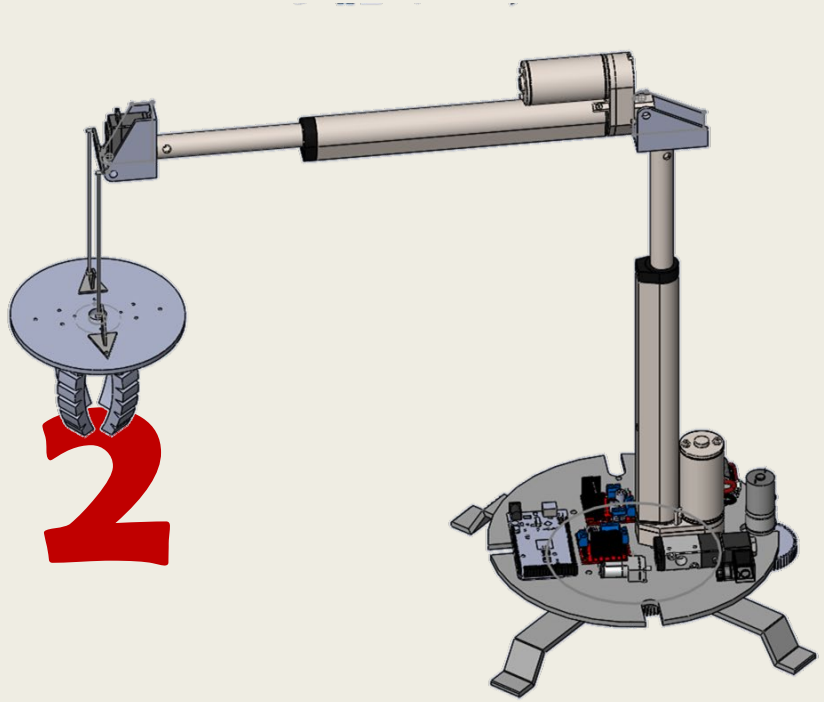
GROUP 2



Shen mengyuan

Yang yiwei

Wu jiajin

Liu shiyi

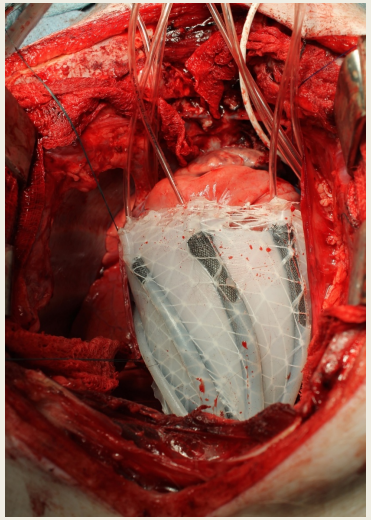
Instructed by professor Ju and TAs

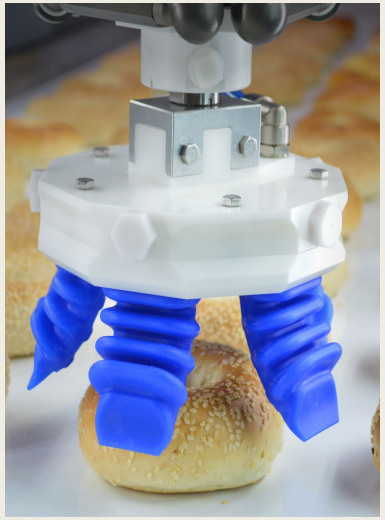
THE GAME

and

Literature Review

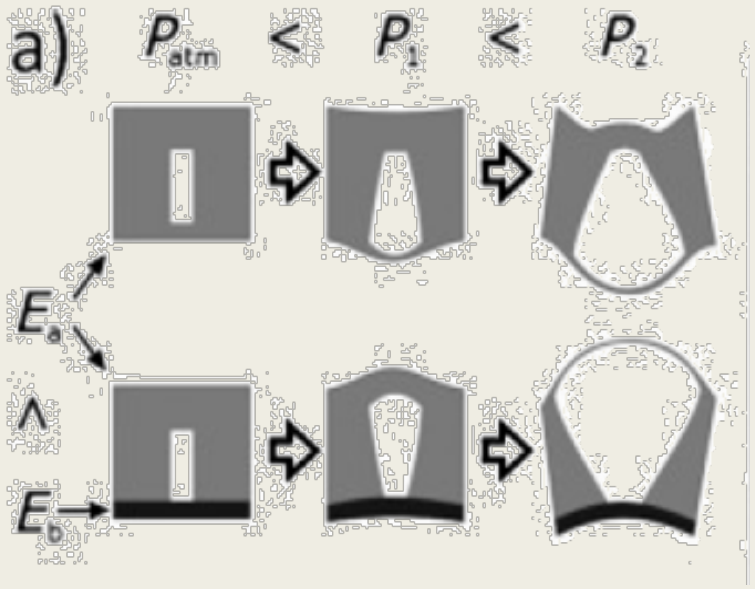
- Soft robotics: a bioinspired evolution in robotics; Author links open overlay panelSangbaeKim[1]CeciliaLaschi[2]BarryTrimmer[3]
- Soft Robotics for Chemists[†]Dr. Filip Ilievski Dr. Aaron D. Mazzeo Dr. Robert F. Shepherd Dr. Xin Chen Prof. George M. Whitesides

