# DESIGN AND CONSTRUCTION OF PRODUCT SORTING SYSTEM USING QR CODE SCANNING BY CAMERA

A thesis
by

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Department Of
Mechanical Engineering
SONARGAON UNIVERSITY (SU)

JANUARY 2024

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In partial fulfillment of the requirements for the award of the degree
of
Bachelor of Science in Mechanical Engineering

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## CERTIFICATION OF APPROVAL

The project entitled "Design and Construction of Product Sorting System Using QR code Scanning by Camera" presented by Ahasun Ullah (ID: BME1803016255), Md. Rakibul Islam (ID: BME2001020276), Md. Mehedi Hasan (ID: BME2001020005), Md. Siddiqur Rahman (ID: BME2001020113), and Md. Majharul Islam (ID: BME2001020135) for the academic session 2020-23 has been duly acknowledged as meeting the necessary criteria for the degree of Bachelor of Science in Mechanical Engineering. This recognition was conferred on December 15, 2023, signifying the successful completion of the academic requirements for the aforementioned degree.

**Countersigned**

................................

Md. Ahatashamul Haque Khan Shuvo Supervisor, Assistant Professor Department in Mechanical Engineering Sonargaon University (SU), Dhaka -1215

## DECLARATION

The undertaken project, titled " Design and Construction of Product Sorting System Using QR code Scanning by Camera" was conducted under the guidance of Md. Ahatashamul Haque Khan Shuvo, who serves as an Assistant professor in the Department of Mechanical Engineering at Sonargaon University, Dhaka. To the best of our understanding and conviction, the content of the project paper does not incorporate any previously published or authored material, except where appropriately acknowledged within the document itself. Furthermore, we affirm our commitment to indemnify the university against any potential loss or damage arising from a violation of the aforementioned obligation.

# ABSTRACT

This research project centers on the fabrication of an advanced product sorting system that leverages QR code scanning technology. The system integrates a two-axis linear actuator mechanism and a network of high-speed QR code scanners to automate the sorting process. Employing QR codes affixed to each product, containing essential information, the system employs real-time image processing algorithms for swift QR code interpretation, ensuring precise sorting. The modular design of the system is a key focus, allowing seamless integration into existing setups while ensuring scalability and adaptability for diverse industrial applications. This project aims to contribute to the academic discourse on automated sorting systems, emphasizing enhanced operational efficiency and applicability across various industries.

List of Contents

Chapter Four



Chapter Five



## List of Figure

# Chapter One

# Introduction

## 1.1 General Background of the Project:

The research initiative delves into the intricacies of constructing an advanced product sorting system, emphasizing the integration of QR code technology using cameras. Envision a dynamic industrial setting where a moveable bucket on a two-axis linear actuator carrying products is adorned with unique QR codes. These codes act as digital fingerprints, encapsulating crucial details indispensable for the accuracy of the sorting process.

Within this elaborate setup, a network of high-speed QR code scanner camera strategically lines the bucket. As products are put into the bucket, the camera swiftly captures and processes the QR codes in real-time. This initiates a complex interplay of algorithms—a sophisticated real-time image processing framework meticulously crafted for the expeditious interpretation of QR codes.

The crux of the system lies in its ability to translate these digital cues into precise sorting instructions. Each product, guided by this intricate digital choreography, navigates to its designated location with pinpoint accuracy, all orchestrated seamlessly by a centralized control system.

Integral to the system's architecture is its modular design philosophy. This isn't merely a technical detail; it's a deliberate choice enabling the system to seamlessly integrate into existing operational configurations. This adaptability not only simplifies the adoption process but also ensures that the system can scale and conform to the distinct requirements of diverse industries.

This research endeavor transcends technological innovation; it constitutes an academic exploration into the realm of automated sorting systems. Beyond the technical intricacies, the project aims to make a significant scholarly contribution, particularly in the realm of enhancing operational efficiency. Its aspirations extend to fostering cross-industry applicability, envisioning a future where this QR Code-Based Product Sorting System becomes a cornerstone in the evolution of modern logistics and manufacturing processes.

## 1.2 **Objectives**:

1. To study and design a product sorting system using QR code.

2. To construct the product sorting system using QR code.

3. To teste the performance of the product sorting system using QR code.

4. To enhance overall operational efficiency by minimizing errors associated with manual sorting and accelerating the sorting process.

## Chapter Two

## Literature Review

### 2.1 Basic Principles:

QR code-based sorting systems have become notable in logistics and supply chain management, providing benefits such as heightened efficiency, precision, and instantaneous tracking. Nevertheless, challenges encompass issues of compatibility, security, and the need for appropriate infrastructure. The potential ramifications include improved supply chain optimization, heightened traceability, and integration with emerging technologies. Further scholarly investigation and collaborative efforts are essential for the effective implementation and progression of these systems.

The modular architecture of the sorting system, integrating a linear actuator mechanism and high-speed QR code scanners, seamlessly aligns with the ethos of mechanical engineering. This modular framework not only allows for facile integration into diverse industrial setups but also showcases a commitment to adaptability and scalability, which are integral elements of established engineering methodologies.

### 2.2 QR code scanning system:

QR code is a two-dimensional code and an ISO standard which can encode information such as text, URL or other data up to 7,089 numeric characters, 4,296 alphanumeric characters and 2,953 binaries. Due to its quick response of decoding and high data capacity, QR code has been used in many applications especially in mobile applications. QR code has many advantages to be used in MAR applications. First, QR code is already widely used in e-commerce, advertisement and product tracking. Using QR code for MAR will enrich existing applications to integra te with more realistic and appealing contents. Second, QR code is self-contained which means that much.

International AR Standards Meeting-February 17-19, 2011

information would be retrieved by decoding the code itself. So, it makes sense to include as much information for MAR as possible under the QR code capacity limit. We envision that QR code can be used for MAR by including three categories of metadata. Once QR code data for MAR is standardized, people can enjoy AR applications on their mobile with the upgraded QR reader applications.

**Code Metadata**: Contains information about QR code (real).

**Content Metadata**: Contains information about content to be augmented (virtual).

**Tracking Metadata**: Contains information about tracking QR code.

## 2.3 Linear Actuator:

A linear actuator lead screw system refers to a mechanical arrangement designed to transform rotational motion into controlled linear displacement. Comprising a threaded rod (lead screw) and a corresponding nut, this system is widely utilized in applications like robotics and automation for achieving accurate and regulated linear movement. The specific thread profiles of the lead screw, such as Trapezoidal or Acme, play a role in determining the system's efficiency and precision.

A succinct analysis of scholarly literature regarding linear actuator lead screw systems elucidates nuanced insights across various critical dimensions:

### 2.3.1 Design Factors:

Academic discourse underscores the pivotal significance of a meticulous examination of lead screw design parameters. This encompasses a thorough evaluation of pitch, diameter, material composition, and nut design, all exerting substantial influence on the overall system performance.

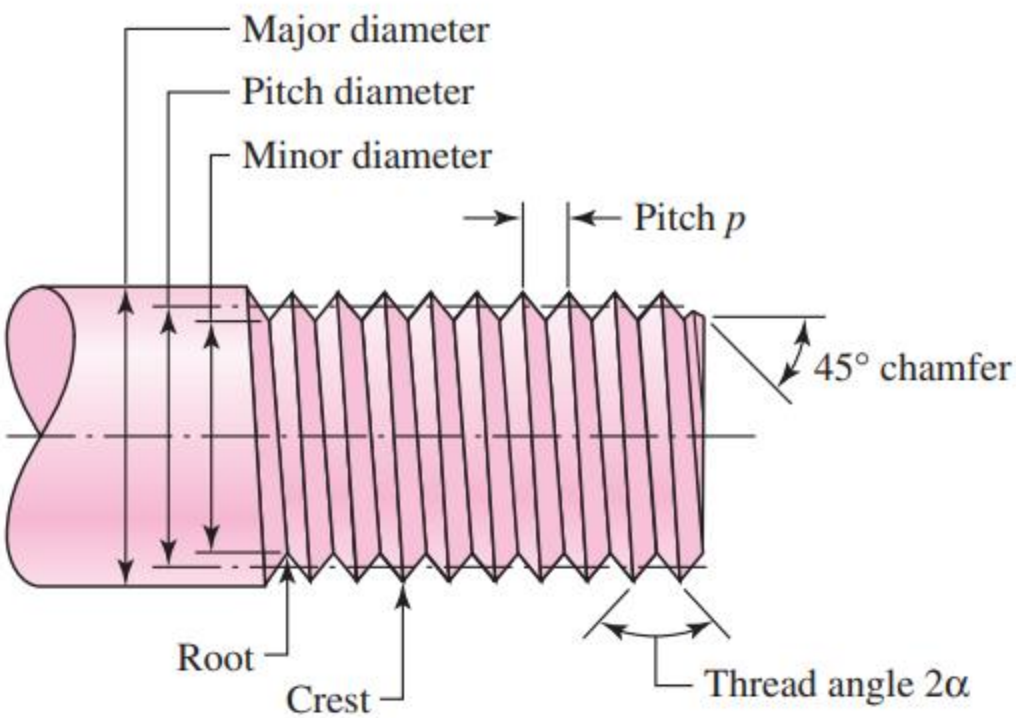


Fig 2.1 Terminology of screw threads.

**2.3.2 Material Selection and Coatings**:

Scholarly investigations delve profoundly into the intricate process of selecting materials for lead screws. Emphasis is placed on attributes such as strength and wear resistance. Concurrently, studies explore a spectrum of coatings designed to enhance the durability of lead screw systems.

Nominal body stresses in power screws can be related to thread parameters as follows. The maximum nominal shear stress τ in torsion of the screw body can be expressed as

$$\tau = \frac{16T}{\pi d_r^3}$$

**2.3.3 Efficiency and Power Consumption**:

Rigorous research navigates the nuanced trade-offs between efficiency and power consumption inherent in linear actuator lead screw systems. Comparative analyses meticulously scrutinize different screw types, such as acme screws and ball screws, shedding light on their respective efficiency profiles.

