple for that the organization has created a facility to keep their footwear outside.

As we enter the temple there is a footwear stand where we can keep our footwears safely. In each column, a person is assigned to keep the footwears in the rack and give a token of a specific shelf number to the person. As the person returns afterward the person can take their footwears back by showing the token given to them while keeping the footwears.

As the person reaches near footwear stand he/she can give footwear to the person standing there called 'sevakari' he will take the footwears and keep it in the rack and give a token of the shelf number he has kept footwears in them you can leave with the token and when the person returns afterward the person can take the footwears back by showing him the token.

This process is very time-consuming and lots of human efforts are also needed to handle the footwears of thousands of people as an alternative to that our system can help them to keep their footwears safely and in less time, this can save human effort.

Figure 1.1 Pile of footwears

1.3 Objective

- To implement IOT and communication systems.
- To save the floor space, and reduce manpower.
- Easy to store and retrieve.
- Reduce error rate.
- Increase Consistency.
- Increase safety.

CHAPTER 2

LITERATURE SURVEY

CHAPTER 2

LITERATURE SURVEY

Suyash Zagade et.al (2022) [2]In this research paper author has mentioned that robot-based handling systems are increasingly applied in distribution centers and are in high demand in e-commerce operations because of their less space requirement, higher operational flexibility, and continuous ability to work thereby continuously produce output 24/7. In this research paper, the author provides a detailed explanation of a specific type of Robot based Automated Storage and Retrieval System developed by a company named "Squid Warehouse Robots" which uses vertical and horizontal tracks all along the inventory racks, thereby allowing the bot to traverse and reach up to any specific location on the rack and therefore providing certain advantages over other alternative methodologies. The system also requires the development of a bot that is equipped with corresponding technology to fulfill the operational needs of climbing along the vertical and horizontal tracks installed on the inventory racks. The study of the Author focused on the advantages and applications of this robotic system in the Automated Storage & Retrieval System, thereby comparing it with the robot operating on the ground.

Ajay et.al(2020)[1] In this research paper author has mentioned the planning and building up a framework for the automated material handling system by diminishing the lead time in the transportation or development of the item and concentrating on the development of the Automated Storage and Retrieval System in the businesses for expanding generation rate and to improve the material handling in the warehouse. The objective of the study is to structure and manufacture an Automated Storage and Retrieval System for a mechanical stockroom and upgrade, reworking it dependent on the parameters like deals point, item prerequisite pitch, or physical parameters like tallness, width, weight, and so forth by utilizing a streamlining procedure.

Konrad Lewczuk, et.al(2020)[4] In this research paper author mentioned about Automated storage systems have become the basis of warehouse logistics. The article presents a discussion on the reliability and dependability of Automated Storage and Retrieval Systems, which are perceived as solutions with high technical reliability. Still, their role in the dependability of the entire warehouse system is to be discussed. The concepts of reliability and dependability in logistics systems like ASRS are defined. On this basis, the factors influencing the dependability of ASRS so author discussed in a way not present in the discussion on this topic so far. Then, the ASRS simulation model (based on FlexSim simulation software) is presented. The model tests the influence of ASRS configuration and assigned resources on the dependability of the warehouse as a master system. This paper includes observations on defining the reliability and dependability of ASRS.

Hanan M. Hameed et.al (2019) [5] By going through this research paper we come to know that author mentioned In industries ASRS systems are the main task designed for automated storage and retrieval of things in manufacturing where their application vary widely from simple storage and retrieval system for small parts to central systems where production, assembly, and manufacturing operations are concentrically located around them. Also selection of the storage system depends upon the available space, weight of items to be stored, method of storage operation, and other factors that take an important role in the design of the automated storage and retrieval systems. In this paper, the authors have all arguments that are needed to construct the ASRS system which will give us a highlight about the factors that consider the backbone to build the warehouses. The performance of ASRS will be the result for the interaction of many complex and stochastic subsystems.

Jainil Prajapati et.al (2017)[3] According to the author in this review paper overview of the design and working process of the automated storage and retrieval system.For reducing the space used for storing and handling different materials like small spare Parts, small inventories, fruits, vegetables, books, etc. The facilitated warehouses and the retrieving systems are used. Utilization of these types of warehouses and retrieval systems, the handling of materials can be safer and more efficient. The ASRS system is working on three-dimensional solid modeling axes. The retrieval system is provided with the required degrees of freedom which is picking and placing the materials. Programming of this system is done with the help of computer software and the system is controlled by microcontrollers and different kinds of sensors. Different kinds of warehouses vertical and horizontal are used for storing the materials on which this ASRS system works. Further different aspects and future work are explained in Author’s paper.

CHAPTER 3

AUTOMATED STORAGE AND RETRIEVAL SYSTEM

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AUTOMATED STORAGE AND RETRIEVAL SYSTEM

3.1 About ASRS

ASRS stands for Automated Storage and Retrieval System. It is a sophisticated technology used in warehouses and distribution centers to automate the storage and retrieval of goods or materials. ASRS systems are designed to efficiently manage inventory, maximize storage space, and streamline warehouse operations.

In an ASRS system, goods are stored in designated storage locations, often using high-density configurations such as racks or shelving systems. The system employs various automated material handling equipment, such as robotic cranes, shuttles, or conveyors, to transport and retrieve items from their storage locations.