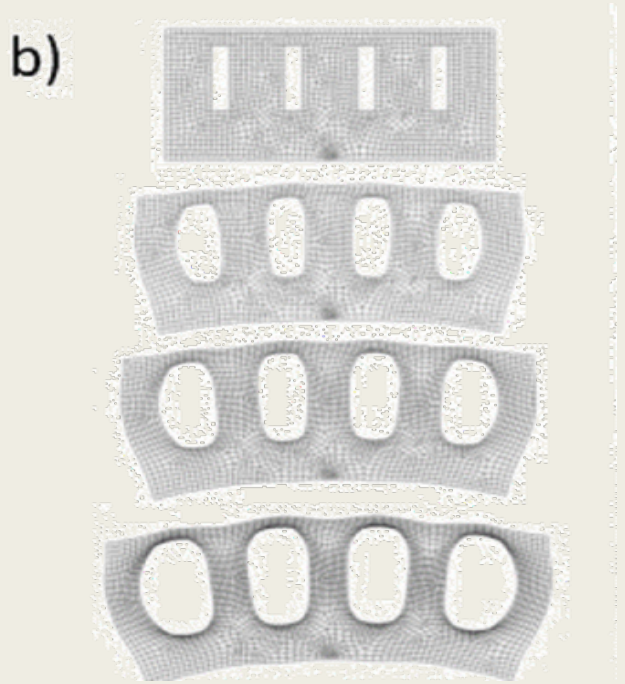




Medicine **Agriculture** **Food Industry**

Literature Review

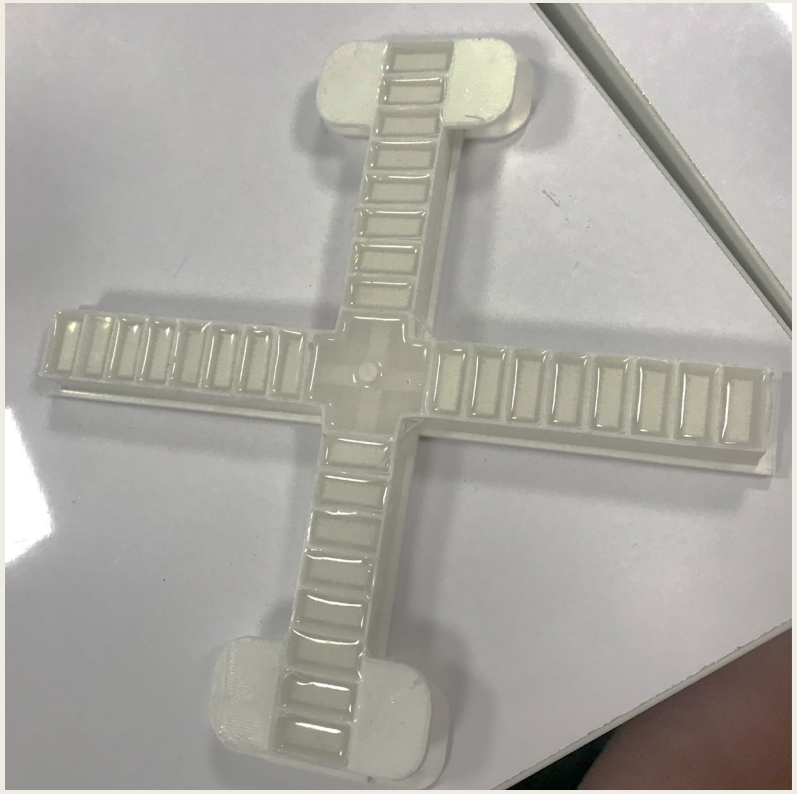