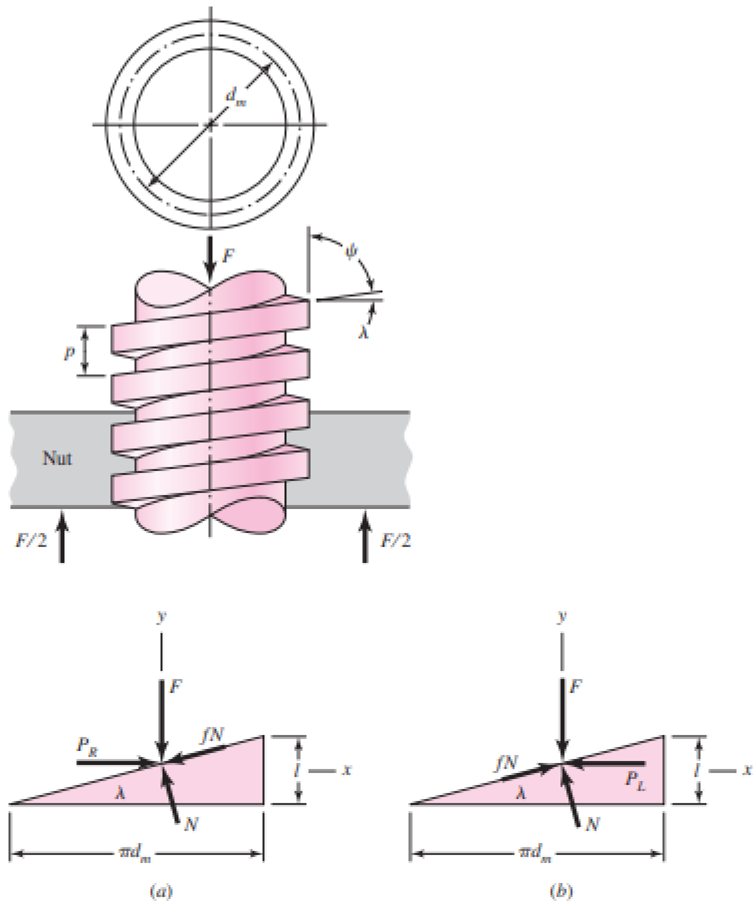


Fig 2.2 Force diagrams: (a) lifting the load; (b) lowering the load.

The load or axial force represents the resistance or the force that needs to be overcome to move an object along the linear axis. This force can be caused by the weight of the load, friction, or other resistive factors. Friction is a significant factor in lead screw systems. The diagram may include components representing static and dynamic friction forces, which can affect the efficiency and accuracy of the linear motion.

If The system is in equilibrium under the action of these forces, and hence, for raising the load, we have

$$\sum F_x = P_R - N \sin\lambda - f N \cos\lambda = 0$$

$$\sum F_y = -F - f N \sin\lambda + N \cos\lambda = 0$$

In a similar manner, for lowering the load, we have

$$\sum F_x = -P_L - N \sin\lambda + f N \cos\lambda = 0$$

$$\sum F_y = -F + f N \sin\lambda + N \cos\lambda = 0$$

For raising the load, this gives

$$P_R = \frac{F(\sin\lambda + f \cos\lambda)}{\cos\lambda - f \sin\lambda}$$

and for lowering the load,

$$P_L = \frac{F(f \cos\lambda - \sin\lambda)}{\cos\lambda + f \sin\lambda}$$

The torque required to raise the load,

$$T_R = \frac{F d_m}{2}\left(\frac{l + \pi f d_m}{\pi d_m - f l}\right)$$

The torque required to lower the load,

$$T_L = \frac{F d_m}{2}\left(\frac{\pi f d_m - l}{\pi d_m + f l}\right)$$

since thread friction has been eliminated, is the torque required only to raise the load. The efficiency is therefore

$$e = \frac{T_0}{T_R} = \frac{F l}{2\pi T_R}$$

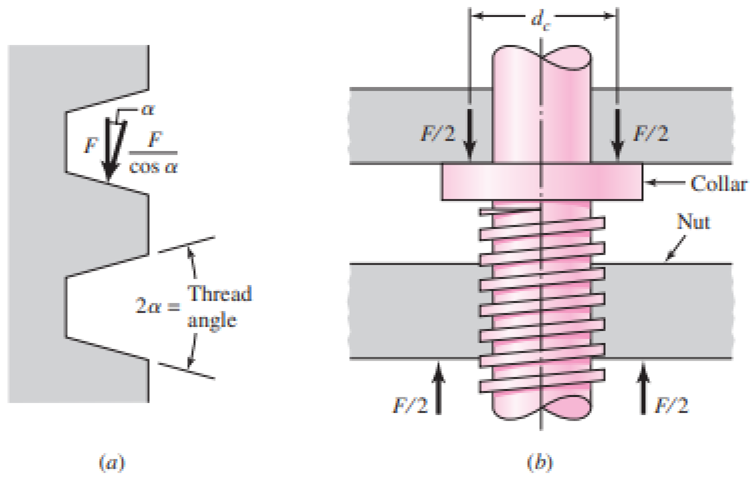


Fig 2.3 Thrust collar friction.

A closer examination of the system's operational efficiency reveals its capability to mitigate errors inherent in manual sorting processes. This reduction in errors not only refines the precision of the sorting system but also resonates with the foundational principles of mechanical engineering, emphasizing the optimization of processes to achieve maximum efficiency gains.

In summation, viewed through the lens of a mechanical engineer, the QR Code-Based Product Sorting System unfolds as a harmonious fusion of modular design, operational efficiency, and adaptability. The multifaceted evaluation, encompassing environmental robustness and QR code readability, serves to comprehensively gauge the system's efficacy within the rigorous standards of mechanical engineering.

## Chapter Three

## Methodology

### 3.1 Process of Project:

- Creating an idea for Design and construction of Product sorting system using QR code scanning system by a camera.
- And designing a block diagram & circuit diagram to know which components need to construct it.
- Collecting all components and programming for the microcontroller to control the system.
- Setting all components in a PCB board & soldering. Then assembling the all block in a board and finally running the system &checking.