3.2 key benefits

ASRS systems offer several key benefits:

- **Increased Storage Capacity:** ASRS systems utilize vertical space effectively, allowing for high-density storage and maximizing the utilization of available warehouse space. This leads to increased storage capacity and the ability to handle larger inventories.
- **Improved Inventory Management:** ASRS systems integrate with inventory management software, providing real-time visibility and control over inventory levels. This enables accurate tracking, efficient stock rotation, and better inventory accuracy, reducing errors and minimizing stockouts.
- **Enhanced Efficiency and Productivity:** By automating the storage and retrieval processes, ASRS systems eliminate the need for manual labor in repetitive and time-consuming tasks. This increases operational efficiency, reduces labor costs, and enables faster order fulfillment and quicker response times.
- **Accuracy and Precision:** ASRS systems minimize human error by automating the handling and movement of goods. The precise positioning and

retrieval mechanisms ensure accuracy and consistency in inventory management.

- **Improved Safety:** ASRS systems enhance workplace safety by reducing the need for manual labor in potentially hazardous areas. Automated equipment follows strict safety protocols and can detect and respond to potential hazards promptly.
- **Scalability and Flexibility:** ASRS systems can be designed to accommodate a wide range of products, sizes, and weights. They can be easily expanded or reconfigured to adapt to changing business needs or accommodate growth.

CHAPTER 4

RFID TECHNOLOGY

CHAPTER 4

RFID TECHNOLOGY

RFID (Radio Frequency Identification) is a technology that uses radio waves to wirelessly identify and track objects or people. It consists of three main components: RFID tags, RFID readers, and a backend system. RFID tags are small electronic devices that contain an integrated circuit and an antenna. They are attached to or embedded within objects, products, or even individuals. These tags store unique identification information that can be read by RFID readers.

RFID readers, also known as RFID interrogators, are devices that transmit radio waves and receive signals from RFID tags within their range. These readers can be stationary or handheld and are used to capture the identification information stored in the RFID tags.

The backend system of an RFID technology setup includes software and databases that manage and process the captured data. It can be integrated with other systems, such as inventory management or supply chain systems, to provide real-time visibility and analytics.

RFID technology offers several advantages over traditional barcode systems:

- **Contactless and Non-line-of-sight:** RFID tags can be read without direct contact or line-of-sight visibility. This enables fast and automated data capture, even in challenging or harsh environments.
- **Simultaneous Reading:** RFID technology allows multiple tags to be read simultaneously, making it highly efficient for inventory management or tracking applications where many items need to be identified quickly.
- **Data Storage Capacity:** RFID tags can store more data compared to traditional barcodes. This can include additional information about the tagged item, such as product details, expiration dates, or maintenance history.

- **Durability:** RFID tags are typically more robust and durable compared to barcode labels, making them suitable for use in challenging environments, such as warehouses or outdoor settings.
- **Real-time Tracking and Visibility:** RFID technology provides real-time tracking and visibility of tagged objects or individuals. This enables improved inventory management, supply chain optimization, and enhanced security and asset tracking.

4.1 RFID Applications:

- **Supply Chain and Logistics:** RFID is extensively used for tracking and managing inventory throughout the supply chain. RFID tags attached to products or packaging enable real-time visibility, efficient stock management, and improved order fulfillment. It helps to streamline processes, reduce errors, and enhance overall supply chain efficiency.

- **Retail and Inventory Management:** Many retailers utilize RFID to automate inventory management and enhance the shopping experience. RFID tags on individual products enable accurate and rapid inventory counts, reduce out-of-stock situations, and enable faster checkouts through self-checkout systems. It also aids in preventing theft and ensuring proper product authentication.

- **Access Control and Security:** RFID technology is widely used in access control systems to grant or restrict entry to authorized individuals. RFID cards or badges are used to identify and authenticate personnel, allowing them access to specific areas. It is also employed in asset tracking to monitor the movement of valuable equipment or assets within a facility.

- **Transportation and Ticketing:** RFID is used in transportation systems, such as toll collection systems, electronic fare payment systems, and automatic vehicle identification. RFID-enabled smart cards or tags are used for convenient and efficient payment and identification in public transportation systems, parking lots, and toll booths.

- **Healthcare and Pharmaceuticals:** In healthcare, RFID is used for patient identification, medication tracking, and inventory management. RFID wristbands or tags can help ensure accurate patient identification, prevent medication errors, and track medical equipment and supplies in hospitals. In the pharmaceutical industry, RFID is used for product authentication, anti-counterfeiting measures, and supply chain visibility.

CHAPTER 5

HARDWARE REQUIREMENTS

CHAPTER 5

HARDWARE REQUIREMENTS

5.1 Arduino Mega

The Arduino Mega is a microcontroller board that features the ATmega2560 microcontroller. It is specifically designed for projects that demand a larger number of I/O pins and more memory compared to standard Arduino boards. Powered by a 5V operating voltage, the board can accept an input voltage between 7V and 12V. It boasts a total of 54 digital I/O pins, with 15 of them capable of providing PWM output. Additionally, there are 16 analog input pins available. The onboard flash memory has a capacity of 256 KB, with 8 KB reserved for the bootloader. The Arduino Mega is equipped with 8 KB of SRAM and 4 KB of EEPROM. Its clock speed is set at 16 MHz.

Figure 5.1 Arduino Mega

In terms of communication, the Arduino Mega provides multiple options. It includes a USB Type B connector for programming and communication with a computer, along with four hardware UART serial ports. It also offers an SPI interface and an I2C interface for further connectivity.

Powering the Arduino Mega can be achieved through either a USB connection or an external power supply within the recommended range of 7V to 12V. The board has a maximum recommended power consumption of 250 mA. Additionally, it features a reset button for resetting the microcontroller and an ICSP (In-Circuit Serial Programming) header for programming using an external programmer. Operating within a temperature range of 0°C to 85°C, the Arduino Mega has dimensions of 101.52mm x 53.3mm.