Introduction

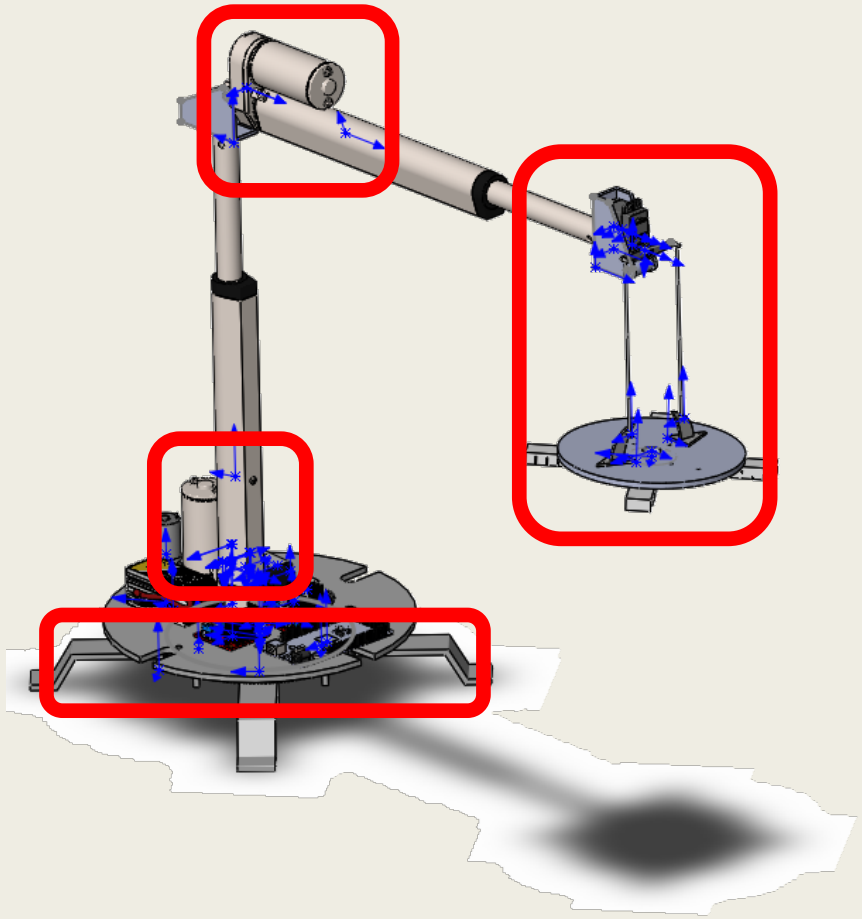
Soft robot Gripper

- Conform to objects of any shape
- Hold with uniform strength