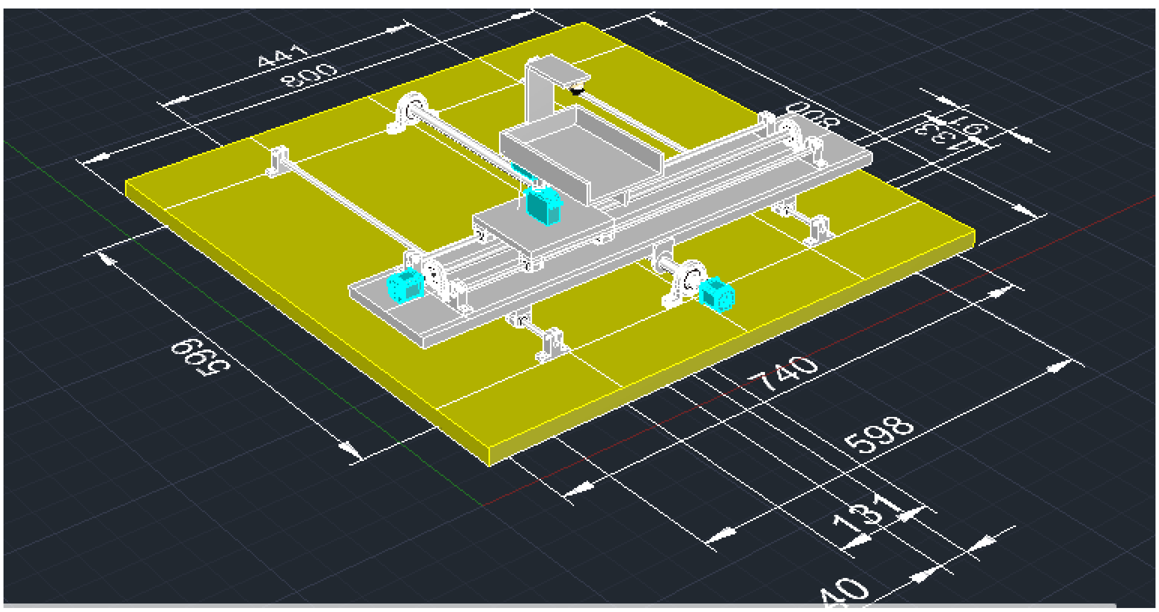


Fig 3.1 Basic Design

**3.2 Block Diagram**:

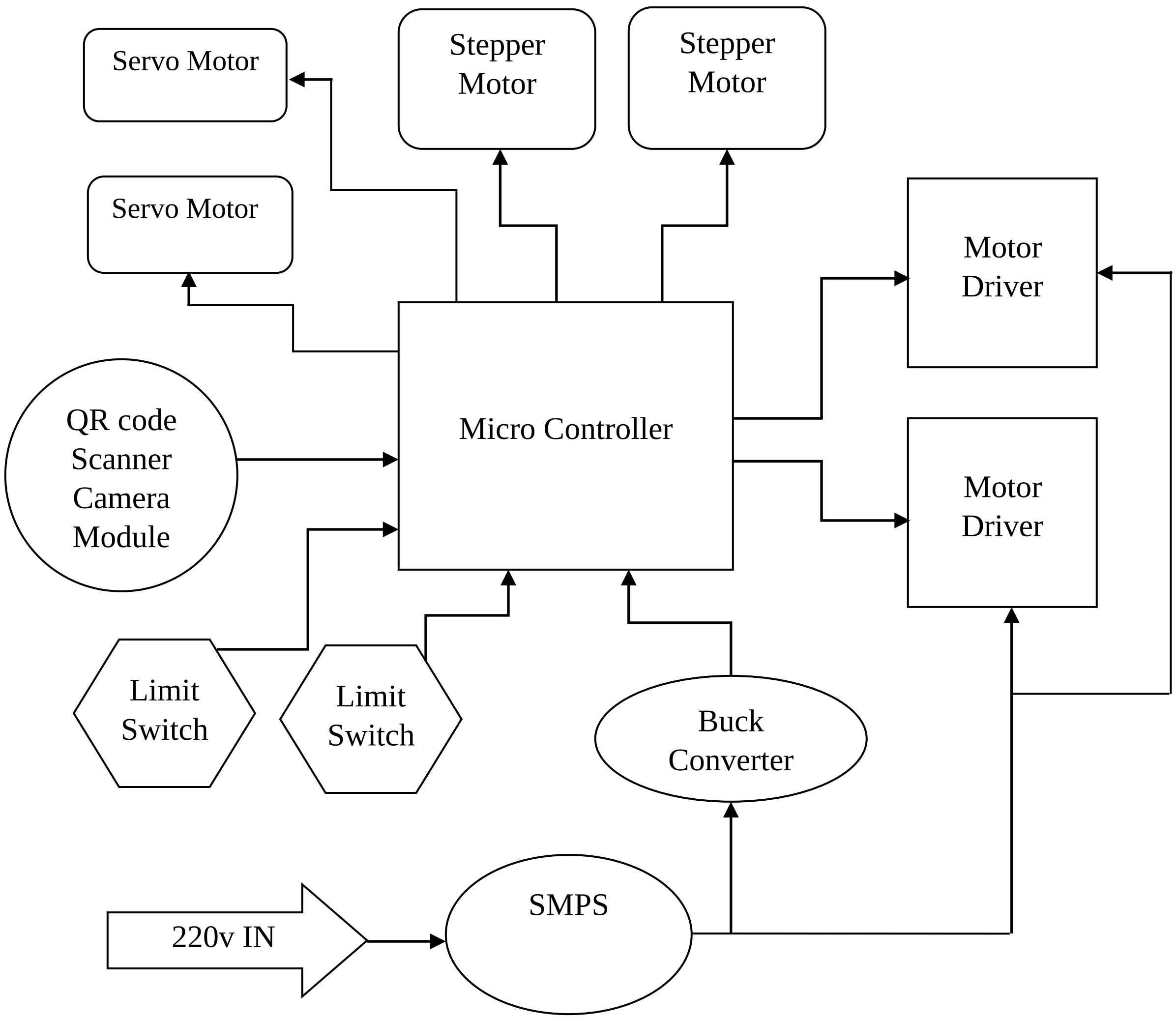


Fig 3.2 Block Diagram of product sorting system

Camera module and limit switches are the act as input and Stepper motors and servo motors act as output for the micro controller. Required voltage is supplied through SMPS and an additional voltage converter added for micro controller voltage input.

**3.3 Circuit Diagram**:

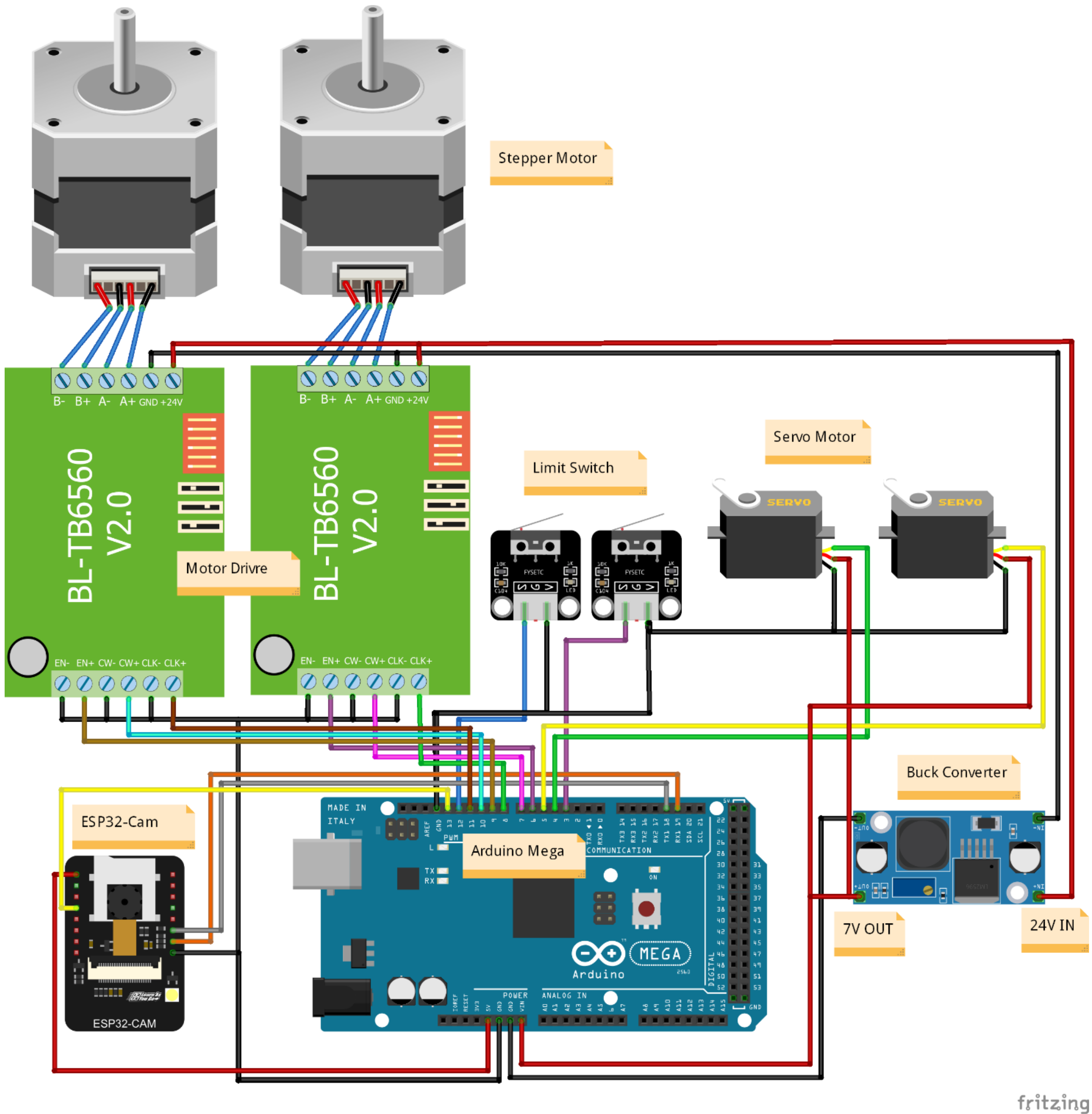


Fig 3.3 Circuit Diagram of product sorting system

Arduino mega is used as the micro controller which digital pin no 13,18,19,5v, GND used to connect with the camera module. Motor drivers are connected to digital pin no

6,7,8,9,10,11 and a common GND pin and stepper motors are connected through the motor drivers. Limit switches and servo motors are placed on 3,4,5,12 no pin where pin no 4,5 are the control signal pin for servo motors.

### 3.4 Construction Process:

In this QR code-based product sorting system we used a programable camera module to read the QR code, and that is the “ESP 32 camera module”. which scan the data adorned in QR code and send data to the micro controller “Arduino mega” using serial communication process. Then the micro controller and process the data and operate the “motors” with “motor Driver”. The motors enable the bucket and linear actuators to do designed work and that is pick and place the product.

#### 3.4.1 Steps:

The method consists of three sections. First section is to Make a system for QR code scanning and then Make a moveable bucket for pic and place the products and third is Make a guide way to transport the product to the selected box. A microcontroller will control all three sections of the proposed methodology. The QR code scanner module will be interfaced with the microcontroller to detect the product. The microcontroller will take the QR code scanner output. After russification of the inputs and applying suitable rules, the microcontroller generates appropriate control signals to Motor drivers.

#### 3.4.2 Make a system for QR code scanning:

The QR code is scanned by camera using ESP32 camera module. The scanned output is compared with the set value. The error or deviation from the set value will cause a delay in operation.

#### 3.4.3 Make a moveable bucket for pic and place the products:

A bucket made up of suitable material and it has to be able do sidewise 90-degree rotation and 45 degree downwards motion by using Servo Motors, which are controlled by the microcontroller.

### 3.4.4 Make a guide way to transport the product to the selected box:

Two set of Linear actuators will use in ‘X’ axis and ‘Y’ axis so that the system can move any direction on the plane. The bucket will be carried by the linear actuators. These actuators components are lead screw, rail shaft, linear bearing, and the lead screw are supported by two pillow block ball bearing. Required torque supplied by two stepper motors. The rotational motion of the stepper motor is converted into linear displacement by the lead screw mechanism, and it will provide required transportation of products.

## 3.5 Required component:

LIST OF COMPONENTS

1. ESP 32 Camera Module
2. 12V 30A Industrial SMPS
3. Thread Lead Screw
4. Linear Rail Shaft
5. Servo Motor
6. Stepper Motor
7. Buck converter step-down module
8. Stepper Motor Driver
9. Pillow block ball bearing
10. Motor mount steel Bracket
11. Linear Motion Ball Bearing
12. Rail Shaft Guide Support Stand
13. Flexible Shaft Coupling
14. Arduino Mega 2560 R3
15. Flange Coupling Connectors
16. Bread Bord
17. Limit Switch

### 3.5.1 ESP 32 Camera Module

The ESP32 Camera module is a versatile and widely used component that integrates a camera along with the ESP32 microcontroller, offering the ability to capture images and stream video. This module is commonly employed in various IoT (Internet of Things) projects, surveillance systems, and other applications where visual data acquisition is essential.