With its extensive range of digital and analog I/O pins, the Arduino Mega is a suitable choice for complex projects that involve multiple sensors, actuators, and communication interfaces. It is compatible with the Arduino IDE and supports various libraries and shields, allowing users to expand its capabilities based on their project requirements.

5.2 NEMA 17 Stepper Motor

Figure 5.2 NEMA 17 Stepper Motor

The NEMA 17 stepper motor is a popular choice for various applications that require precise and controlled motion. It is characterized by its compact size and high torque output. Specifically, the NEMA 17 stepper motor with a torque of 4.4 kg is capable of delivering a significant amount of rotational force, making it suitable for tasks that require moving heavy loads or providing strong torque. With its standardized dimensions according to the National Electrical Manufacturers Association (NEMA) standards, this stepper motor is widely compatible and can be easily integrated into different projects and systems.

5.3 RFID Reader Module

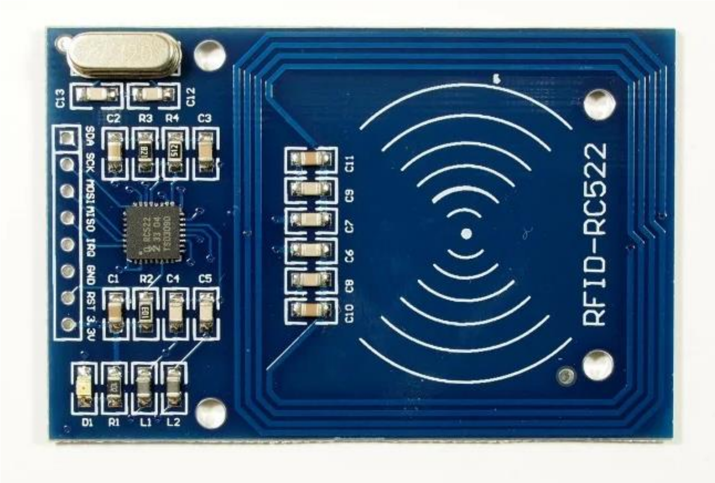

Figure 5.3 RFID Reader Module

This RC522 RFID Card Reader Module 13.56MHz is a low-cost MFRC522-based RFID Reader Module that is easy to use and can be used in a wide range of applications. The MFRC522 is a highly integrated reader/writer IC for contactless communication at 13.56 MHz. RC522 is the highly integrated RFID card reader which works on non-contact 13.56mhz communication, is designed by NXP with a low power consumption, low cost, and compact size read and write chip, is the best choice in the development of smart meters and portable hand-held devices. MF RC522 uses the advanced modulation system, fully integrated at 13.56MHz with all kinds of positive non-contact communication protocols. Support 14443A compatible answer signal. DSP deals with ISO14443A frames and error correction. Furthermore, it also supports rapid CRYPTO1 encryption to validate Mifare series products. MFRC522 supports Mifare series higher speed non-contact communication, duplex communication speed up to 424 kb/s. As a new family member in the 13.56MHz RFID family, MF RC522 has many similarities to MF RC5200 and MF RC530 and also has more new features. This module can fit directly in handheld devices for mass production. The module uses a 3.3V power supply and can communicate directly with any CPU board by connecting through SPI protocol, which ensures reliable work at, a high reading distance.

5.4 RFID Cards

Figure 5.4 RFID Cards

This is a 125KHz RFID Card used for Contactless transmission of data and supplies energy with no battery needed. Its Operating distance is Up to 100mm depending on antenna geometry. The operating frequency is 125KHz and the Data transfer speed is 106 kbit/s.

5.5 Lead Screw

Figure 5.5 Lead Screw

The 500mm Trapezoidal 4 Start Lead Screw 8mm Thread 2mm Pitch Lead Screw with Copper Nut is used for general machine tools such as 3D printing. It has good wear resistance and strength, high accuracy, is hard to rust, and has good performances due to low friction coefficients and long usage spans. This Trapezoidal Lead Screw with Copper Nut is a new type of screw that is mainly used in stepper motors, machine tool rails, and other types of equipment.

5.6 Coupling

Figure 5.6 Coupling

This flexible type motor coupling can connect your driving shaft with the driven shaft while it is very efficient in eliminating any misalignment to the possible extent. Minimum backlash is another great advantage of this Aluminium Flexible Shaft Coupling 5mm x 5mm.

5.7 Bearing

Figure 5.7 Bearing

This 8mm Inner Diameter Zinc Alloy Pillow Block Flange Bearing KFL08 is a quality flanged ball bearing end mount, widely used in CNC and 3D printing applications. Made from a zinc-aluminum alloy, it houses a 608 bearing, which supports linear shafts, lead screws, or ball screws. Secured using two grub screws, this bearing mount is a convenient option for your project or CNC machine.

The insert bearings are the deep groove ball bearings with wide inner rings. Pillow Block Flange Bearing is widely used in various types of machinery, such as machinery and equipment, conveyors, machine manufacturing, etc

5.8 Dual Channel Relay Module

Figure 5.8 Dual Channel Relay Module

This is a 2 Channel isolated 5V 10A relay module Optocoupler for Arduino PIC ARM. It can be used to control various appliances and other types of equipment with a large current. It can be controlled directly with 3.3V or 5V logic signals from a microcontroller (Arduino, 8051, AVR, PIC, DSP, ARM, ARM, MSP430, TTL logic). This relay has a 1×4 (2.54mm pitch) pin header for connecting power (5V and 0V), and for controlling the 2 relays.

