Design and Fabrication of a Magnet Based Pick and Place Mechanism for Industrial Applications

A project report submitted to the Department of Mechanical Engineering of Sonargaon University (SU) in partial fulfillment of the requirements for the award of the degree of Bachelor of Science (B.Sc) in Mechanical Engineering

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DECLARATION

We, hereby declare that the work presented in this Project "Design and Fabrication of an Magnet Based Pick and Place Mechanism for Industrial Applications" is the outcome of the investigation performed by us under the supervisor of Saikat Biswas, Assistant Professor, Department of Mechanical Engineering of Sonargaon University, in partial fulfillment of the requirements of the degree of Bachelor of Science (B.Sc) in Mechanical Engineering.

We also declare that no part of this project has been or is being submitted elsewhere for the award of any degree.

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ABSTRACT

In today’s factories and shop floors, industrial automation is everywhere and it is difficult to imagine a production line without automation. Industrial automation uses control systems and equipment, such as computer software and robots, to perform tasks that were historically done manually. These systems operate industrial equipment automatically, significantly reducing the level of operator involvement and oversight required. One machine/mechanism that is most visible in industrial automation is the Mechanical pick and Place mechanism. Pick and place automation speeds up the process of picking up parts or items and placing them in other locations. A pick and place mechanism can achieve a throughput of 60 objects per minute with an accuracy rate of 99.9%, compared to a human operator's throughput of 10 objects per minute with an accuracy rate of 90%.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Introduction: Magnet-Based Pick and Place Mechanism Project

The field of industrial automation continues to evolve, with increasing emphasis on improving productivity, efficiency, and precision in manufacturing processes. Among the various automation technologies, magnet-based pick and place mechanisms have gained considerable attention due to their versatility and effectiveness in handling a wide range of objects. This project thesis aims to design and develop a magnet-based pick and place mechanism that offers enhanced capabilities for efficient and accurate object manipulation in industrial applications.

Pick and place operations are common in industries such as assembly, packaging, and material handling, where objects need to be moved from one location to another with precision. Traditional methods often involve manual labor or complex robotic systems. However, magnet-based pick and place mechanisms provide an alternative approach that utilizes the attractive force of magnets to grip and release objects, eliminating the need for physical contact or complex gripping mechanisms. This approach offers advantages such as reduced complexity, increased flexibility, and improved adaptability.

The primary objective of this project thesis is to design and develop a magnet-based pick and place mechanism that surpasses existing solutions in terms of efficiency, accuracy, and versatility. The mechanism will be designed to handle objects of various sizes, shapes, and materials, offering reliable gripping and release capabilities. The project aims to achieve the following specific objectives:

a. Design a modular and flexible magnet-based pick and place mechanism that can be easily integrated into existing production lines or adapted to specific application requirements.

b. Develop an efficient control system that allows precise positioning, gripping, and release of objects, while ensuring smooth and reliable operation.

c. Implement advanced sensing and feedback mechanisms to enhance object detection, positioning, and grip force control, thereby improving overall accuracy and operational reliability.

d. Conduct comprehensive performance evaluations and compare the magnet-based pick and place mechanism against existing methods in terms of speed, precision, adaptability, and reliability.

The successful development of an efficient and reliable magnet-based pick and place mechanism will have several practical implications in industrial automation. It can significantly improve productivity by reducing manual labor requirements and minimizing the time required for pick and place tasks. The enhanced accuracy and adaptability of the mechanism will also contribute to improved quality control and reduced errors in manufacturing processes. Furthermore, the modularity and flexibility of the mechanism will facilitate easy integration into existing production lines, enabling seamless automation without significant disruption.

The project will follow a systematic methodology that includes the following key steps:

a. Literature review: Conduct an extensive review of existing literature, research papers, and patents related to magnet-based pick and place mechanisms, focusing on design principles, control strategies, sensing technologies, and performance evaluation methods.

b. Conceptual design: Based on the literature review and understanding of application requirements, develop initial design concepts for the magnet-based pick and place mechanism, considering factors such as magnet types, arrangement, gripping mechanisms, and actuation methods.

c. Mechanical and electrical design: Refine the initial design concepts into detailed mechanical and electrical designs, addressing aspects such as structural integrity, force calculations, magnet selection, and electrical control system design.

d. Prototype development and testing: Fabricate a prototype of the magnet-based pick and place mechanism and perform comprehensive testing to evaluate its performance in terms of gripping force, accuracy, speed, adaptability, and reliability.

e. Performance evaluation and comparison: Conduct experiments to compare the performance of the magnet-based pick and place mechanism with existing methods, analyzing factors such as speed, accuracy, efficiency, adaptability, and reliability.

The remainder of this thesis is structured as follows: Chapter 2 provides an in-depth review of the existing literature and research related to magnet-based pick and place mechanisms. Chapter 3 presents the conceptual design

1.2 Objective of the Project

The main objective of this project is to "Design and Fabrication of Magnet Based Pick and Place Mechanism for Industrial Applications""" Project for the main purpose is to create a smart system so that we can take many benefits from one project.

- To study an automatic pick and place mechanism.
- To design an automatic pick and place machine
- To develop a pick and place with a variety of change options available for use in different applications.
- To performance study, research and develop "Magnet Based Pick and Place Mechanism for Industrial Applications", our project, aims to show the simple working of the mechanism.

1.3 Background of the Project

This review project highlights the various aspects of a magnet-based pick and place mechanism after reviewing several successful research papers on manipulators. Nowadays, pick and place mechanism are being used in industries to minimize the human errors and increase efficiency, productivity, precision of the operations taking place. One of the most important advantages of introducing Robotic arm in Industries is that it can work in crucial conditions like high temperatures, pressures where it's risky for humans to work. Since a manipulator comes under Flexible Automation, they can be updated and modified easily. We have referred several research papers which have been experimentally verified to observe the different types of controllers used and different methodologies used by different authors to decide the degrees of freedom of a manipulator used for the picking of an object and placing it at specified position. Thus, knowledge acquainted after referring all these papers, will help in Designing the pick and place mechanism.

Another advantage is the simplified design and reduced complexity of magnet-based pick and place mechanisms. By eliminating the need for complex gripping mechanisms, these systems offer a more streamlined and efficient approach to object manipulation.

Moreover, magnet-based pick and place mechanisms provide a faster and more efficient solution compared to manual labor. With their ability to operate at high speeds and carry out repetitive tasks consistently, these mechanisms significantly increase productivity and throughput in industrial processes. They can be integrated into existing production lines, complementing other automation technologies and enhancing overall efficiency.

In summary, the development of a magnet-based pick and place mechanism holds great potential for improving efficiency, adaptability, and precision in industrial automation.. This project aims to design and develop a magnet-based pick and place mechanism that addresses these advantages and challenges, ultimately contributing to the advancement of industrial automation and manufacturing processes.

1.4 Advantages of Pick and Place Mechanism:

Efficiency: Pick and place mechanisms can operate at high speeds consistently, resulting in increased productivity and throughput compared to manual labor.

Precision: Automated pick and place mechanisms offer superior precision and accuracy, ensuring consistent and reliable object placement, which is essential for tasks requiring high levels of accuracy.

Adaptability: These mechanisms can be programmed and easily reconfigured to handle different objects, sizes, and shapes, making them highly adaptable to changing production requirements and facilitating efficient product changeovers.

Safety: By eliminating the need for human workers to perform repetitive and physically demanding tasks, pick and place mechanisms improve workplace safety by reducing the risk of injuries and accidents associated with manual labor.

Scalability: Automated pick and place mechanisms can be integrated into existing production lines or scaled up for increased capacity, enabling seamless integration into different manufacturing processes.

1.5 Disadvantages of Pick and Place Mechanism:

Initial Investment: Implementing a pick and place mechanism requires an upfront investment in equipment, programming, and integration, which may be costly for some organizations, especially small businesses.

Complex Programming: Designing and programming a pick and place mechanism can be a complex task, requiring expertise in robotics, automation, and control systems. Skilled personnel or external specialists may be needed for the setup and maintenance of the system.

