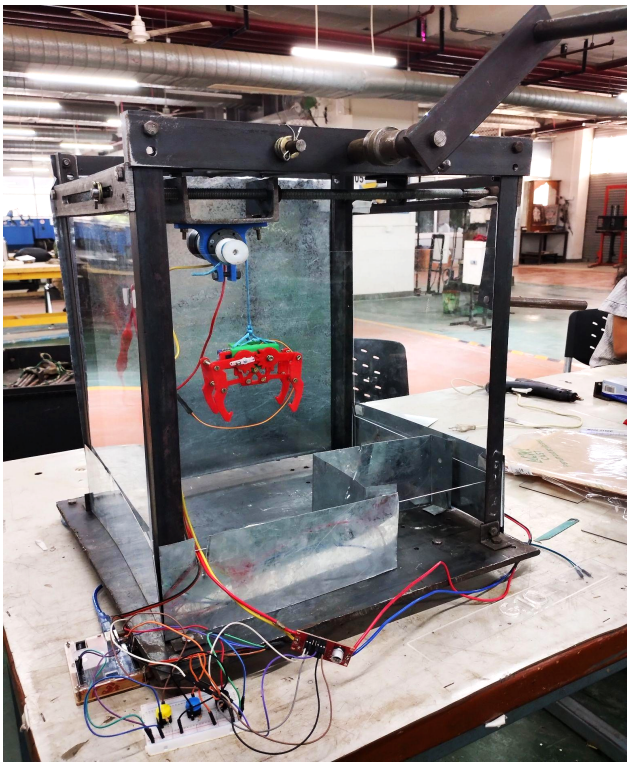
TA212 – Manufacturing Processes–II

2nd Sem 2024-25

Group No. 10

CLAW MACHINE



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PROJECT OVERVIEW

The objective of this project was to develop a claw machine using a set of DC motors, claw, arduino, handles and lead screws to pick up different types of objects using a claw and move and drop to a specific position. This machine aims to provide real working models of object grabbing and moving in industrial factories, by using different mechanisms and demonstrating the working of the claw mechanism in particular. The project resembles the soft toy claw machine which we see in arcades.

KEY OBJECTIVES

1. Claw Movement Control : Able to move the claw in all three directions (x, y and z axes) using lead screws and motor and orient itself to pick up objects.
2. Picking and Dropping Objects : The claw is able to lift any small object using a powerful servo motor and move to its desired position and drop it.

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to all those who supported us throughout the course of this project. Their guidance, encouragement and valuable insights have been instrumental in the successful completion of this work.

First and foremost, we extend our heartfelt thanks to Mr. Kishan Babu Prajapati, our Guide for the group G10, for his continuous support, expert guidance and constructive feedback at every stage of the project.

We would also like to thank Dr. Arvind Kumar for providing the necessary facilities and a conducive environment to carry out the project work smoothly.

Lastly, we are grateful for the effort of our team in bringing this project to its completion.

This project would not have been possible without the contributions and support of everyone mentioned above.

MOTIVATION

The idea for this project came from our interest in how fun arcade claw machines actually work and how similar mechanisms are used in real-life factories. We wanted to build something that was both cool and useful — a machine that could grab and move objects just like in industrial automation. This project gave us a chance to apply what we've learned about motors, Arduino, and mechanical movement in a hands-on way. It was also a great way to bring together mechanical and electronic systems into one working model, and we were excited to see something we built actually move and work like a mini factory robot.

ABSTRACT

Automation and precision handling have become vital in modern industries, including packaging, sorting, and light object manipulation. To support small-scale operations and educational or experimental environments, a compact and cost-effective claw mechanism can play an essential role. This project focuses on designing a small claw machine capable of picking, moving, and placing objects with accuracy and consistency. The claw mechanism is designed to replicate human hand movements in a simplified mechanical form, operated via basic control systems. It serves not only as a prototype for industrial miniaturization but also as a learning tool for robotics and automation. While this project focuses on small-scale application, the same concept can be scaled up for heavy-duty operations—allowing larger claw machines to lift and transport heavier objects in industrial and construction environments. The objective of this project is to build an efficient, user-friendly claw mechanism for small-scale object handling tasks with potential applications in educational settings, automation labs, and low-cost industrial environments.

PARTS LIST

S no.	Component	Material	Qty	Dimension	Machining Process	Page no.
1	MS Angle	Mild Steel	4	25mm * 25mm * 3mm * 506mm	Cutting, Drilling	
2	Bracket	Mild steelSteel	15	25mm * 25mm * 3mm* 25mm	Cutting, Drilling	
3	Back Plate	GI sheet	1	414mm * 464mm	Cutting	
4	Base Plate	Mild Steel	1	458mm * 460mm	Drilling	
5	Supporting Rod	Mild Steel	2	414mm * 10mm dia	Cutting, Drilling	
6	Supporting flat	Mild steel	2	38mm * 411mm * 6mm	Cutting, Drilling	
7	Side Supporting Plate	GI sheet	2	354mm * 107mm	Cutting,	
8	Front Supporting Plate	GI sheet	1	270mm * 103mm	Cutting	
9	Side Slit	Mild steel	2	352mm * 39mm * 6mm	Drilling, Milling	
10	Claw Platform Rod	Mild Steel	1	300mm * 8mm dia	Drilling, Threading	
11	Claw Platform Base	Mild Steel	1	315mm * 81mm * 2mm	Cutting, Drilling	
12	Claw Platform (Upper Block)	Mild Steel	1	18mm * 19mm * 182mm	Cutting, Drilling	
13	Lead Screw Handles	Mild Steel	2	172mm * 40mm * 6mm 16mm dia * 165mm	Cutting, Drilling, Welding, Turning	
14	Lead Screw X	Mild Steel	1	517mm * 12.7mm dia	Lathe, Threading	
15	Lead Screw Y	Mild steel	1	499mm * 12.7mm dia	Lathe Threading	
16	Robotic Claw- ● Grip Hand ● Sheet A ● Arm 1a	PLA	1 4 1 1		3D Printing	