5.9 Plywood

Figure 5.9 Plywood

CHAPTER 6

DESIGN

CHAPTER 6

DESIGN

Design is an important aspect. The system is designed using 3D model software i.e. Solidworks to visualize the system and ensure that it meets the required specifications. The system is designed to be modular, allowing for easy assembly and maintenance. In this system, we have used a cartesian coordinate configuration of the robotic system. The cartesian plane is a two-dimensional coordinate plane formed by the intersection of two perpendicular lines. The horizontal line is known as X-axis, and the vertical line is known as Y-axis. The Robotic storage and retrieval system for footwear is designed and fabricated using various components.

Design Objectives

The objective of the design is to create a Robotic Storage and Retrieval System for footwear that can:

- Store and retrieve footwear efficiently and accurately
- Minimize the space required for storage
- Increase the speed of the storage and retrieval process
- Minimize the chances of errors in the storage and retrieval process
- Minimize the cost of the system.

Design of components

1. Frame:- The frame is supported as a base for the structure of the system. All components are assembled on the frame. As per the required parameters we have designed a frame.
   Material = Wood
   Length of base = 750 mm
   Width of base = 500 mm
   Height of Vertical block = 600 mm

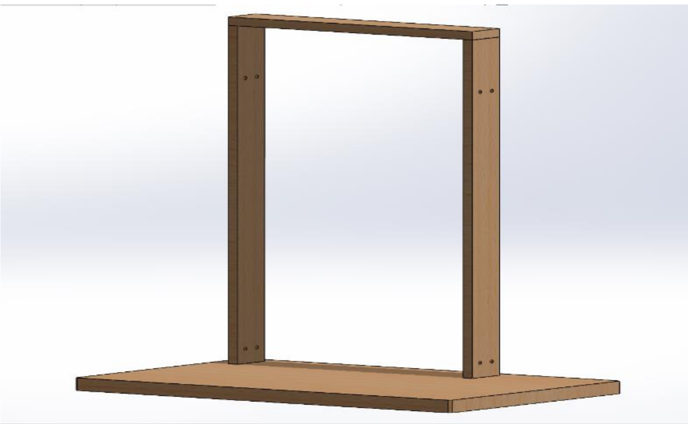

Figure 6.1 Isometric View of Frame

2. Lead Screw and Rod:- Lead screw is an important mechanism in the system. The lead screw is responsible for the horizontal and vertical movements of the X-axis and Y- axis. The rods provide support for the bed.
   Material = Stainless steel
   Length= 500
   Diameter = 8mm
   Pitch = 4 mm

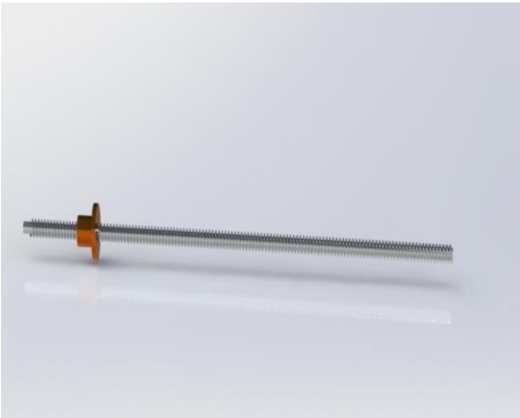

Figure 6.2 Lead Screw

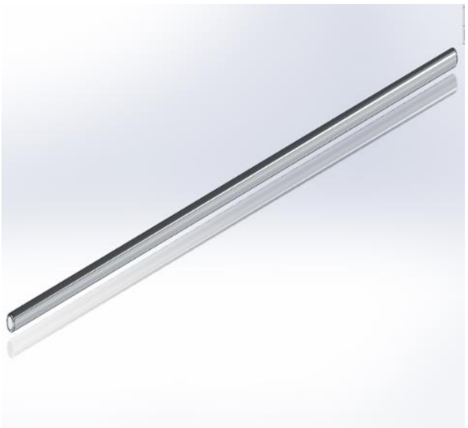

Figure 6.3 Steel Rod

3. Shelf:- Shelf is used to store footwears. Shelf are designed as per requirement. We have provided slots at specific distances. For our system, We have used 9 slots in shelves.
   Material = Wood
   Length = 400 mm
   Height = 600 mm