Limited Flexibility: While pick and place mechanisms are generally adaptable, there may be limitations in terms of the range of objects they can handle. Unusual shapes, sizes, or fragile objects may pose challenges for automation, requiring manual intervention or specialized mechanisms.

Maintenance and Downtime: Like any automated system, pick and place mechanisms require regular maintenance and occasional downtime for repairs, updates, or adjustments. Organizations need to consider the costs and potential production interruptions associated with maintenance activities.

Complexity of Integration: Integrating a pick and place mechanism into existing production lines may require modifications or adaptations to the overall system, including interfaces with other equipment or control systems. This integration process can be time-consuming and may disrupt ongoing production.

It is important to note that the advantages and disadvantages may vary depending on the specific pick and place mechanism, the application, and the organization's requirements. Proper evaluation and planning are necessary to determine the suitability of automation in each particular scenario.

CHAPTER 2

THEORETICAL ASPECTS

2.1 Introduction

Mankind has always strived to give life like qualities to its artifacts in an attempt to find substitutes for himself to carry out his orders and also to work in a hostile environment. The popular concept of a robot is of a machine that looks and works like a human being. The industry is moving from current state of automation to Robotization, to increase productivity and to deliver uniform quality. The industrial robots of today may not look the least bit like a human being although all the research is directed to provide more and more anthropomorphic and humanlike features and super-human capabilities in these. One type of pick and place mechanism commonly used in industry is a robotic manipulator or simply a robotic arm. It is an open or closed kinematic chain of rigid links interconnected by movable joints. In some configurations, links can be considered to correspond to human anatomy as waist, upper pick and place mechanism arm and forearm with joint at shoulder and elbow. At end of arm a wrist joint connects an end effector which may be a tool and its fixture or a gripper or any other device to work.

2.2 Structure

The structure of a pick and place mechanism robot is usually mostly mechanical and can be called a kinematic chain. The chain is formed of links, actuators, and joints which can allow one or more degrees of freedom. Most contemporary robots use open serial chains in which each link connects the one before to the one after it. These robots are called serial pick and place mechanism and often resemble the human arm. Pick and place mechanism used as manipulators have an end effector mounted on the last link. The motor rotates the pulley with the help of a belt. Pick and place automation speeds up the process of picking up parts or items and placing them in other locations. This end effector can be anything from a iron to a mechanical hand used to manipulate the environment.

2.3 Manipulation

Robots which must work in the real world require some way to manipulate objects; pick up, modify, destroy, or otherwise have an effect. Thus the 'hands' of a robot are often referred to as end effectors, while the arm is referred to as a manipulator. Most robot arms have replaceable effectors, each allowing them to perform some small range of tasks. Some have a fixed manipulator which cannot be replaced, while a few have one very general-purpose manipulator, for example a humanoid hand.

2.4 Mechanical Grippers

One of the most common effectors is the gripper. In its simplest manifestation it consists of just magnet-based pick and place mechanism which can magnetics and magnetics to pick up and let go of a range of small objects. Here is a metal plate with two slots for reciprocating mechanism. One of the reciprocating mechanisms is driven by the pulley. This reciprocating causes the metal plate to oscillate. This oscillating motion is transferred to a spring-loaded part through the second reciprocating mechanism. The spring-loaded tool is attached to the pick and place part.

2.5 Design of Pick and Place Mechanism

According to the paper the motor consists of 360 degrees of freedom is being made for the purpose of spot welding, gripper will be used in the arm. The end effector consists of an arrangement of spur gears and threaded shafts along with a DC motor. Aims considered while building the pick and place mechanism.

- To have a rigid structure.
- Movement of parts to defined angles.
- To attain consumption of power at optimum level.
- To perform spot operation with the help of pick and place part.

The material used for manufacturing the bottom of pick and place mechanism was plywood which has the dimensions as follows Length-50 cm, Breadth-30 cm, Thickness-8 cm.
Arm manipulator will be made up of iron and has the following description-
Weight= (2000)2= 4000g for big arm and (1500)2=3500 g for small arm. Length= 50 cm for big arm and 30cm for small arm.
At the assembly point of wrist and end effector, 2 end iron effectors are used, in which one end effector is fixed and the other is movable, the end effector assembly has meshing of spur gears and worm gears which are connected to a 12 V DC gear motor. The gear motor has a step angle of 360 degrees and a speed of 100rpm. Force calculation on joints is done. This design of the pick and place robotic arm has two d.o.f. which performs the function of lifting, and for each linkage the center of mass was acting at the half of the length. Since there are many possible configurations for the robotic arm, the maximum degrees of rotation of each joint is 180 degrees. All the locations of the End Effector to which it can reach so that the workspace required can be calculated. This type of technology which is used in pick and place mechanism arms can help in doing spot welding operation more efficiently. The material handling was carried out easily by picking and placing of the desired object. We can change the variation in the pick and place mechanism arm structure and their angle of movement.

2.6 Inspection and Testing

The role of inspection as applied to the fabrication of pick and place mechanism is fundamentally to ensure that the customer receives a quality product built to his requirements and meeting minimum safety requirements. From fabricator's view point, a well-coordinated program of inspection can be instrumental in a significant reduction of costly rework. The most common methods of inspection used in pick and place mechanism fabrication are magnetic particle, motor pulley, belt and etching. The choice method and extent of its use for inspection depends primarily on the intended service of the pick and place mechanism.
The testing practice for completed pick and place mechanism will produce stress somewhat above the design maximum for a long-established safety measure. The principal objective aside from the detection of leaks is to give same assurance of the absence of serious defects in workmanship, materials and design. The test does not guarantee that the pick and place mechanism will with stand subsequent applications of the same pressure or that periodic applications of the same pressure might not produce failure. For reasonable assurance of safe

construction, other inspection for the detection of flaw like hydrostatic testing, proof testing and routine testing is essential. This can be further improved by incorporating the following changes to get better results. The process that we used in the Scotch yoke mechanism does not work efficiently. This skill can be enhanced by using some other mechanisms.

2.7 Block Diagram of This Project

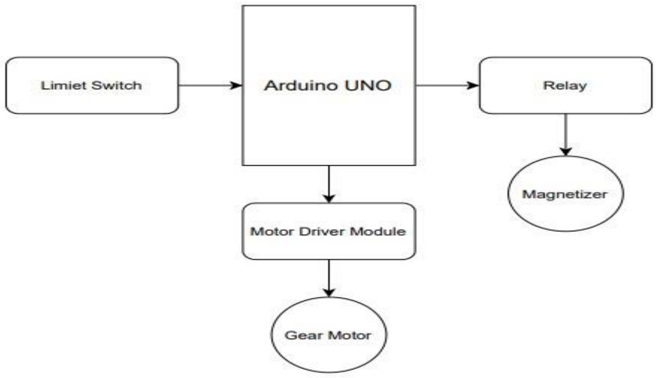


Fig-2.1: Block Diagram

2.8 Circuit Diagram of This Project

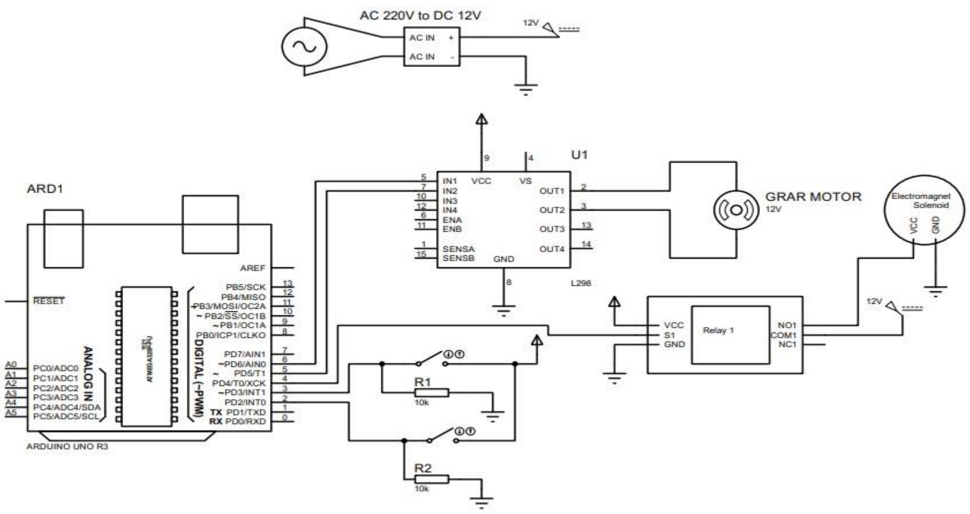


Fig-2.2: Circuit Diagram

2.9 Software Tools

The software that is used to program the microcontroller is open-source-software and can be downloaded for free on www.arduino.cc. With this “Arduino software” we can write little programs with the microcontroller. These programs are called “Sketch”. In the end the sketches are transferred to the microcontroller by USB cable. More on that later on the subject “programming”.