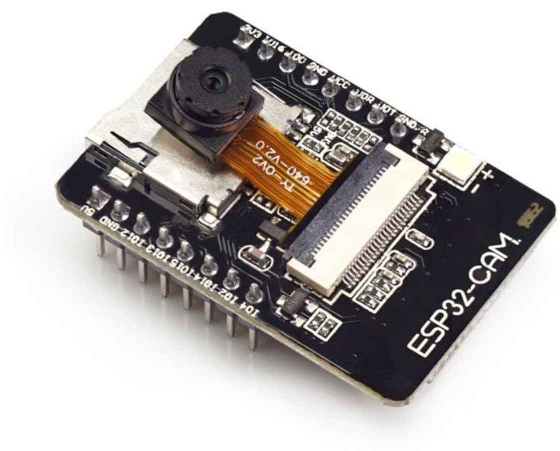


Fig 3.4 ESP32 Camera module

**Pin Diagram of ESP32 Camera Module**:

The ESP32 Camera module typically has pins arranged for easy integration and connectivity. Below is a simplified pin diagram highlighting the key pins:

**VCC** (Power): Provides the power supply for the module. Typically connected to a 3.3V source.

**GND** (Ground): Ground reference for the module, connected to the system ground.

**SDA** (Data): Serial Data line for I2C communication.

**SCL** (Clock): Serial Clock line for I2C communication.

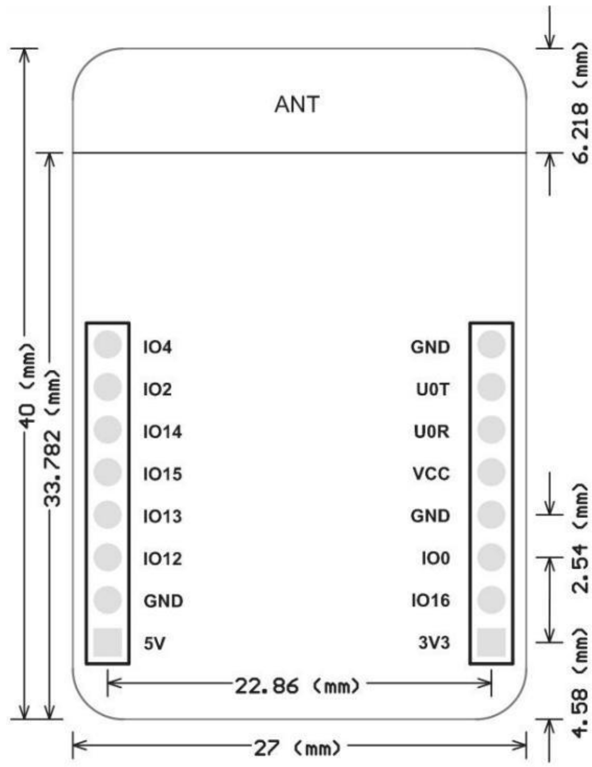


Fig 3.5 ESP32 pin diagram

**IO23 - IO34** (GPIOs): General-purpose input/output pins that can be configured for various functions. Some of these pins are often used for camera control and data lines.

**CS** (Chip Select): This pin is used to enable or disable the camera module.

**HREF** (Line Validity): Horizontal reference signal that indicates the valid data lines.

**VSYNC** (Vertical Synchronization): Synchronization signal for capturing frames.

**PCLK** (Pixel Clock): Clock signal for reading pixel data.

**D0 - D7** (Data Lines): Eight data lines for transmitting pixel information from the camera.

**RESET** (Reset Pin): Resets the camera module.

**XCLK** (External Clock): External clock input for controlling the pixel clock.

**3.3V** (Power): Additional power supply for certain components of the camera module.

**GND** (Ground): Ground reference for the camera module.

### 3.5.2 12V 30A Industrial SMPS (Switch Mode Power Supply)

A 12V 30A industrial Switch Mode Power Supply (SMPS) functions by initially converting input voltage, usually from an AC power source, into high-voltage DC through rectification. Power Factor Correction (PFC) may be incorporated to enhance efficiency. The rectified DC undergoes filtration and smoothing to establish a stable DC bus voltage, serving as an intermediate stage. Subsequently, high-frequency switching through an inverter, controlled by pulse-width modulation (PWM), facilitates efficient power conversion. The switched voltage passes through a transformer to step down the voltage to the desired 12V output.

Output rectification and additional filtering reduce any remaining ripples, and a feedback circuit monitors the regulated DC output, adjusting the switching frequency for constant 12V stability. Protective measures, such as overcurrent and overvoltage protection circuits, are often integrated to ensure the safety of the power supply and connected devices. Cooling mechanisms, such as fans or heat sinks, manage heat dissipation, given the substantial currents involved.

The final 12V DC output is accessible through output terminals suitable for industrial applications. Operation necessitates adherence to manufacturer guidelines, proper cooling measures, and strict safety precautions. Specific details related to the SMPS unit can be found in the product's datasheet or user manual, guiding users to ensure safe and efficient utilization.

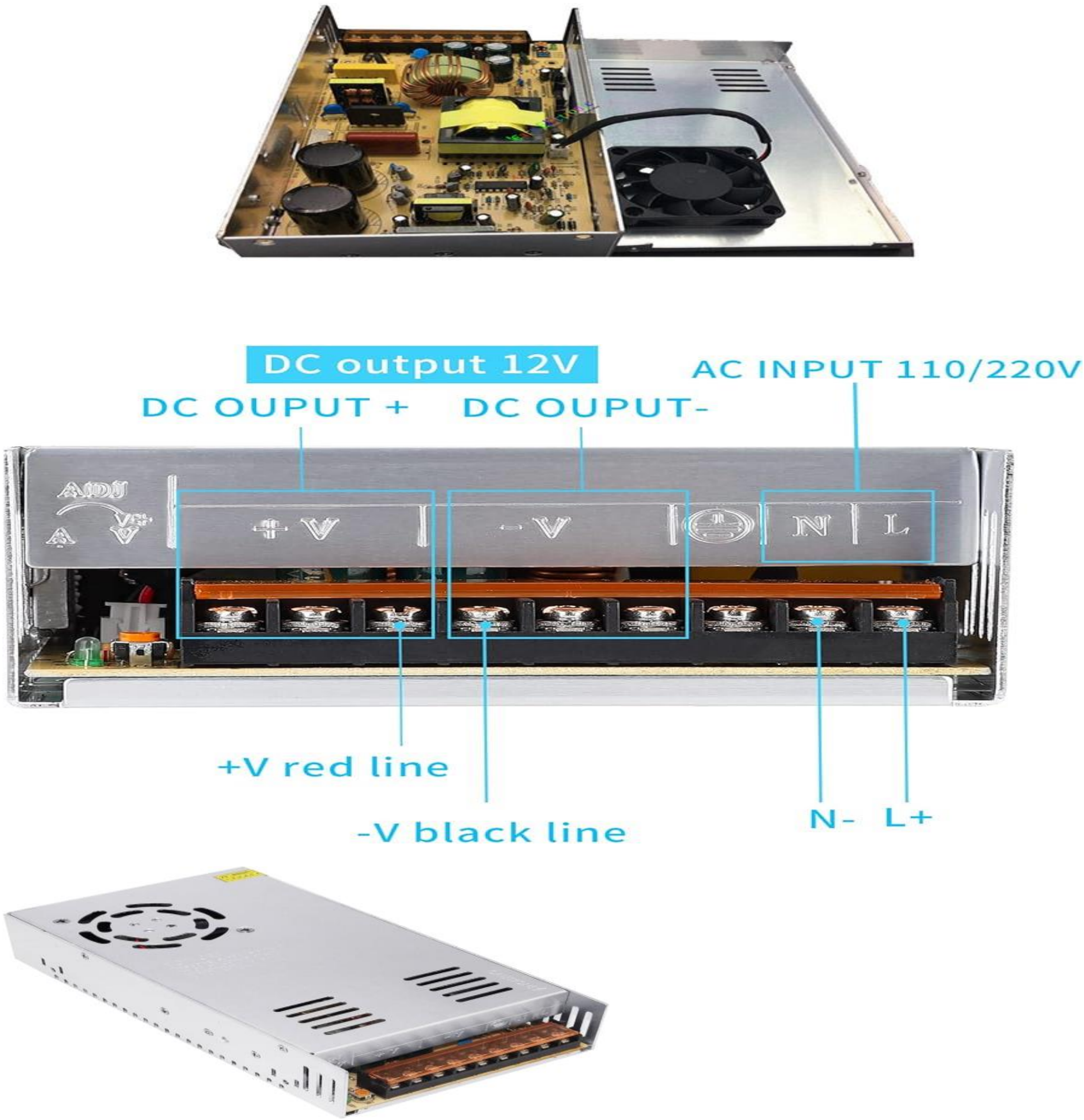


Fig 3.6 12V 30A Industrial SMPS (Switch Mode Power Supply)

### 3.5.3 Thread Lead Screw

The T8 700mm lead screw, characterized by its Trapezoidal thread profile, 700mm length, 8mm thread diameter, and 2mm lead, functions by converting rotary motion into controlled linear motion. Commonly used in precision machinery like CNC machines and 3D printers, it necessitates careful alignment, lubrication, and coupling with an actuation mechanism for optimal performance, with specific guidelines provided by the manufacturer being crucial for its successful implementation.

Fig 3.7 T8 700mm Lead Screw 8mm Thread Lead Screw 2mm.

### 3.5.4 Linear Rail Shaft

The 8mm stainless steel CNC linear rail shaft, measuring 700mm, plays a vital role in a 3D printer's functionality. Constructed from corrosion-resistant stainless steel, it provides stability for precise linear motion. The shaft guides moving printer components smoothly with bearings or linear guides. Its integration into the printer frame requires meticulous alignment for accurate translational motion. Lubrication may enhance longevity. In essence, this shaft ensures structural stability and durability, contributing to effective 3D printing.

Fig 3.8 CNC Linear Rail Shaft.

### 3.5.5 Servo Motor

The MG996mechanismtor, comprising a DC motor, gear train, control circuit, and feedback mechanism, enables precise angular control. Pulse width modulation (PWM) signals, interpreted by the control circuit, dictate the desired position within the motor's 180-degree range. Widely applied in robotics and model airplanes, the MG996R operates on a 4.8V to 6V power supply, known for its affordability and adaptability. In summary, it utilizes PWM signals and feedback mechanisms for accurate and controlled rotary motion.