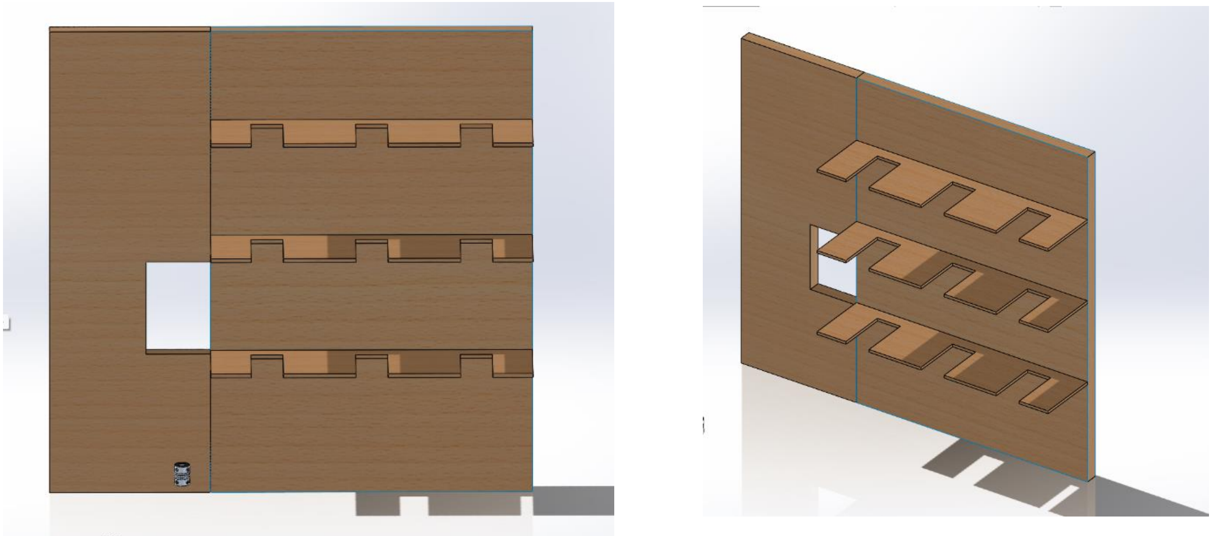

Figure 6.4 Shelf

Assembly

The Frame is a base for the system. ARSRS (Robotic Storage and Retrieval System) for footwear assembly using RFID cards is a sophisticated system that is designed to store and retrieve shoes in a highly efficient manner. The system consists of several components, including lead screws, rods, beds, couplings, stepper motors, and a horizontal and vertical motion system.

The horizontal and vertical motion systems are responsible for moving leadscrew along with boxes that store boxes in shelves. These shelves are designed to hold boxes of shoes, and a strip is used to guide the boxes into the appropriate location. The system uses RFID cards to keep track of the location of each box, making it easy to retrieve shoes when needed.

The lead screws and rods are responsible for moving the shelves in a precise and controlled manner. These components work together to ensure that the shelves are positioned accurately, allowing the shoes to be stored and retrieved efficiently.

The bed is the foundation of the system, providing support for the shelves and other components. The coupling connects the lead screws to the stepper motors, allowing the system to move the shelves in a smooth and controlled manner.

Overall, a Robotic storage and retrieval system for footwear assembly using RFID cards is a highly sophisticated system that is designed to streamline the storage and retrieval of shoes. With its precise motion control and RFID tracking capabilities, the system is capable of storing and retrieving shoes quickly and efficiently, making it an ideal solution for footwear manufacturers and distributors.