- **Installation** Now one after another the Arduino software and the USB driver for the board have to be installed.

- **Installation and setup of the Arduino software**

1. We have downloaded the Arduino software from www.arduino.cc and installed it on the computer (This was NOT connected to the PC). After that we opened the software file and installed the program named arduino.exe.

Two set ups on the program are important and should be considered.

a) The board that we want to connect has to be selected on the arduino software. The “Arduino Uno” is here known as “Arduino / Genuino Uno”.

b) We have to choose the right “Serial-Port”, to let the computer know to which port the board has been connected. That is only possible if the USB driver has been installed correctly. It can be checked this way:

At the moment the Arduino wasn‟t connected to the PC. If we now choose “Port”, under the field “Tool”, we will already see one or more ports here (COM1/ COM2/ COM3…). The quantity of the shown ports doesn't depend on the quantity of the USB ports on the computer. When the board gets connected to the computer, we will find one more port.

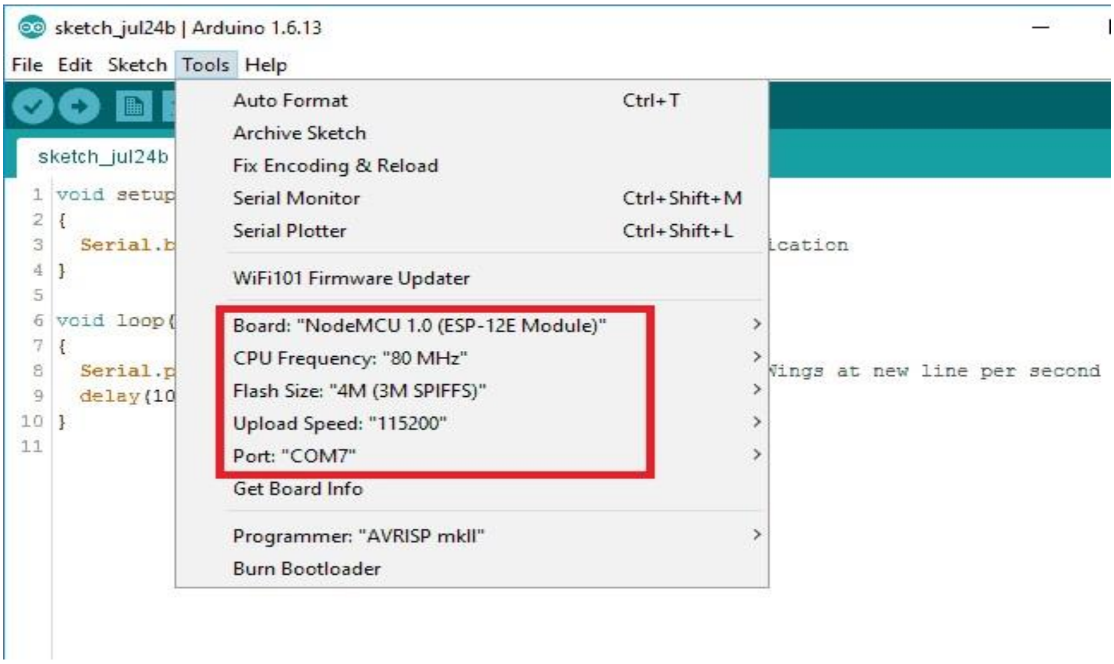


Fig-2.3: Program Installation Process

2.10 Programming

The development cycle is divided into 4 phases:

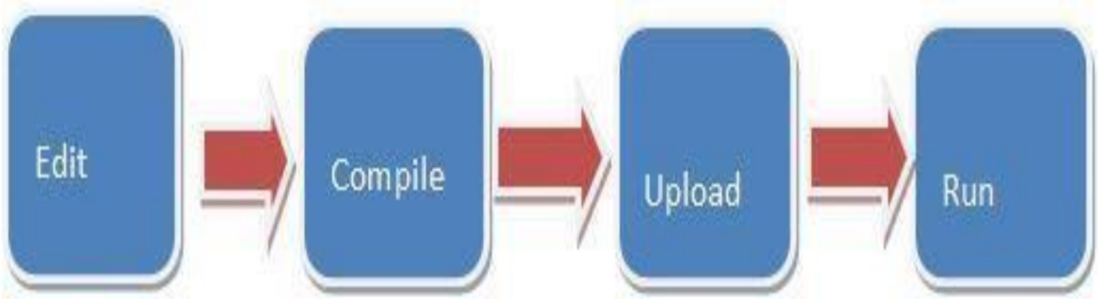


Fig-2.4: Flowchart of the Compiling Process

Compile: Compile means to translate the sketch into machine language, also known as object.

Code Run: Arduino sketch is executed as soon as terminates the step of uploading on the board.

2.11 Arduino Program Development

- Based on C++ without 80% of the instructions.
- A handful of new commands.
- Programs are called 'sketches'.
- Sketches need two functions:
- void setup ( )
- Void loop ( )
- Setup ( ) runs first and once.
- loop ( ) runs over and over, until power is lost or a new sketch is loaded.

2.12 Proposed Project in Proteus

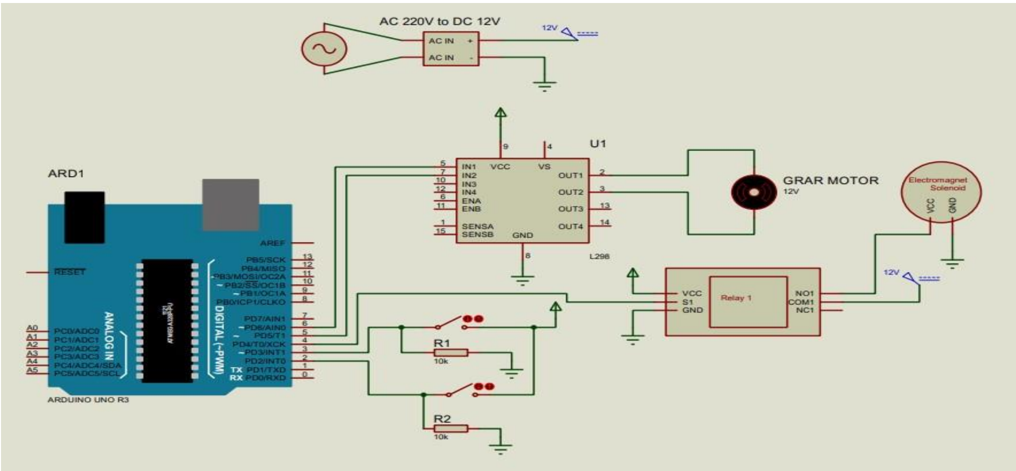


Fig-2.5: User Interface of Proteus 8.9

Proteus 8 is best simulation software for various designs with microcontroller. It is mainly popular because of availability of almost all microcontrollers in it. So it is a handy tool to test programs and embedded designs for electronics hobbyist. You can simulate your programming of microcontroller in Proteus 8 Simulation Software. After simulating your circuit in Proteus 8 Software you can directly make PCB design with it so it could be a all in one package for students and hobbyists. So I think now you have a little bit idea about what is proteus software.