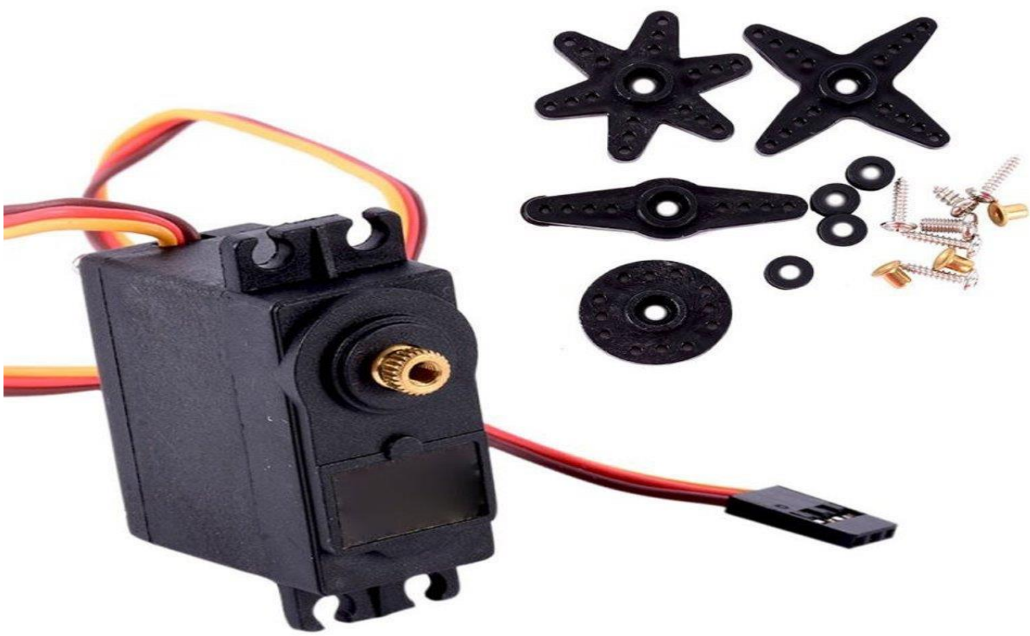

Fig 3.9 Servo Motor MG996R (180 Degree)

### 3.5.6 Stepper Motor

The NEMA 17HS8401B is a NEMA 17 stepper motor with a single shaft, 48mm in length. It operates as a hybrid stepper motor, combining features of permanent magnet and variable reluctance designs. With two phases and a 4-wire configuration, it responds to electrical pulses through a driver circuit, allowing precise control over its rotation in discrete steps. This type of stepper motor is commonly used in applications demanding accurate position or speed control, including 3D printers and CNC machines.

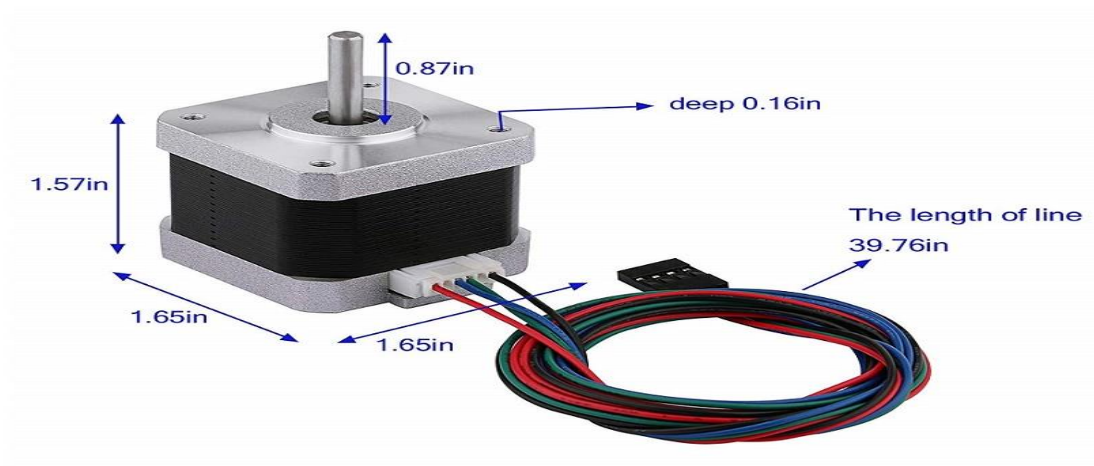


Fig 3.10 NEMA 17HS8401B Single Shaft Stepper Motor

### 3.5.7 **Buck converter step-down module**.

The LM2596 is a DC-DC buck converter that lowers input voltage. Using pulse-width modulation, it regulates output voltage by controlling a power transistor's on-off cycles. Integrated into a module, it includes components for stability. The input voltage is switched to the output through high-frequency cycles, and continuous feedback adjusts the output. Its adjustability, often through a potentiometer, makes it versatile for stable and adjustable power supplies in various electronic applications.

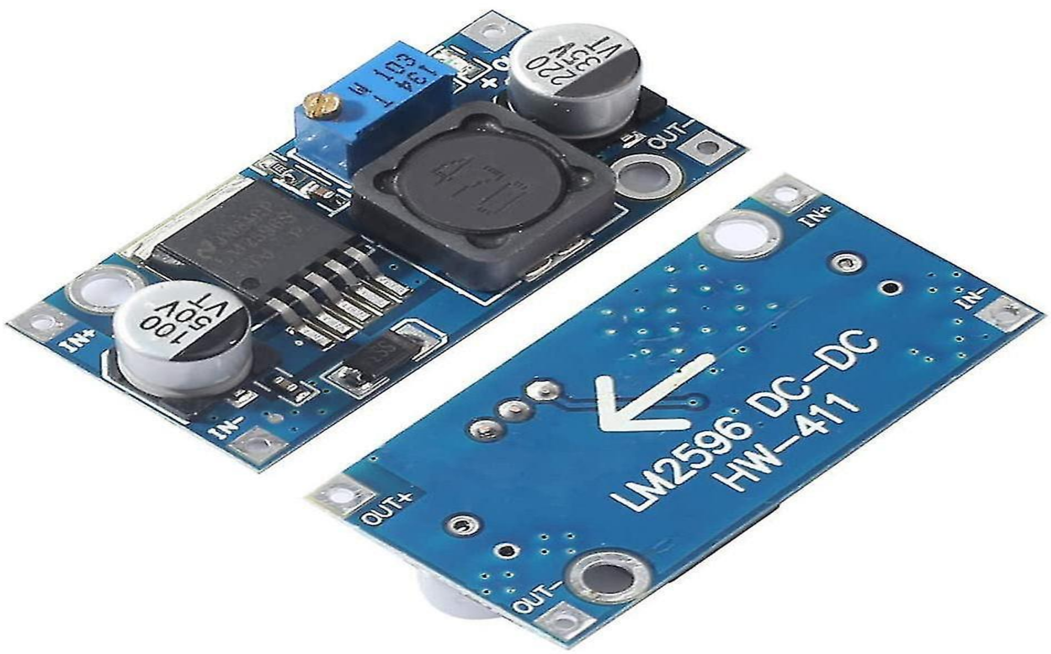


Fig 3.11 The LM2596 is a type of DC-DC buck converter step-down module.

### 3.5.8 Stepper Motor Driver

The TB6560 is a stepper motor driver that translates control signals, often pulses, into precise movements for a stepper motor. Operating with features like Pulse Width Modulation (PWM) for speed control and current regulation to prevent overheating, it facilitates smooth and controlled motion. Additionally, it may support micro stepping for finer resolution. The TB6560 is widely used in applications such as CNC machines and 3D printers where precise control of stepper motors is essential.

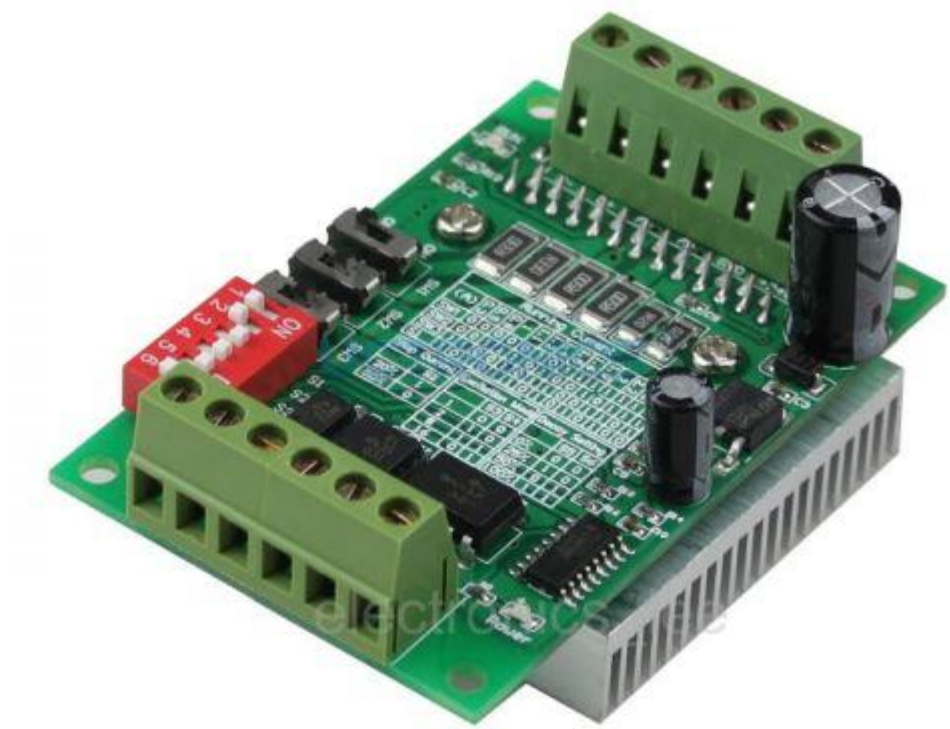

Fig 3.12 TB6560 Single Axis 3A Stepper Motor Driver

### 3.5.9 Pillow Block Ball Bearing

The KP000 10mm Bore Diameter Ball Bearing Pillow Block Mounted Support is a mechanical component designed to provide stable support for a 10mm diameter rotating shaft. The assembly includes a ball bearing housed within a pillow block, which is securely mounted on a surface or frame. This arrangement minimizes friction, ensures proper shaft alignment, and facilitates smooth rotational motion. Widely used in machinery and equipment applications, this unit enhances efficiency and longevity by maintaining stable support for rotating shafts.