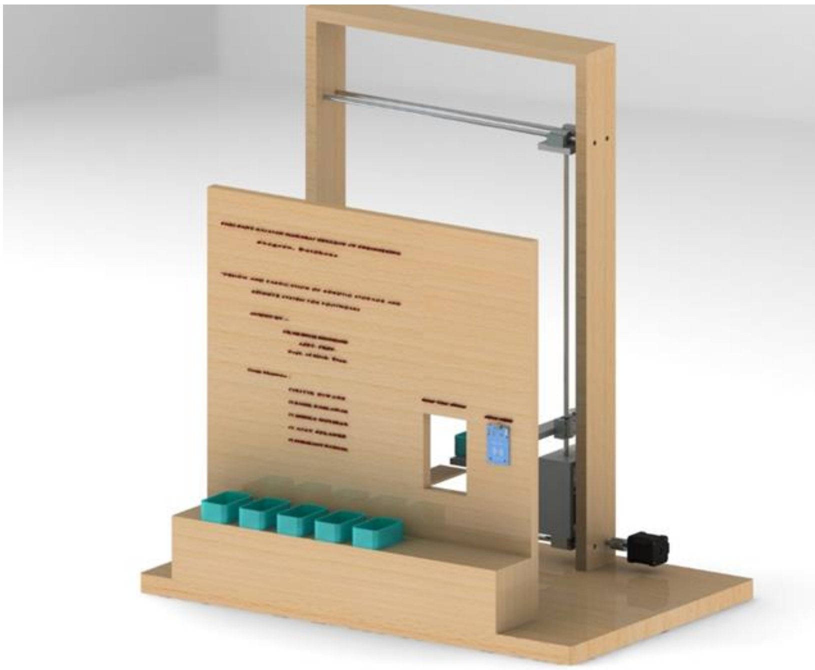

Figure 6.5 Isometric View of Model

Assembly of Model

Figure 6.6 (a) Step 1

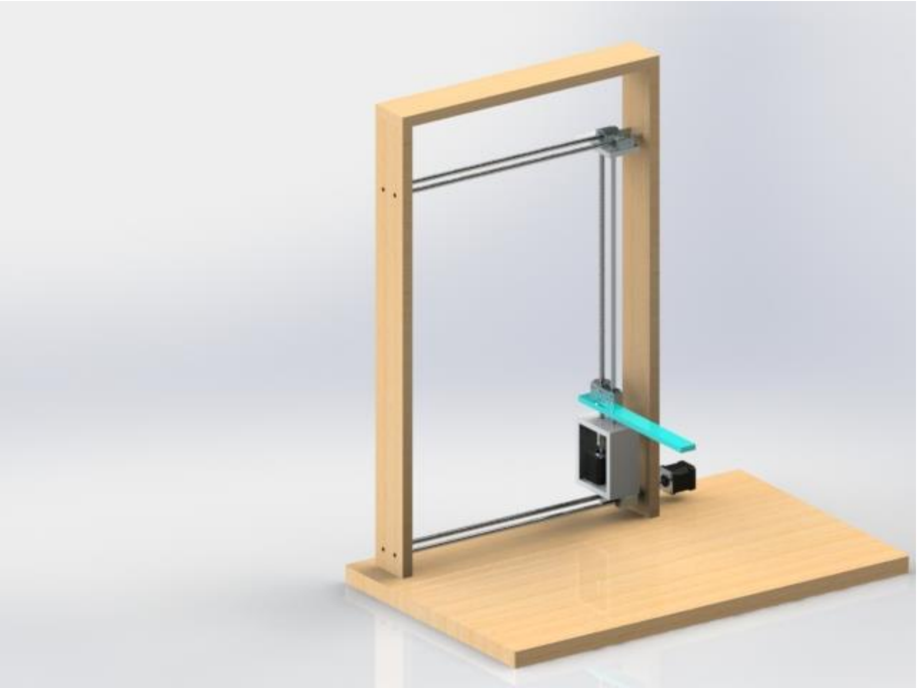

Figure 6.6 (b) Step 2

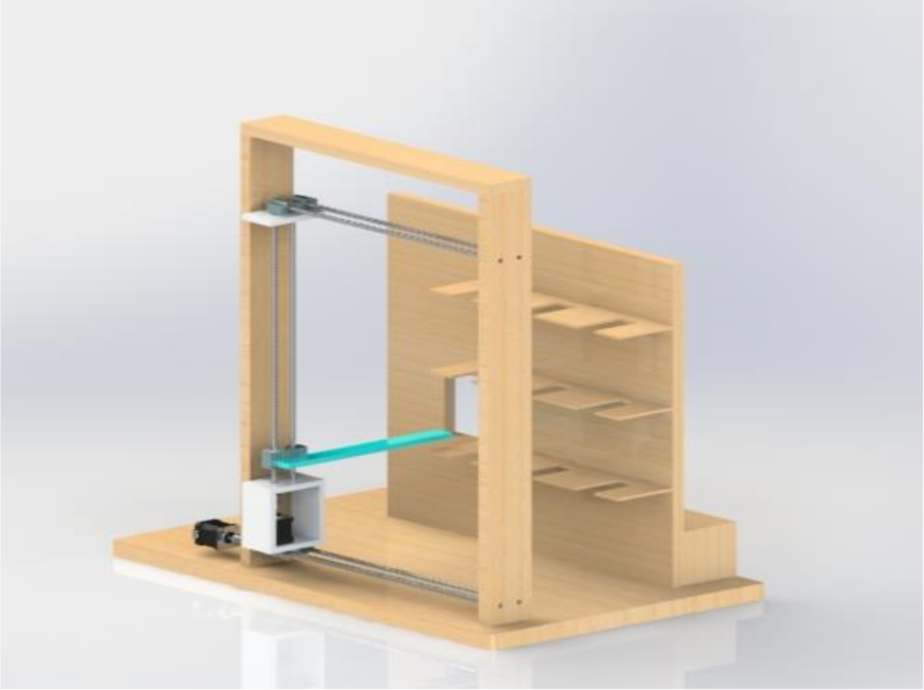

Figure 6.6 (c) Step 3

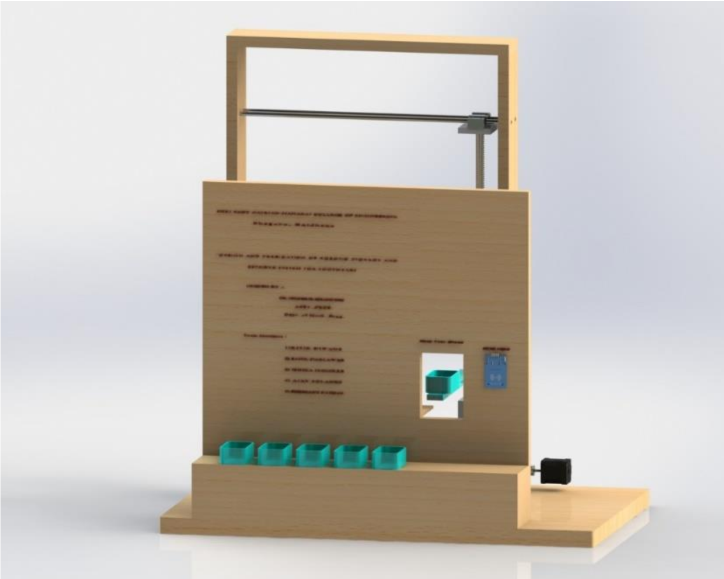

Figure 6.7 CAD model

CHAPTER 7

WORKING

CHAPTER 7

WORKING

Start: The process begins.

Keep: Keeping box containing footwears on the arm.

Figure 7.1 Storing the Box

Scan RFID: The RFID Card dispensed is scanned.

Figure 7.2 Scanning the RFID card

Validate RFID Tag: The system validates the RFID tag to ensure it is authentic and matches a valid storage location in the system.

Store: If the RFID tag is valid, the system proceeds to store the box on the specified shelf to that tag.

After Storing the box return to the starting position.

Retrieve Item: The system retrieves the item from the storage position.

Move to Storage: If the RFID Card is scanned again which was used to store it, the arm moves to that specified shelf and retrieves the box.

After taking the box from the shelf the arm returns to the starting position.

End: The process concludes.