2.13 Time Plan

The following tables define the main tasks in the project introduction and project itself.

T1	Project Definition	1 Week
T2	Collecting data	11 Weeks
T3	Analysis	7 Weeks
T4	Theoretical calculation	4 Weeks
T5	Documentation	10 Weeks
T6	Prepare for presentation	2 Weeks

Table-02: Time Scheduled Table for Project Introduction

The time of the project introduction is scheduled over 16 weeks, table 2 shows how the work was scheduled over this time:

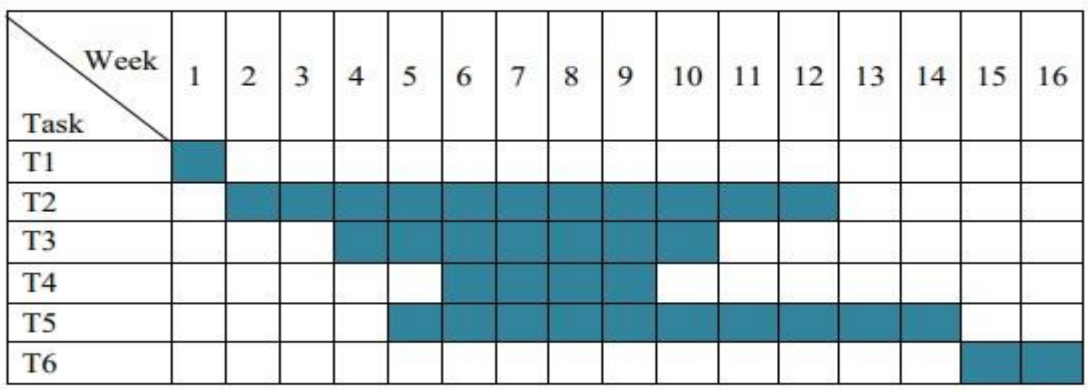


Table-03: Time Plan Table for Project Introduction

The following table defines the main tasks in the project:

T1	Collecting data	3 Week
T2	Implementation	10 Weeks
T3	Analysis	5 Weeks
T4	Building and testing the system	8 Weeks
T5	Documentation	10 Weeks
T6	Prepare for presentation	2 Weeks

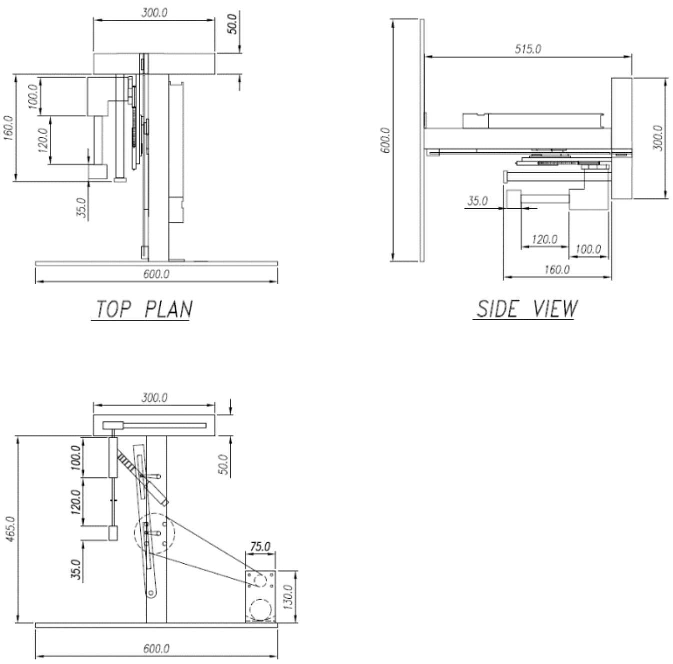
Table-04: Time Scheduled Table for Project

The time of the project is scheduled over 16 weeks, table 4 shows how the work was scheduled over this time:

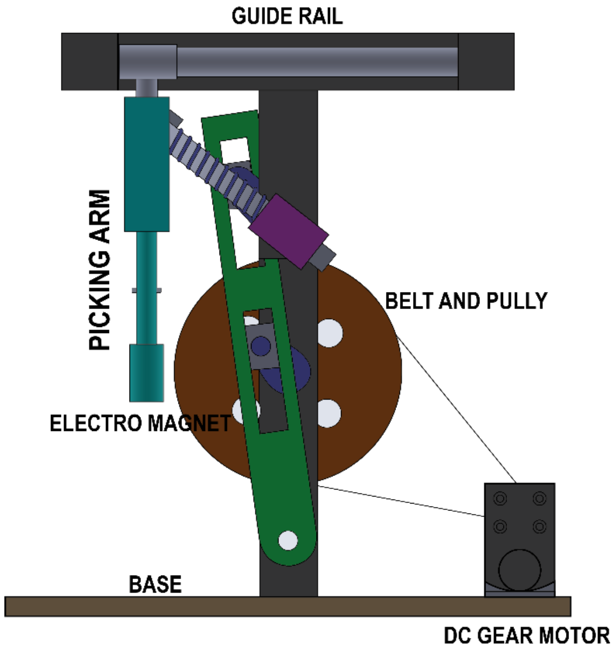
Task \ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
T1	■	■	■													
T2			■	■	■	■	■	■	■	■	■	■				
T3				■	■	■	■	■								
T4							■	■	■	■	■	■	■	■		
T5					■	■	■	■	■	■	■	■	■	■		
T6															■	■

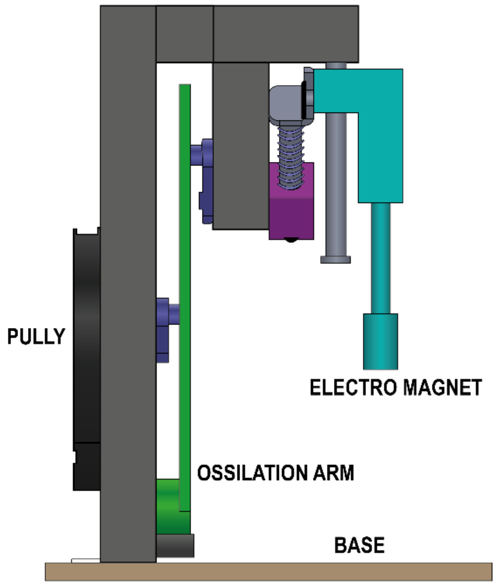
Table-05: Time Plan Table for Project

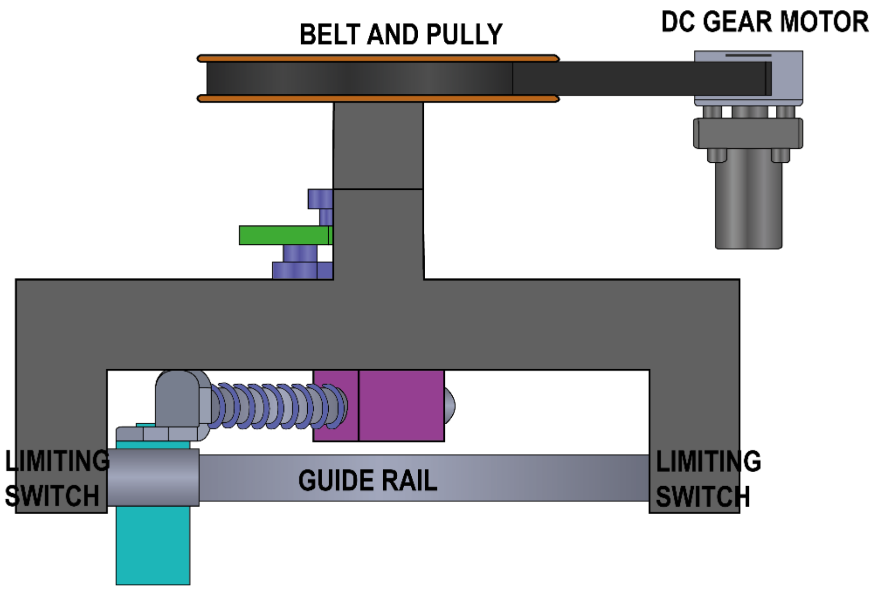
2.14 Schematic Diagram of the Project



2.15 2D Design of the Project







2.15 Project Flow Chart

In any programming related project there is a part named "flowchart" is must. As per rules we made our project flowchart then wrote our proposed project program. There are several parts of our project thus many flowcharts we made.