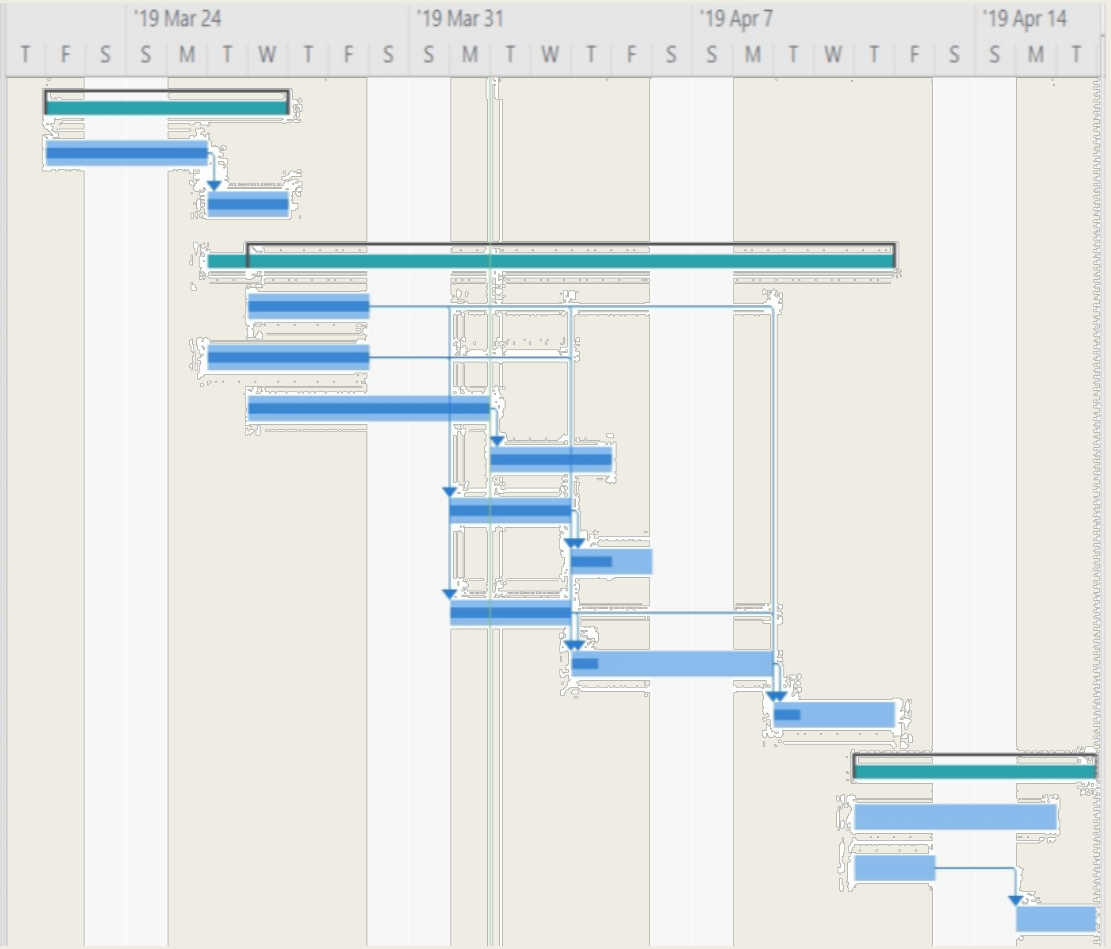
Objectives

- Servo motor & soft robot gripper
- Linear actuators
- Motor & gear set
- PS2 remote controller