7.1 Block Diagram

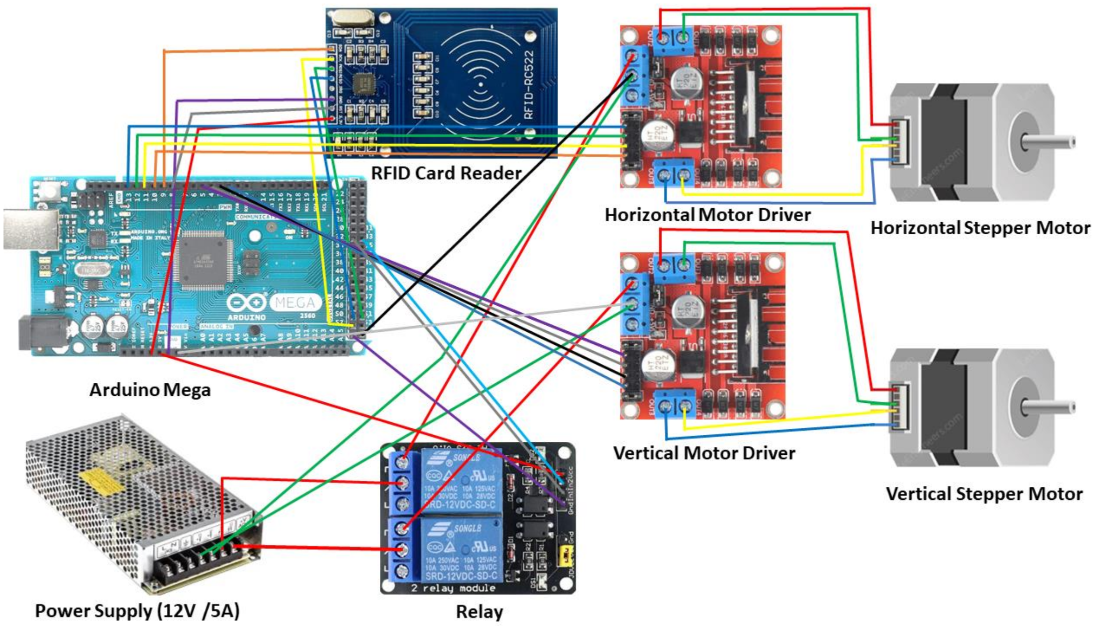

Figure 7.3 Block Diagram

7.2 Program Code

```
//Code is using Decimal Number as UID
#include <SPI.h>
#include <RFID.h>
#define SS_PIN 9
#define RST_PIN 8
#include <Stepper.h>
RFID rfid(SS_PIN, RST_PIN);
int relay1 = 32;
int relay2 = 33;
int box1=0;
int box2=0;
int box3=0;
int box4=0;
int box5=0;
int box6=0;

const int stepsPerRevolution = 200;
Stepper myStepper(stepsPerRevolution, 2,3,4,5); // Vertical Motor - up
+ dpwn
Stepper myStepper1(stepsPerRevolution, 10,11,12,13); // Horizontal
Motor  -down  + up

String rfidCard;

void setup() {
  Serial.begin(9600);
  Serial.println("Starting the RFID Reader...");
  SPI.begin();
  rfid.init();
  pinMode(8, OUTPUT);
  pinMode(relay1, OUTPUT);
  pinMode(relay2, OUTPUT);
}

void loop() {
    for(int i=1;i>0;i++){
    if (rfid.isCard()) {
    if (rfid.readCardSerial()) {
      rfidCard = String(rfid.serNum[0]) + "" + String(rfid.serNum[1]) +
"" + String(rfid.serNum[2]) + "" + String(rfid.serNum[3]);
      Serial.println(rfidCard);
      //If loop for box1
  if(rfidCard == "1505614237"){
           if(box1==0){
          //Relay ON
          digitalWrite(relay1, LOW);
```

```
digitalWrite(relay2, LOW);

//Set Speed of motor
myStepper.setSpeed(60);  //Vertical Motor
myStepper1.setSpeed(100);  // Horizontal Motor

//Moving upwards towards 1st box
myStepper.step(-stepsPerRevolution);
myStepper.step(-stepsPerRevolution);
myStepper.step(-stepsPerRevolution);
myStepper.step(-stepsPerRevolution);
myStepper.step(-stepsPerRevolution);
myStepper.step(-stepsPerRevolution);
myStepper.step(-stepsPerRevolution);
myStepper.step(-stepsPerRevolution);
delay(500);

// moving right towards 1st box
myStepper1.step(stepsPerRevolution);
myStepper1.step(stepsPerRevolution);
myStepper1.step(stepsPerRevolution);
myStepper1.step(stepsPerRevolution);
myStepper1.step(stepsPerRevolution);
myStepper1.step(stepsPerRevolution);
myStepper1.step(stepsPerRevolution);
myStepper1.step(stepsPerRevolution);
myStepper1.step(stepsPerRevolution);
myStepper1.step(stepsPerRevolution);
myStepper1.step(stepsPerRevolution);
myStepper1.step(stepsPerRevolution);
myStepper1.step(stepsPerRevolution);
myStepper1.step(100);
delay(500);

//Moving downwars towards 1st box
myStepper.step(stepsPerRevolution);
myStepper.step(stepsPerRevolution);
myStepper.step(stepsPerRevolution);
myStepper.step(stepsPerRevolution);
myStepper.step(stepsPerRevolution);
myStepper.step(stepsPerRevolution);
myStepper.step(stepsPerRevolution);
 myStepper.step(stepsPerRevolution);
delay(500);

//moving left from 1st box
myStepper1.step(-stepsPerRevolution);
myStepper1.step(-stepsPerRevolution);
```

```
        myStepper1.step(-stepsPerRevolution);
        myStepper1.step(-stepsPerRevolution);
        myStepper1.step(-stepsPerRevolution);
        myStepper1.step(-stepsPerRevolution);
        myStepper1.step(-stepsPerRevolution);
        myStepper1.step(-stepsPerRevolution);
        myStepper1.step(-stepsPerRevolution);
        myStepper1.step(-stepsPerRevolution);
        myStepper1.step(-stepsPerRevolution);
        myStepper1.step(-stepsPerRevolution);
        myStepper1.step(-stepsPerRevolution);
        myStepper1.step(-100);

        box1=box1+1;
        digitalWrite(relay1, HIGH);
        digitalWrite(relay2, HIGH);
         }

         //Returning BOX 1
         else{
        //Relay ON
        digitalWrite(relay1, LOW);
        digitalWrite(relay2, LOW);

        //Set Speed of motor
        myStepper.setSpeed(60);  //Vertical Motor
        myStepper1.setSpeed(100);  // Horizontal Motor

         // moving right towards 1st box
        myStepper1.step(stepsPerRevolution);
        myStepper1.step(stepsPerRevolution);
        myStepper1.step(stepsPerRevolution);
        myStepper1.step(stepsPerRevolution);
        myStepper1.step(stepsPerRevolution);
        myStepper1.step(stepsPerRevolution);
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        myStepper1.step(stepsPerRevolution);
        myStepper1.step(stepsPerRevolution);
        myStepper1.step(stepsPerRevolution);
        myStepper1.step(stepsPerRevolution);
        myStepper1.step(stepsPerRevolution);
        myStepper1.step(stepsPerRevolution);

        delay(500);

        //Moving upwards towards 1st box
        myStepper.step(-stepsPerRevolution);
        myStepper.step(-stepsPerRevolution);
```

```
          myStepper.step(-stepsPerRevolution);
          myStepper.step(-stepsPerRevolution);
          myStepper.step(-stepsPerRevolution);
          myStepper.step(-stepsPerRevolution);
          myStepper.step(-stepsPerRevolution);
          delay(500);

         //moving left from 1st box
          myStepper1.step(-stepsPerRevolution);
          myStepper1.step(-stepsPerRevolution);
          myStepper1.step(-stepsPerRevolution);
          myStepper1.step(-stepsPerRevolution);
          myStepper1.step(-stepsPerRevolution);
          myStepper1.step(-stepsPerRevolution);
          myStepper1.step(-stepsPerRevolution);
          myStepper1.step(-stepsPerRevolution);
          myStepper1.step(-stepsPerRevolution);
          myStepper1.step(-stepsPerRevolution);
          myStepper1.step(-stepsPerRevolution);
          myStepper1.step(-stepsPerRevolution);
          myStepper1.step(-stepsPerRevolution);


          //Moving downwars towards 1st box
          myStepper.step(stepsPerRevolution);
          myStepper.step(stepsPerRevolution);
          myStepper.step(stepsPerRevolution);
          myStepper.step(stepsPerRevolution);
          myStepper.step(stepsPerRevolution);
          myStepper.step(stepsPerRevolution);
          myStepper.step(stepsPerRevolution);
          delay(500);



         box1=box1-1;
          digitalWrite(relay1, HIGH);
          digitalWrite(relay2, HIGH);

           }
     }
```