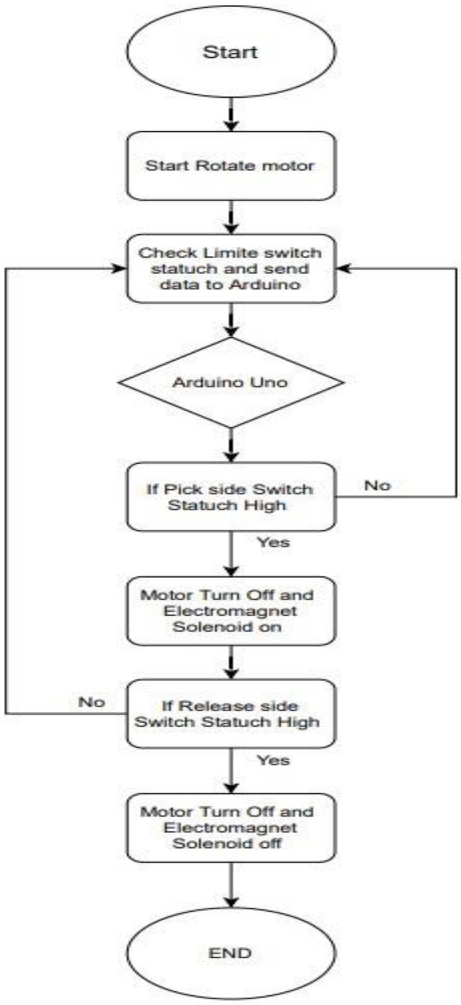


Fig-4.2: Project Flow Chart

CHAPTER 3 DESIGN AND CONSTRUCTION

3.1 Introduction

A magnet-based pick and place mechanism arm is basically a machine which is very similar to a human hand, it consists of a combination of links attached in series or parallel. It can be controlled by programming it to perform a specific task. Joints of the manipulator connect the links that leads to the displacement which is dither translational or rotational. A kinematic chain is formed by the links of the arm. End Effector is the terminating part of this kinematic chain and it can be considered as the hand of a human.

3.2 Methodology

Basically, the design and development of this project are divided into two main parts which are hardware architecture and software details. In the hardware architecture, the design of the circuit was constructed and the prototype of the project was built. While in the software development, the whole complete prototype was operated via programming codes. The final objective is to develop a pick and place mechanism which will be able to lift a sensitive object safely. The arm will employ a closed loop control system using the sensor as the input sensor and the computer or microcontroller as the controller and the controller will control the gear motor. We used C to write the program which will control the drive circuit. The data acquisition for the force sensor was done by a data acquisition card.

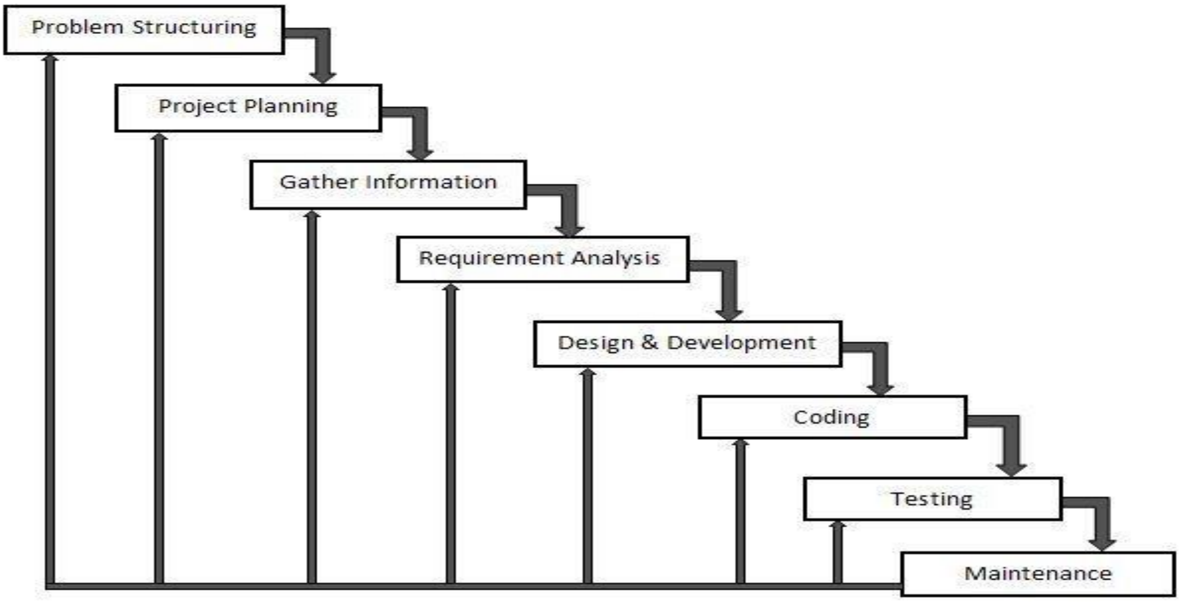


Fig-3.0: Methodology

3.3 Literature Survey

A previous Bachelor‟s Thesis "Human controlled robotic arm" by Simon Ahlin Högfeldt and Daniel Söderman was used for inspiration. The goal of their robotic arm was to test the feedback system using PID controller and to implement haptic control [1]. Haptic means "Of or relating to the sense of touch". Haptic control combines vision, sound, touch, force, pressure or heat (or a combination of several) and often used to make the simulation realistic to the user [2]. The gaming industry has for example developed haptic feedback on the game controllers with force feedback and vibrations. Though it was not the purpose of this project to test the haptic feedback of the robot, there were many similarities and lots of useful information. Mainly the controlling part, using servomotors for the robotic arm and potentiometers for the arm unit. The problems they faced was the servomotors not being able to create the torque given by the manufacturer and this caused them to shorten the length and weight of the robot arm itself rather than buying a stronger servomotor. Haptic feedback would give the user a feeling of the object improves the application of the robot, especially if the robotic arm and the user are separated.

The wireless inspiration came from the Bachelor‟s thesis "Communications solution for refugee settlement: Investigation of nRF24L01+ modules for use in a communications network" by Martin Engquist and Simon Bethdavid. The Radio Frequency Module, NRF24L01 is used for the wireless network combined with Arduino. Messages such as text, audio and commands were able to send and receive but the NRF24L01 Modules was not very reliable to their project [3].

Jorge Kazacos Winter [4] has developed android controlled robot automation. Main aim of his project was the transfer of information wirelessly between a Smartphone and the robot and developing the robot and its communication system underneath a low price and open-source philosophy. He used 3D design technique to style the structure of the robot with the facilitation of parametrical modeling software. The style, when fed to the 3D printer can print the parts of the robot in a layered manner one by one and can then use these parts to assemble the robot simply. He has used Arduino micro-controller and Wi-Fi technology in this robot.

M. Selvam [5] in his paper has design to develop a robotic system which has a wireless camera attached to the surveillance. Bluetooth was implemented in his project for providing connection between robot and smart phone. Wireless night vision camera was used for providing the robot surveillance. The video which is recorded by camera is then transmitted to TV unit through radio frequency signal. He used 8051 micro-controllers for the robotic unit.

Ranjith Kumar Goud and B. Santosh Kumar [6] have invented a pick and drop robot. They wanted it to be used for diffusing a bomb remotely with safety. For the robotic arm, they used a pair of motors and another pair as the wheels of the robot for controlling the movement. Connectivity is established using Bluetooth. The micro-controller used is LPC2148. They had also attached wireless camera for remote surveillance. They have worked on this project mainly for industrial and military applications.