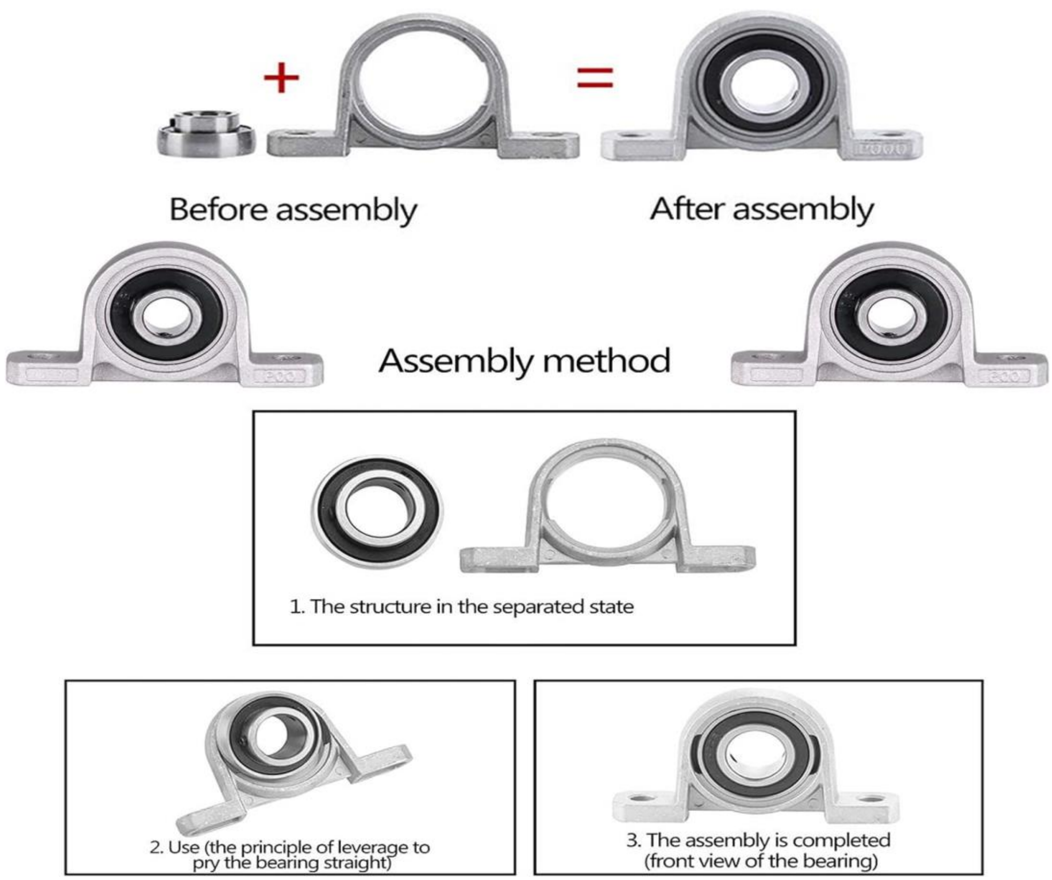


Fig 3.13 KP000 Ball Bearing Pillow Block Mounted Support.

### 3.5.10 Motor Mount Steel Bracket

The NEMA 17 motor mount steel bracket is designed for the secure attachment and fixed positioning of a NEMA 17 stepper motor within a mechanical system. Utilizing screws or similar fasteners, the bracket, constructed from steel for stability, is affixed to a designated surface or frame. Its design facilitates proper alignment, minimizing vibrations and ensuring the reliable performance of the stepper motor. Widely applied in applications such as 3D printers and CNC machines, this bracket contributes to precise motor control and positioning within diverse machinery.

Fig 3.14 Nema 17 Mounting L Bracket Mount

### 3.5.11 Linear Motion Ball Bearing

The SC8UU is an 8mm Aluminum Linear Motion Ball Bearing Slide Bushing, designed for precision linear motion in applications like CNC machines. Featuring an aluminum housing with dimensions of 58mm x 34mm x 22mm, the ball bearings inside the bushing reduce friction, enabling smooth movement along an 8mm diameter shaft. Mounted onto a fixed surface or frame, the aluminum housing provides stability. Widely utilized in CNC machines, this component supports controlled and accurate linear motion for various machine parts or work pieces.

Fig 3.15 SC8UU Linear Motion Ball Bearing Slide Bushing for CNC

### 3.5.12 Rail Shaft Guide Support Stand

The SK8 Linear Rod 8mm Rail Shaft Guide Support Stand, designed for CNC machines and 3D printers, functions by offering stable support and guidance to an 8mm diameter linear rod. Attached to a fixed structure with screws or bolts, it maintains proper alignment of the rod, preventing bending and ensuring precise linear motion. Widely applied in CNC machines and 3D printers, this support stand facilitates the controlled movement of various components, enhancing overall operational accuracy and stability.

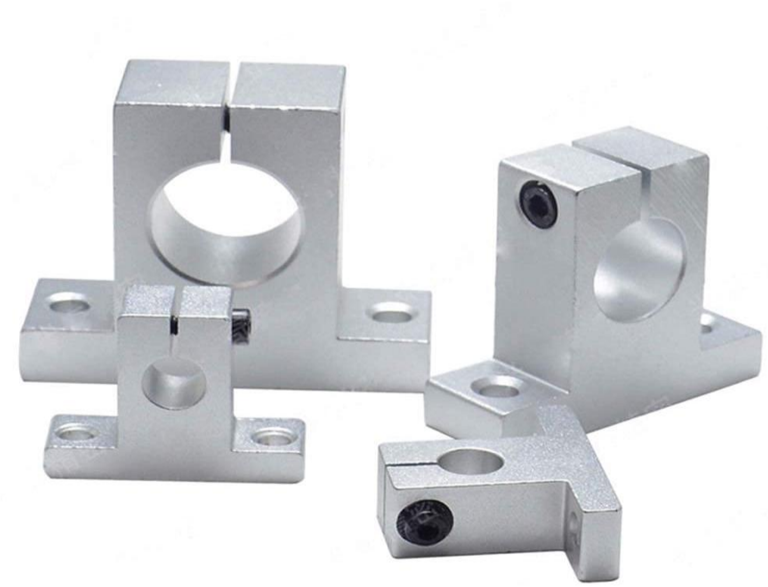

Fig 3.16 SK8 Linear Rod 8mm Rail Shaft Guide Support Stand

### 3.5.13 Flexible Shaft Coupling

The 5mm x 8mm Aluminum Flexible Shaft Coupling (OD19mm x L25mm) functions as a torque-transmitting component in CNC machinery. Designed to connect shafts with 5mm and 8mm diameters, its aluminum construction provides a balance of lightness and corrosion resistance. The coupling allows for slight flexibility to address misalignment and dampen vibrations during operation. Connection to shafts is achieved through set screws or clamps, ensuring secure attachment. Widely applied in CNC systems, this coupling facilitates precise rotational force transmission, contributing to controlled and accurate movement in machinery.


Fig 3.17 Aluminum Flexible Shaft Coupling

### 3.5.14 Arduino Mega 2560 R3

The Arduino Mega 2560 R3 is a microcontroller board featuring the ATmega2560 microcontroller. It functions by allowing users to develop programs using the Arduino IDE, written in a C/C++-like language. Equipped with a substantial number of digital and analog I/O pins, it enables interaction with various electronic components. The board supports USB programming and communication, with the capability to be powered externally or through USB. Additionally, it incorporates multiple UART ports for serial communication and offers extensive memory (256 KB Flash, 8 KB SRAM, 4 KB EEPROM) for program storage and data retention. The Arduino Mega 2560 R3 serves as an open-source platform, encouraging community-driven modifications and improvements.

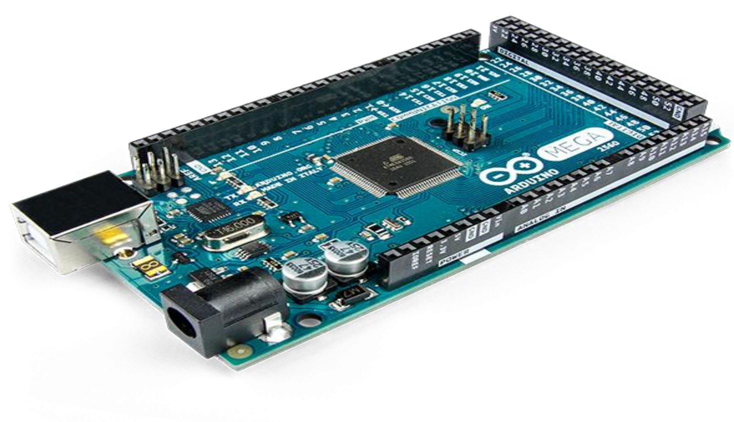

Fig 3.18(a): Arduino Mega 2560 R3 - Made in Italy

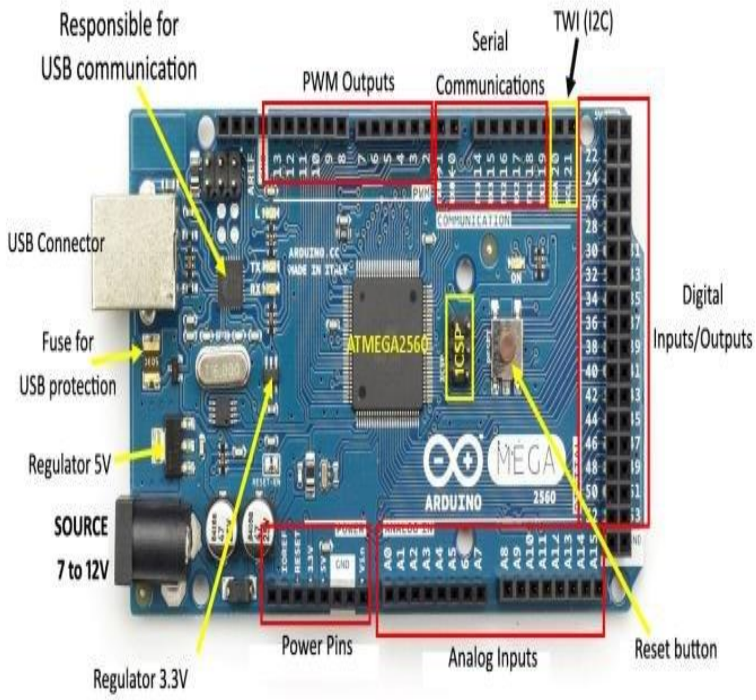


Fig 3.18(b): Block Diagram of Arduino Mega 2560 R3

### 3.5.15 Flange Coupling Connectors

The Flange Coupling Connectors, available in a 4-pack and designed for DIY RC model motors with 6mm shafts, function by securely connecting two shafts. Their flange design and robust construction ensure stable coupling, facilitating the efficient transmission of torque between the shafts. These connectors are instrumental in achieving precision and reliability in the mechanical systems of RC models, commonly used in applications like RC cars, drones, boats, or airplanes.