CHAPTER 8

CONCLUSION

CHAPTER 8

CONCLUSION

In conclusion, the Robotic Storage and Retrieval System is a highly efficient and advanced technology that revolutionizes the way goods are stored and retrieved. This system offers numerous benefits, including increased storage capacity, improved inventory management, and enhanced productivity.

By automating the storage and retrieval processes, this system minimizes human error and ensures accuracy and precision in handling goods. Additionally, this system streamlines order fulfillment processes, reducing processing time and enhancing personal satisfaction. With automated material handlings equipment, such as robotic cranes or shuttles, the system enables fast and efficient retrieval of items, leading to shorter lead times and improved overall efficiency.

From this, we can conclude that RFID technology offers several benefits such as a reduction in manpower, space required for storage, accuracy, and convenience with a reduction in the handling time of footwears.

The implementation of this system can significantly improve the overall pilgrim places visiting experience for visitors, reducing waiting times and ensuring a smooth and hassle-free process.

CHAPTER 9

FUTURE SCOPE

CHAPTER 9

FUTURE SCOPE

A robotic storage and retrieval system for footwear is commonly used in pilgrim places, hospitals, and tourist spots to store footwear. The system utilizes advanced technologies such as Automated Storage and Retrieval System (ASRS) and Radio Frequency Identification (RFID) to enhance the quality, speed, and accuracy of the process. To further improve the system in the future :

- An advanced feature called face detection will be implemented. This feature will assist in locating missing RFID cards, thus helping individuals find their footwear box.
- An automatic box-coming system will be introduced to simplify the usage process.
- Furthermore, a two-sided system will be fabricated, with one side dedicated to storage and the other to retrieval. This arrangement will help control crowds and reduce congestion.

These enhancements will ensure that the system is efficient, accurate, and user-friendly, enhancing the overall experience for all users.

CHAPTER 10

ACHIEVEMENTS

CHAPTER 10

ACHIEVEMENTS

On April 8th, 2023, a remarkable event unfolded at our esteemed institution, Shri Sant Gajanan Maharaj College of Engineering Shegaon. The IEEE-sponsored project competition, known as TECHNOVATION, provided a platform for talented students from various colleges within our division to showcase their ingenuity and technical prowess. This captivating competition witnessed the participation of an impressive number of 39 groups, each vying for recognition and success.

Amidst this vibrant atmosphere, our team shone brightly, surpassing expectations and capturing the awe of both the audience and the judges. It is with immense pride and joy that we announce our team's remarkable achievement of securing the esteemed 2nd prize at the division level.

Figure 10.1 2^{nd} Prize in IEEE Project Competition

Figure 10.2 During IEEE Project Exhibition

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