Arpit Sharma, Ritesh Verma, Saurabh Gupta, Sukhdeep Kaur Bhatia [7] as configured an android Smartphone which can control a robot via Bluetooth technology. The phone uses motion sensors and records the gestures sent via an android mobile phone. It also has an inbuilt accelerometer and Bluetooth module for controlling the movements of a robot.

Autonomous systems and robots can contribute in plenty of functional operations over the world. The robotic arm can solve many limitations of humans in industrial fields especially with the aid of the distance-controlled feature. Robotic arms‟ functions and their operations are extensively used in research laboratories and industries to automate processes and reduce human errors. Some of the tasks achieved by robotic arms include assembly lines and motions that demand the force control with feedback to its controller [8], [9].

Robotic systems have grown broadly due to their increasing applications in all fields of industry and their ability to decrease errors and wastage of material. Many different robotic systems have been developed for invasive proposes [10], [11]. The robotic arms could initially be used to move objects from one place to another [12], [13] in any industrial area [14], [15] that needs to achieve tasks repetitively for manufacturing products. Some industrial environments are not suitable for humans, thus robotic arms may be used. For instance, cases in which human workers cannot easily or safely gain access are handling radio-active materials or dealing with work in the deep sea and space [16], [17].

3.4 List of Device and Components

- Arduino UNO.
- Adaptor.
- Motor Driver Module.
- Relay Module.
- DC Gear Motor.
- Limit Switch.

3.5 Arduino UNO

The Arduino UNO is a microcontroller board based on the ATmega328p. It has 14 digital input/output pins (of which 5 can be used as PWM outputs), 6 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller.

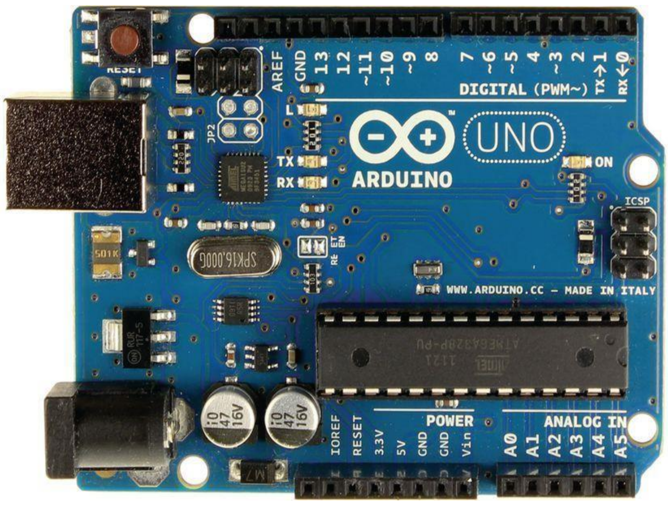


Fig-3.1: Arduino UNO

Technical Specifications

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limit): 6-20V
- Digital I/O Pins: 14 (of which 5 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 56 KB of which 8 KB used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Length: 101.52 mm
- Width: 53.3 mm
- Weight: 37 g

Applications

- Arduboy, a handheld game console based on Arduino.
- Arduinome, a MIDI controller device that mimics the Monome.
- Ardupilot, drone software and hardware.
- ArduSat, a cubesat based on Arduino.
- C-STEM Studio, a platform for hands-on integrated learning of computing, science, technology, engineering, and mathematics (C-STEM) with robotics. ▪ Data loggers for scientific research.

- OBDuino, a trip computer that uses the on-board diagnostics interface found in most modern cars.
- OpenEVSE an open-source electric vehicle charger.
- XOD, a visual programming language for Arduino.

3.6 Adapter

12V 5A Micro Power Adpater. For using with Arduino /Raspberry Pi 3 Model A+/B/B+/Zero and running any other high current devices.

Specifications

- Input: 100V - 40V AC, 50Hz/60Hz. ▪ Output: 12V 5A.

Fig-3.2: Adapter

3.7 Motor Driver Module

The L298 is an integrated monolithic circuit in a 15-lead Multi watt and PowerSO20 packages. It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors.
Two enable inputs are provided to enable or disable the device independently of the input signals. The emitters of the lower transistors of each bridge are connected together and the corresponding external terminal can be used for the connection of an external sensing resistor. An additional supply input is provided so that the logic works at a lower voltage. Check here for L298 datasheet.

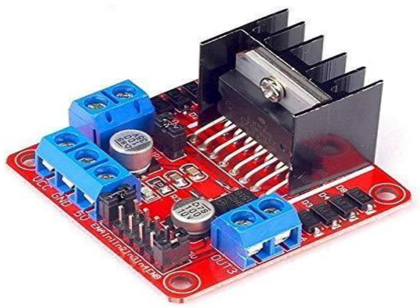


Fig-3.3: Motor Driver Module

Specifications

- Driver: L298
- Driver power supply: +5V~+46V
- Driver peak current: 2A
- Logic power output Vss: +5~+7V (internal supply +5V)
- Logic current: 0~36mA
- Controlling level: Low -0.3V~1.5V, high: 2.3V~Vss
- Enable signal level: Low -0.3V~1.5V, high: 2.3V~Vss
- Max drive power: 25W (Temperature 75 ℃)
- Working temperature: -25℃~+130℃

Pin Description

- Out 1: Motor A lead out(+ve)
- Out 2: Motor A lead out(-ve)
- Out 3: Motor B lead out(+ve)
- Out 4: Motor B lead out(-ve)
- 12V:12V input from DC power source(12V jumper – remove this if using a supply voltage greater than 12V DC. This enables power to the on board 5V regulator)
- GND: Ground
- 5V: 5V input (unnecessary if your power source is 7v-35v, if the power source is 7v-35v then it can act as a 5v out)
- EnA: Enables PWM signal for Motor A

- In1: Enable Motor A
- In2: Enable Motor A
- In3: Enable Motor B
- In4: Enable Motor B
- EnB: Enables PWM signal for Motor B

3.8 Relay Module

A relay is an electrically operated device. It has a control system and (also called input circuit or input contactor) and controlled system (also called output circuit or output cont. actor). It is frequently used in automatic control circuit. To put it simply, it is an automatic switch to controlling a high-current circuit with a low-current signal.

Fig-3.4: Relay Module

The advantages of a relay lie in its lower inertia of the moving, stability, long-term reliability and small volume. It is widely adopted in devices of power protection, automation technology, sport, remote control, reconnaissance and communication, as well as in devices of electro mechanics and power electronics. Generally speaking, a relay contains an induction part which can reflect input variable like current, voltage, power, resistance, frequency, temperature, pressure, speed and light etc. It also contains an actuator module (output) which can energize or de-energize the connection of controlled circuit. There is an intermediary part between input part and output part that is used to coupling and isolate input current, as well as actuate the output. When the rated value of input (voltage, current and temperature etc.) is above the critical value, the controlled output circuit of relay will be energized or de-energized.

NB: input into a relay can be divided into two categories: electrical quantities (including current, voltage, frequency, power etc.) and non- electrical quantities(including temperature, pressure, speed, etc.)