	● Sheet 4 ● Arm 1b ● Gear 2 ● Gear 2b ● Servo head		1 1 1 1 1		
17	Pulley	Delrin	1	25mm * 25mm dia	Lathe
18	Lead Screw Holder	Mild Steel	1	74mm * 98mm * 47mm	Drilling, Welding
19	Box	GI Sheet	1	185mm * 126mm * 112mm	Cutting
20	Motor Mount	PLA	1	39mm dia * 50mm	3D Printing

LEAD SCREW CALCULATION (For 12 TPI)

1. Pitch:

Pitch is the distance the nut moves linearly with one complete turn of the screw.

Since we have 12 threads per inch (TPI):

$$\text{Pitch} = \frac{1}{\text{TPI}} = \frac{1}{12} \approx 0.0833 \text{ inches/turn}$$

So, for every full rotation of the screw, the nut moves:

→ **0.0833 inches**

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2. Lead:

For a single-start thread (which is most common unless otherwise stated), the lead is equal to the pitch.

$$\text{Lead} = \text{Pitch} = 0.0833 \text{ inches}$$

If it were a multi-start thread (e.g. 2-start), the lead would be:

$$\text{Lead} = \text{Pitch} \times \text{Number of Starts}$$

But for 1-start threads (standard), just use:

→ **Lead = 0.0833 inches**

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3. Linear Travel per Revolution:

If you rotate the lead screw by 1 full revolution, the nut or load will move:

→ **0.0833 inches**

To convert that into millimeters:

$$0.0833 \text{ inches} \times 25.4 = 2.116 \text{ mm/rev}$$

Summary:

Parameter	Value
Threads per Inch (TPI)	12
Pitch	0.0833 inches
Lead (single start)	0.0833 inches
Travel per Revolution	0.0833 in / 2.116 mm

MOTOR TORQUE REQUIREMENTS

$I_{driven} = I_{rotordisk} + I_{rod4} + I_{rod2} + 2I_{bevelgear} + I_{drawingdisk} + I_{wormgear} + I_{wormwheel} + I_{holders}$

$I_{holders} + I_{rod4} + I_{rod2} \sim 0$

$I_{driven} = I_{rotordisk} + 2I_{bevelgear} + I_{drawingdisk} + I_{wormgear} + I_{wormwheel}$

$I_{driving} = 1.2 \times 10^{-3}$ kg-m^2

Since motor is directly connected to pulley without the use of any gears,

$I_{driven} = 0$

$I_{total} = (2 \times I_{driven}) + I_{driving} = 0 + 1.2 \times 10^{-3} = 1.2 \times 10^{-3}$ kg-m^2

$M = I_{total} \times \alpha$

$\alpha = \pi/2$ rad/s^2

So, $M = 1.2 \times 10^{-3} \times \pi/2 = 1.885 \times 10^{-3}$ N-m

Taking into account inefficiency (Efficiency=0.5), friction at axle (a factor of 2 is taken), FOS (factor of 2).

Now, the motor torque required is $M_{motor} = 8 \times (1.885 \times 10^{-3}$ N-m) = 0.01508 N-m

Torqued provided by motor = 1N - m

Therefore a single motor is enough to drive the Claw.

Required Power $0.01508 \times \pi = 0.047$ Watts

Material Costs

Component	Material	Qty	Weight (kg)	Rate (Rs./kg)	Cost (Rs.)
MS Angle	Steel	6	3.0	100	300
Bracket	Steel	15	1.5	100	150
Back Plate	Steel	1	1.0	100	100
Supporting Rod	Steel	2	0.6	100	60
Side Supporting Plate	Steel	2	0.8	100	80
Front Supporting Plate	Steel	1	0.5	100	50
Slit	Steel	2	0.4	100	40
Claw Platform Rod	Steel	1	0.3	100	30
Claw Platform Base	Steel	1	0.5	100	50
Claw Platform (Upper Plate)	Steel	1	0.4	100	40
Claw Platform (Side Plate)	Steel	2	0.4	100	40
Lead Screws	Steel	2	0.4	100	40
Lead Screw Handles	Steel	2	0.2	100	20
Pulley	Delrin	1	0.2	400	80
Motor	Steel	1	0.3	100	30

Holder					
Base Platform	Steel	1	14.5	100	1,450
Total Material Cost			**25 kg**		**2,620**

Manufacturing Costs

Machine Type	Time (Hours)	Cost (Rs.)
Drilling	7	385
Milling	6	1,500
Turning	1	150
Lathe	6	2,100
CNC	0	0
3D Printing	1.5	150
Total Machining Cost	**7.5 Hours**	**4,285**

Labor Costs

Labor Type	Time (Hours)	Rate (Rs./8 Hours)	Cost (Rs.)
Unskilled	90	650	7,313
Skilled	50	850	5,313
Total Labor Cost	**140 Hours**		**12,626**

Additional Costs

Item	Cost (Rs.)
Electric Kit	1,000
Motors	500
Total Additional Costs	**1,500**

Total Estimated Project Cost

Category	Cost (Rs.)
Material Cost	2,620
Manufacturing Cost	4,285
Labor Costs	12,626
Additional Costs	1,500
Grand Total	**21,031**