Fig 3.19 Flange Coupling Connectors

### 3.5.16 Bread Board

The breadboard serves as a transient substrate for the experimentation and evaluation of electronic circuits without the need for soldering. Characterized by an arrangement of interlinked metal clips, rows, and columns, it accommodates the facile insertion of components. Electrical power is facilitated through designated power rails, while jumper wires establish connections between various points. This tool offers engineers a nimble means of prototyping and refining circuit designs expeditiously before committing to a permanent integration on printed circuit boards.

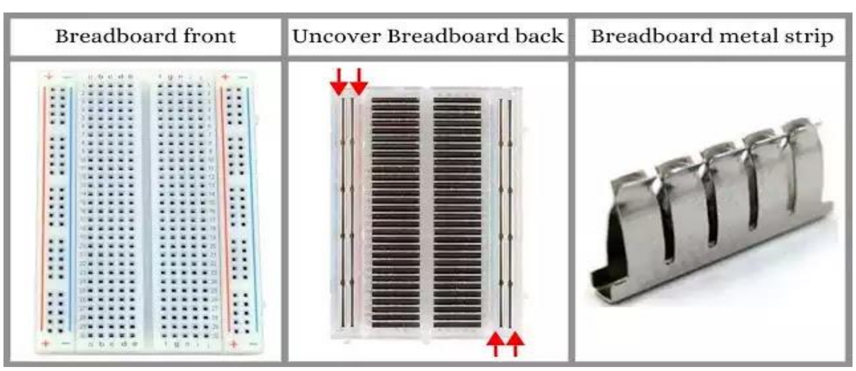


Fig 3.20 Bread Board

### 3.5.17 Limit Switch:

A limit switch is a crucial component in various mechanical and industrial systems, serving as a sensing device that detects the presence or absence of an object and triggers a response when a specific limit or position is reached. These switches are employed in a wide range of applications, providing a simple yet effective means of controlling and monitoring the position of machine components. Here are some key aspects of limit switches:

Functionality:

Position Sensing: Limit switches are primarily used for position sensing in machinery. They help determine the presence or absence of an object and can define specific positions within a mechanical system.

End-of-Travel Detection: In many applications, limit switches are placed at the end of a mechanical travel path to detect when a moving component has reached its intended position.

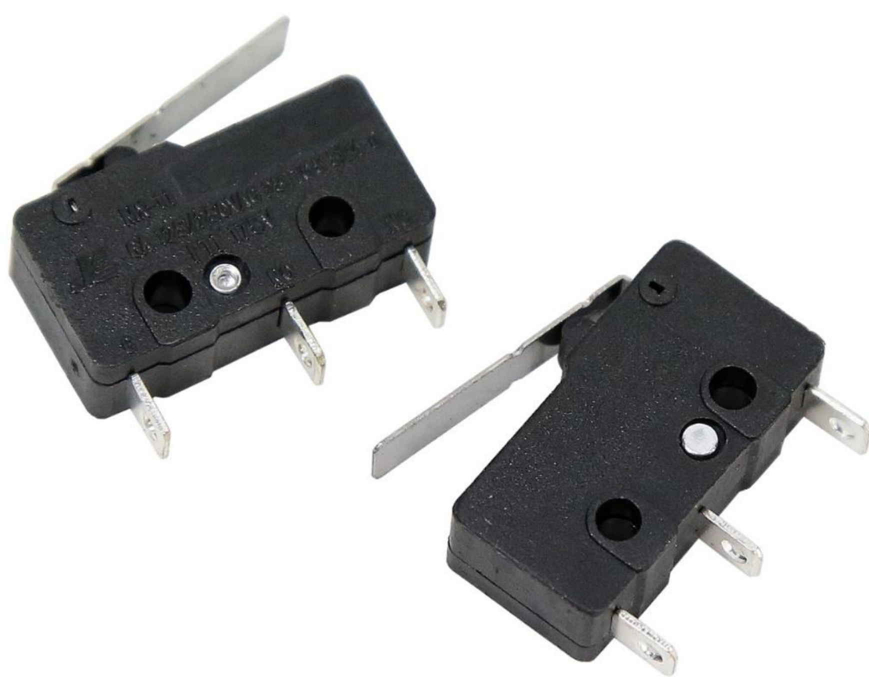

Fig 3.2 Limit switch

## Chapter Four

## Result and Discussion

### 4.1 Result:

Finally, we were able to create our project successfully. After making the Mechanical body, we designed a circuit to control it and when we operated it by an adorned with unique QR code, it can correctly place the product in the desired bucket; we called it working pretty well. It is very well controlled and is able to repeat the process quickly. Below is a picture of our successfully completed entire project.

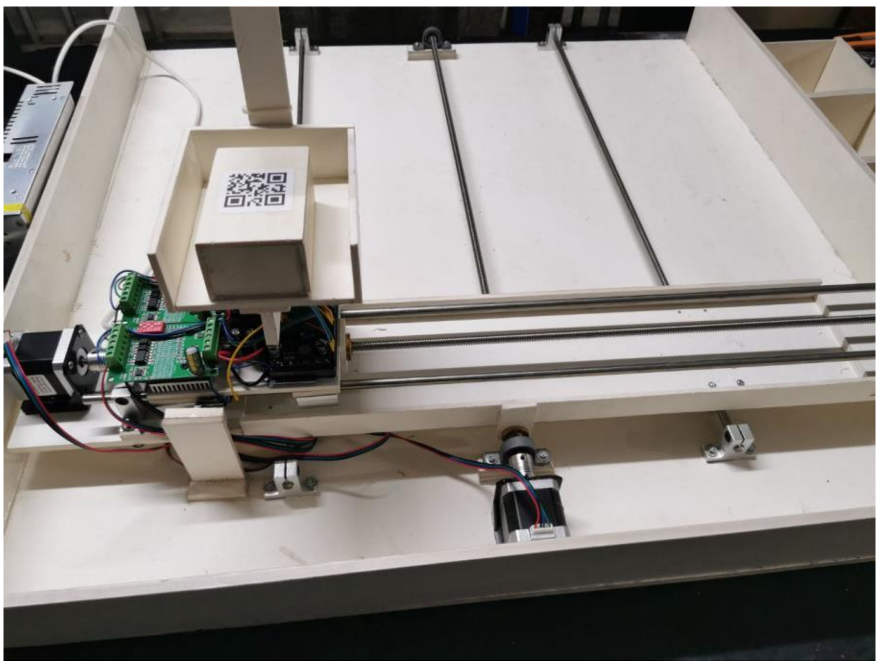

Fig 4.1 Entire Project (a)

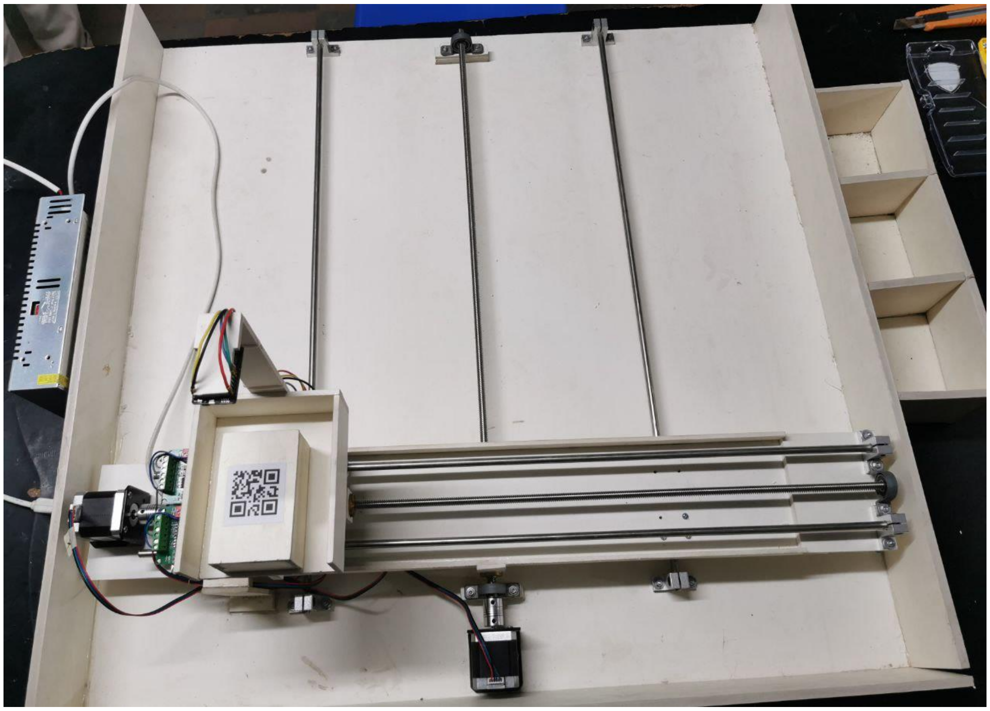

Fig 4.1 Entire Project (b)