Features

The features of 1-Channel Relay module are as follow:

i. Good in safety. In power system and high voltage system, the lower current can control the higher one.

ii. 1-channel high voltage system output, meeting the needs of single channel control

iii. Wide range of controllable voltage.

iv. Being able to control high load current, which can reach 240V, 10A

v. With a normally-open (NO) contact and a normally-closed (NC) contacts

Interface Specifications

The output contacts of a relay (including NO, NC, and the common port) works as a SPDT – Single Pole Double Throw switch. Its operating principle is as follow: VCC----5V,

GND----for ground

IN1 connects to the control valve which output 3V-5V

Output contacts: connect to applications
Interface Connecting and Setting:

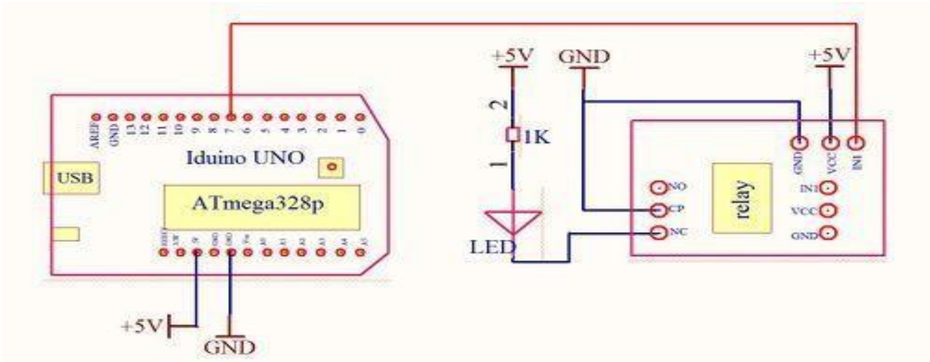


Fig-3.5: Sematic of Relay Module

Arduino board (any versions), wires, LED, 5v power supply. Software resource: Arduino IDE The one-channel relay can be programmed to realize the open and close automatically. NB: customers can use any software or firmware to control the module as long as the IN1 of which can input a voltage of 3V-5V.

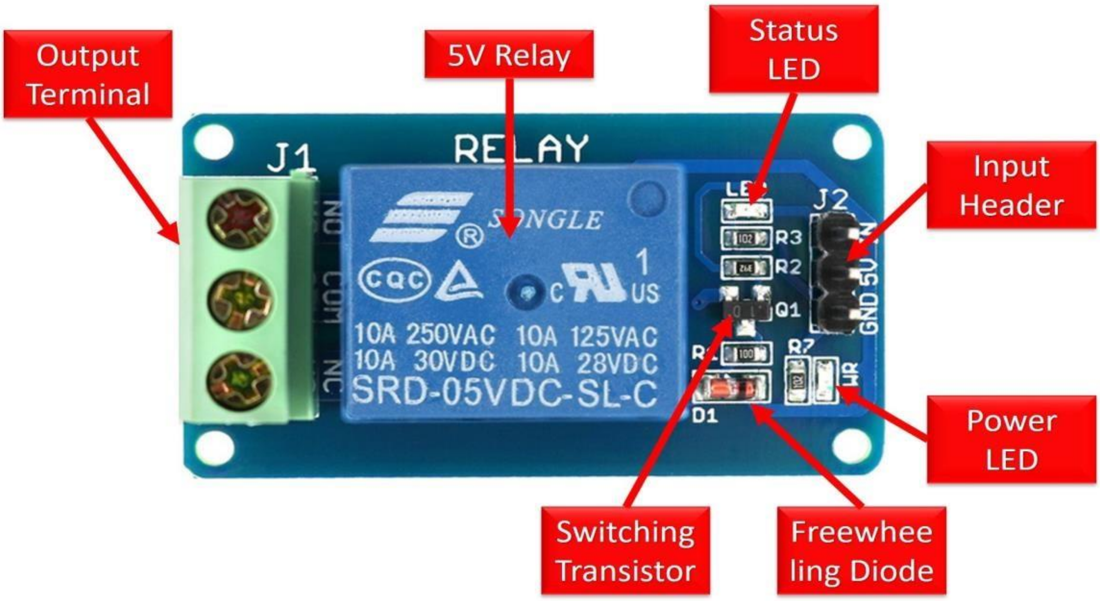


Fig-3.6: Pin out of Relay Module

you can do further development with the development tool you like as well as test it in the way of testing firmware. Firmware test: after the connection as in picture1-4, pay attention to the blink of LED, listen to the flicker of relay when it is working.

Software test code:

```
  void setup(){
pinMode(7,OUTPUT);
}
void loop(){
pinMode(7,OUTPUT);
delay(2000);
digitalWrite(7,LOW);
delay(2000);
}
```

3.9 DC Gear Motor

A DC motor is any of a class of rotary electrical motors that converts direct current (DC) electrical energy into mechanical energy. The most common types rely on the forces produced by induced magnetic fields due to flowing current in the coil. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor. DC motors were the first form of motors widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor, a lightweight brushed motor used for portable power tools and appliances can operate on direct current and alternating current. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

Fig-3.7: Gear Motor

Technical Specifications

- 200RPM 12V DC motors with Metal Gearbox and Metal Gears.
- 700 RPM base motor.
- 6mm Dia shaft with M3 thread hole.
- Length 63 mm without shaft.
- Shaft length 30mm.
- 375gm weight.
- 20 kg cm torque.
- No-load current = 0.15 mA, Load current = upto 4 A(Max).

3.10 Limit Switch

In electrical engineering, a limit switch is a switch operated by the motion of a machine part or the presence of an object. A limit switch can be used for controlling machinery as part of a control system, as a safety interlock, or as a counter enumerating objects passing a point. Limit switches are used in a variety of applications and environments because of their ruggedness, ease of installation, and reliability of operation. They can determine the presence, passing, positioning, and end of travel of an object. They were first used to define the limit of travel of an object, hence the name "limit switch". A limit switch with a roller-lever operator; this is installed on a gate on a canal lock, and indicates the position of a gate to a control system.
Standardized limit switches are industrial control components manufactured with a variety of operator types, including lever, roller plunger, and whisker type. Limit switches may be directly mechanically operated by the motion of the operating lever. A reed switch may be used to indicate proximity of a magnet mounted on some moving part. Proximity switches operate by the disturbance of an electromagnetic field, by capacitance, or by sensing a magnetic field. Rarely, a final operating device such as a lamp or solenoid valve is directly controlled by the contacts of an industrial limit switch, but more typically the limit switch is wired through a control relay, a motor contactor control circuit, or as an input to a programmable logic controller.

Fig-3.8: Limit Switch

3.11 List of Components with Price

SL NO	Components Name	Quantity	Unite Price	Total Price (BDT)
1	Arduino UNO	1	1500	1500
2	Adapter	1	400	400
3	Motor Driver Module	1	400	400
4	Relay Module	1	150	150
5	Gear Motor	1	2,500	2,500
6	Limit Switch	2	300	600
7	Motor Pulley and Belt			1,000
8	Bearing	2	400	800
16	Mini Bearing	3	100	300
17	Iron Frame			3,000
24	Others			6,000
Totally Cost				16,750 Tk

Table-01: List of Components with Price

3.12 Power Calculation

A rough estimate: 40 Watts and the efficiency of the gear will be at best 80% which means 40 * 0.8= approx 32 W or Joules/second.

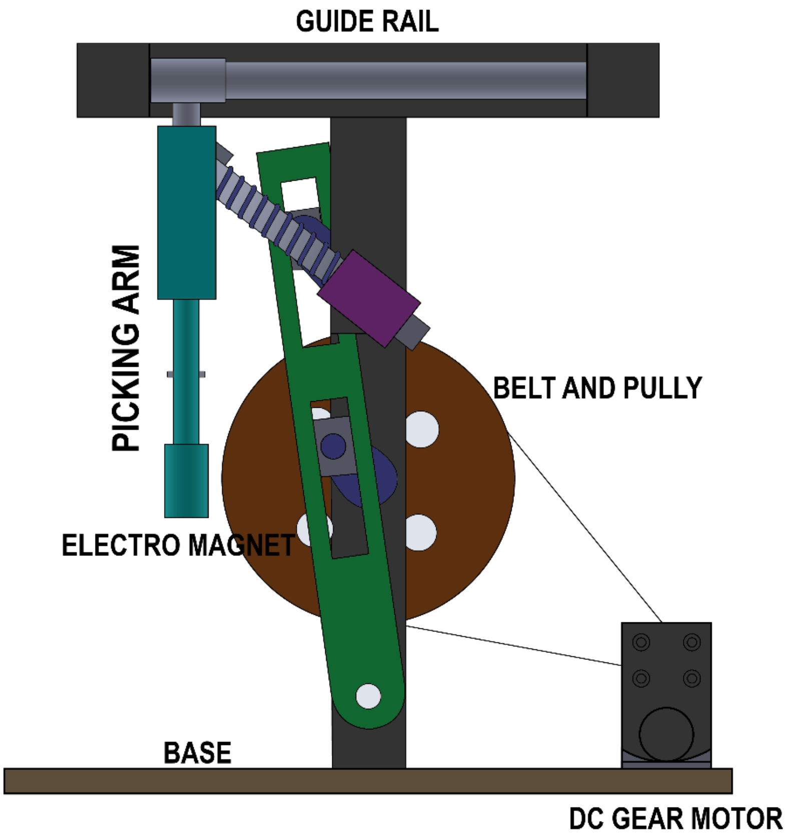
Neglecting the losse, will give you E=m.g.H = 1000x10x10 (g taken as 10 and the vertical distance of approx 10.37m as 10m) E= 100000 joules. Time = 100,000 / 32 = 3,125 sec or 52 minutes

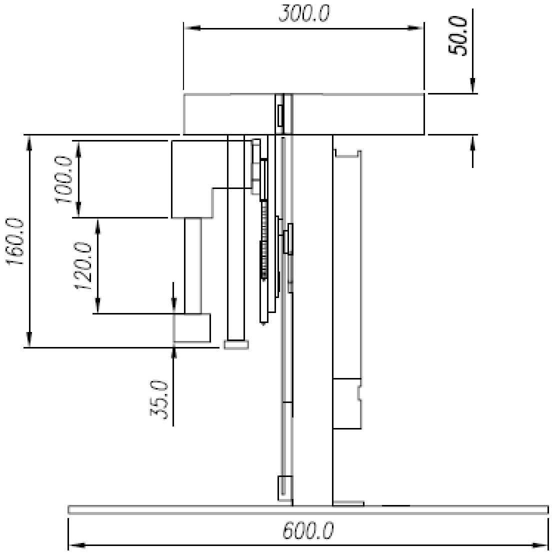
To Generate This Demand Power

Load Calculation:

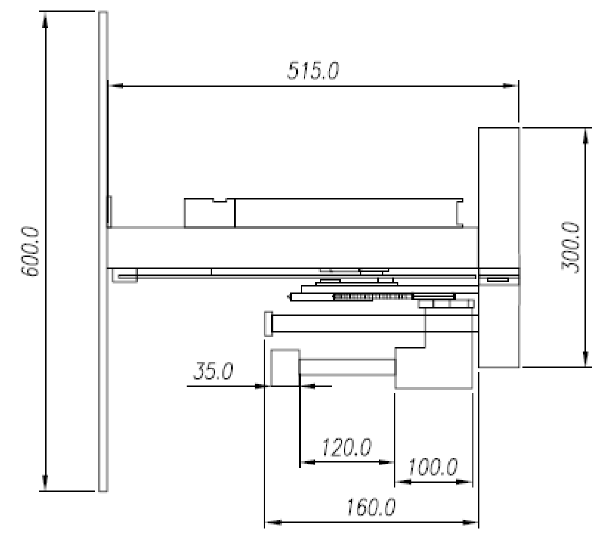
1) Arduino, Relay and Motor Driver Power = 1 amp
2) Motor Power = 3amp

   Totally Power Consumption = 1+3 = 4amp [When, DC 12v Supply]

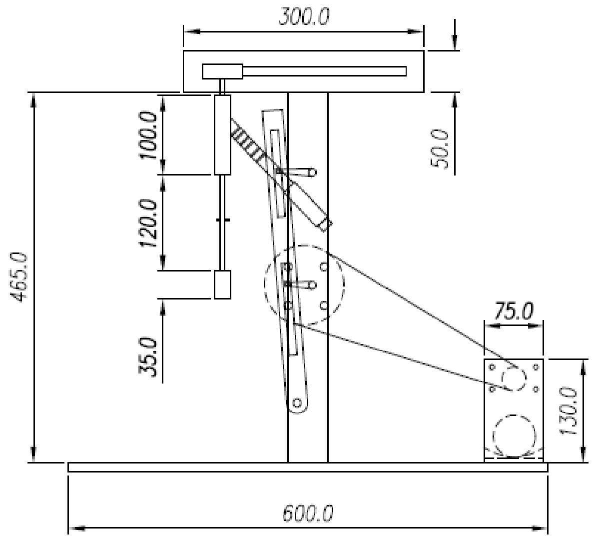




TOP PLAN



SIDE VIEW



CHAPTER 4
DISCUSSION AND CONCLUSION

4.1. Testing, Analyzing, Data

Here's a table for a data table in a magnet-based pick and place

Trial	Object Size	Object Weight (N)	Positioning Accuracy (mm)	Transfer Time (seconds)
1	Small	8.5	0.1	7
2	Medium	12.3	0.2	7
3	Large	16.7	0.2	8
4	Small	7.9	0.1	7
5	Medium	11.8	0.2	7
6	Large	15.2	0.3	7

In this table, each row represents a trial or test performed on the magnet-based pick and place mechanism. The columns include specific parameters that are being measured or evaluated, such as object size, gripping force, positioning accuracy, and transfer time.

4.2 Result and Conclusion

Here's a table summarizing the performance comparison between a human operator and a pick and place mechanism:

Performance Metric	**Human Operator**	**Pick and Place Mechanism**
Speed	10 objects/min	60 objects/min
Precision	90% accuracy	99.9% accuracy
Adaptability	Training required for different objects	Easily reconfigured for different objects
Safety	Risk of injuries due to physical strain	Eliminates physical strain and reduces accidents
Cost	Labor cost and potential variations in performance	Initial investment, long-term productivity gains

Please note that the transfer time values may vary based on the complexity of the mechanism, object characteristics, and the specific requirements of the project. You can update the table with the actual results obtained during the performance test to showcase the efficiency and productivity of your magnet-based pick and place mechanism in handling 8 objects within 1 minute. But modifying the program we can achieve at least 30 objects in a minute

Please note that the values in the table are based of tests done and can vary depending on the specific system and application.

4.3 Discussion

This Mechanism is used for pick and place the object from one place to another place. Concepts of automobile and robotics are combined in this project. Transmission of power due to meshing of gear motor is used for lifting purpose. Worm drive is also used for power steering. These systems operate industrial equipment automatically, significantly reducing the level of operator involvement and oversight required. Pick and place automation speeds up the process of picking up parts or items and placing them in other locations.

During this period we have been exposed to user friendly environment and real time industrial application development. Because of it we learned skills like team work, working with time bound and dealing with professional persons in Industry.

4.4 Future Scope

We have successfully completed our project with available sources. But the results and changes do not depend on expectations. This can be further improved by incorporating the following changes to get better results. The process that we used in the Scotch yoke mechanism does not work efficiently. This skill can be enhanced by using some other mechanisms.

- Include a high level of movement flexibility.
- This will allow the use of advanced sensors.
- This project is to give the way for providing bigger effective pick and place mechanism for industrial applications.

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Appendix

Program for Arduino UNO:

```
int m_pin1 = 5;
int m_pin2 = 6;
int speed = 80;

int pick = 2;
int pickdata;
int relise = 3;
int relisedata;

int relay = 4;

void setup() {
pinMode(relay, OUTPUT);
pinMode(pick, INPUT);
pinMode(relise, INPUT);
Serial.begin(9600);
}

void loop() {
   pickdata = digitalRead(pick);
  relisedata = digitalRead(relise);

  analogWrite(m_pin1, speed);
  analogWrite(m_pin2, 0);

  if (pickdata == 1) {
analogWrite(m_pin1, 0);
analogWrite(m_pin2, 0);
digitalWrite(relay, LOW);
delay(5000);
  }

  if (relisedata == 1) {
analogWrite(m_pin1, 0);
analogWrite(m_pin2, 0);
delay(5000);
digitalWrite(relay, HIGH);
delay(2000);
  }
```