**4.2 Data table**:

**Table-1**

Box no 1 time chart using different weights

| Product Weight, kg | Pic and Place Time, sec | Bucket Homing Time, sec |
|---|---|---|
| .025 kg | 24 | 28 |
| 1 kg | 24 | 28 |
| 2 kg | 24 | 28 |
| 3.5 kg | 24.1 | 28 |
| 6 kg | Failure | 00 |

**Table -2**

Box no 2 time chart using different weights

| Product Weight, kg | Pic and Place Time, sec | Bucket Homing Time, sec |
|---|---|---|
| .025 kg | 26 | 30 |
| 1 kg | 26 | 30 |
| 2 kg | 26 | 30 |
| 3.5 kg | 26.3 | 30 |
| 6 kg | Failure | 00 |

**Table-3**

Box no 3 time chart using different weights

| Product Weight, kg | Pic and Place Time, sec | Bucket Homing Time, sec |
|---|---|---|
| .025 kg | 28 | 32 |
| 1 kg | 28 | 32 |
| 2 kg | 28 | 32 |
| 3.5 kg | 28.1 | 32 |
| 6 kg | Failure | 00 |

**4.3 Discussion**:

From the above displayed figures, we can observe that the linear actuator system can work precisely in exact time. The QR code scanning & control portion is also experimentally verified using prototype model of products. It can carry up to 3kg within designed criteria and the safe working load is 3kg. After 3kg ok load it starts taking more time in operation. The maximum load that it can carry is 5.5 kg and at a 6kg load it stopped working. The project factor of safety is reliable.

**4.4 Advantages**:

There are many advantages of our system because of its accuracy. Some of the advantages are pointed out below:

- Proficient in QR code scanning procedures.
- Demonstrates high precision in object detection.
- A time-efficient industrial machine.
- Automates product sorting seamlessly.
- Remarkably effective in product identification.
- Minimizes energy consumption.
- Operates without the need for oil.
- Requires minimal technical expertise.
- Simplified installation process.
- Maximizes profit with minimal time investment.
- Boasts straightforward construction.
- User-friendly operation.

**4.5 Limitation**:

It is a demo project, so we found some limitations. In future we will work to reduce this kind of limitation. These limitations are –

- Our project may delay in work for small range instruments.
- The product will be placed manually.

**4.6 Applications**:

1. **Library Systems**: Simplify book borrowing and tracking with QR codes on library items.

2. **Tourism and Travel**: Provide quick luggage sorting and information to tourists using QR codes.

3. **Supply Chain Optimization**: Streamline logistics by enabling traceability from manufacturing to distribution.

4. **Retail POS**(Point of sale): Expedite checkout processes by quickly scanning products with QR codes.

5. **Quality Control**: Enhance quality control measures by storing detailed product information.

6. **Automated Sorting**: Enable machines to identify and sort products in manufacturing and distribution.

7. **Anti-Counterfeiting**: Use QR codes to authenticate products and combat counterfeiting.

8. **Healthcare**: Facilitate medication tracking, inventory management, and patient information accuracy.

9. **Marketing Campaigns**: Engage customers with QR codes linking to promotions, videos, or websites.

10. **Document Management**: Streamline document retrieval and organization with QR codes.

11. **Personal Identification**: Use QR codes on ID cards for quick and secure identification.

12. **Utilities Maintenance**: Track and manage maintenance tasks for equipment using QR codes.

13. **Inventory Tracking**: Efficiently manage and track product stock levels in real-time.

# Chapter Five

# Conclusion

## 5.1 Conclusion:

We successfully designed a QR code scanning system, here we used a programmable camera to scan QR code. And we designed a movable bucket for picking and placing the product and used linear actuators to transport the bucket. After completion of the design process, we successfully constructed it. In summary, the QR Code-Based Product Sorting System stands as a noteworthy progression in logistics and supply chain management. Its integration of QR codes introduces unprecedented efficiency, precision, and real-time tracking capabilities, addressing enduring issues associated with conventional sorting methodologies.

## 5.2 Future Scope of Work:

The model can be improved by making some changes in the program and components. Some suggestions are given below-

• We can add a monitoring-based control to automated control.

• We will add a product counting system.

• We will increase its working accuracy level.

• Integration with IoT and Industry 4.0

Explore seamless integration with IoT technologies to enhance real-time data exchange. Consider collaboration with Industry 4.0 concepts for a more interconnected supply chain ecosystem.

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## Appendix

```
// Include the AccelStepper library:

#include <AccelStepper.h>

#include <Servo.h>

#define limitPinX 3

#define limitPinY 12

#define servoPinX 4

#define servoPinY 5

#define enablePinX 6

#define dirPinX 7

#define stepPinX 8

#define enablePinY 9

#define dirPinY 10

#define stepPinY 11

#define CameraPin 13

#define motorInterfaceType 1

int pos = 0;

long initial_homing=1;

long X_homing=1;

long Y_homing=1;

int Object = 0;

AccelStepper stepperX = AccelStepper(motorInterfaceType, stepPinX, dirPinX);

AccelStepper stepperY = AccelStepper(motorInterfaceType, stepPinY, dirPinY);
```

```
Servo servoX;
Servo servoY;
void setup() {
  Serial.begin(115200);
  Serial1.begin(115200);
  stepperX.setMaxSpeed(1000);
  stepperX.setAcceleration(1000);
  stepperY.setMaxSpeed(1000);
  stepperY.setAcceleration(1000);
  servoX.attach(servoPinX);
  servoY.attach(servoPinY);
  pinMode(limitPinX, INPUT_PULLUP);
  pinMode(limitPinY, INPUT_PULLUP);
  pinMode(CameraPin, OUTPUT);
  servoX.write(0);
  servoY.write(5);
  while (digitalRead(limitPinX)) {
    stepperX.moveTo(initial_homing);
    initial_homing++;
    stepperX.run();
    Serial.println("backward_x");
  }
  stepperX.setCurrentPosition(0);
```

```
stepperX.setMaxSpeed(100);
stepperX.setAcceleration(100);
initial_homing=-1;
while (!digitalRead(limitPinX)) {
  stepperX.moveTo(initial_homing);
  stepperX.run();
  initial_homing--;
  delay(5);
  Serial.println("forward_x");
}
initial_homing=1;
while (digitalRead(limitPinY)) {
    stepperY.moveTo(initial_homing);
    initial_homing++;
    stepperY.run();
    Serial.println("backward_y");
}
stepperY.setCurrentPosition(0);
stepperY.setMaxSpeed(100);
stepperY.setAcceleration(100);
initial_homing=-1;
while (!digitalRead(limitPinY)) {
  stepperY.moveTo(initial_homing);
```

```
    stepperY.run();
    initial_homing--;
    delay(5);
    Serial.println("forward_y");
  }
}
void loop() {
  digitalWrite(CameraPin,HIGH);
  while (Serial1.available()>0)  {
    digitalWrite(CameraPin,LOW);
    Object = Serial1.parseInt();
    if(Object == 1001){
      servoX_ACW();
      forward_x();
      forward_y(-5000);
      servoY_ACW();
      delay(2000);
      servoY_CW();
      backward_x();
      backward_y();
      servoX_CW();
    }
    else if(Object == 1002){
```

```
  servoX_ACW();
  forward_x();
  forward_y(-11500);
  servoY_ACW();
  delay(2000);
  servoY_CW();
  backward_x();
  backward_y();
  servoX_CW();
}
else if(Object == 1003){
  servoX_ACW();
  forward_x();
  forward_y(-18000);
  servoY_ACW();
  delay(2000);
  servoY_CW();
  backward_x();
  backward_y();
  servoX_CW();
}
else{
  Serial.println(Object);
```

```
    }
  }


}
void home()


}
void forward_x(){
  stepperX.setMaxSpeed(4000);
  stepperX.setAcceleration(1000);
  Serial.println("forward_x");
  // Set the target position:
  stepperX.moveTo(-23500);
  :
  stepperX.runToPosition();
}
void forward_y(int positionY){
  stepperY.setMaxSpeed(2000);
  stepperY.setAcceleration(1000);
  // Set the target position:
  stepperY.moveTo(positionY);


  stepperY.runToPosition();
```

```
}
void backward_x(){
  X_homing=1;
  while (digitalRead(limitPinX)) {
      stepperX.moveTo(X_homing);
      X_homing++;
      stepperX.run();
      Serial.println("backward_x");
  }
  stepperX.setCurrentPosition(0);
  stepperX.setMaxSpeed(100);
  stepperX.setAcceleration(100);
  X_homing=-1;
  while (!digitalRead(limitPinX)) {
    stepperXmoveTo(X_homing);
    stepperX.run();
    X_homing--;
    delay(5);
    Serial.println("forward_x");
  }
}
void backward_y(){
  Y_homing=1;
```

```
  while (digitalRead(limitPinY)) {
      stepperY.moveTo(Y_homing);
      Y_homing++;
      stepperY.run();
      Serial.println("backward_y");
  }
  stepperYsetCurrentPosition(0);
}
void servoX_CW(){
  for (pos = 90; pos >= 0; pos -= 1) {
    servoX.write(pos);
    delay(15);
  }
}
void servoX_ACW(){
  for (pos = 0; pos <= 90; pos += 1) { // goes from 0 degrees to 90 degrees
    // in steps of 1 degree
    servoX.write(pos);              // tell servo to go to position in variable 'pos'
    delay(15);                       // waits 15ms for the servo to reach the position
  }
}
void servoY_CW(){
  for (pos = 35; pos >= 5; pos -= 1) { // goes from 90 degrees to 0 degrees
```

```
    servoY.write(pos);              // tell servo to go to position in variable 'pos'
    delay(15);                       // waits 15ms for the servo to reach the position
  }
}
void servoY_ACW(){
  for (pos = 5; pos <= 35; pos += 1) { // goes from 0 degrees to 90 degrees
    // in steps of 1 degree
    servoY.write(pos);              // tell servo to go to position in variable 'pos'
    delay(10);                       // waits 15ms for the servo to reach the position
  }
}
```