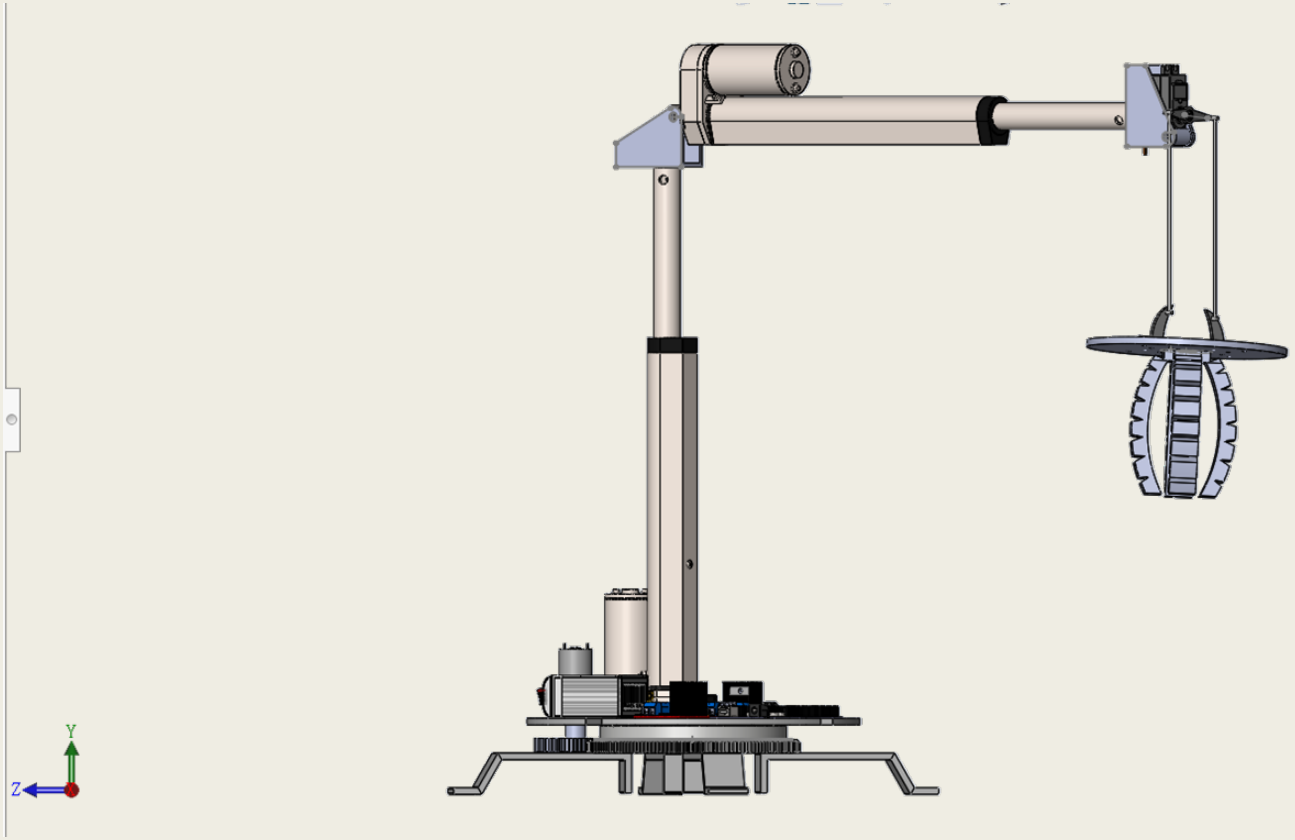
Gantt chart

任务名称	Duration	Start	Finish	Principal
Designing	**4 days**	**'19 Mar 22**	**'19 Mar 27**	
Mechanical Structure	2 days	'19 Mar 22	'19 Mar 25	Yang & Wu
Electronical System	2 days	'19 Mar 26	'19 Mar 27	Shen & Liu
Manufacturing	**12 days**	**'19 Mar 27**	**'19 Apr 11**	
Linear Actuator	3 days	'19 Mar 27	'19 Mar 29	Yang & Wu
L-Shaped Support	4 days	'19 Mar 26	'19 Mar 29	Yang & Wu
Air Pump & Solenoid Valve	4 days	'19 Mar 27	'19 Apr 1	Shen & Liu
PS2 Control Panel	3 days	'19 Apr 2	'19 Apr 4	Shen & Liu
Gripper	3 days	'19 Apr 1	'19 Apr 3	Shen & Liu
Servo Stick & Arm	2 days	'19 Apr 4	'19 Apr 5	Yang & Wu
Bearing	3 days	'19 Apr 1	'19 Apr 3	Yang & Wu
Gear & DC Motor	3 days	'19 Apr 4	'19 Apr 8	Yang & Wu
Carbon Fiber Plate	3 days	'19 Apr 9	'19 Apr 11	Yang & Wu
Assebmling	**4 days**	**'19 Apr 11**	**'19 Apr 16**	
Mechanical Parts	3 days	'19 Apr 11	'19 Apr 15	Yang & Wu
Electronic Parts	2 days	'19 Apr 11	'19 Apr 12	Shen & Liu
Programming	2 days	'19 Apr 15	'19 Apr 16	Shen & Liu

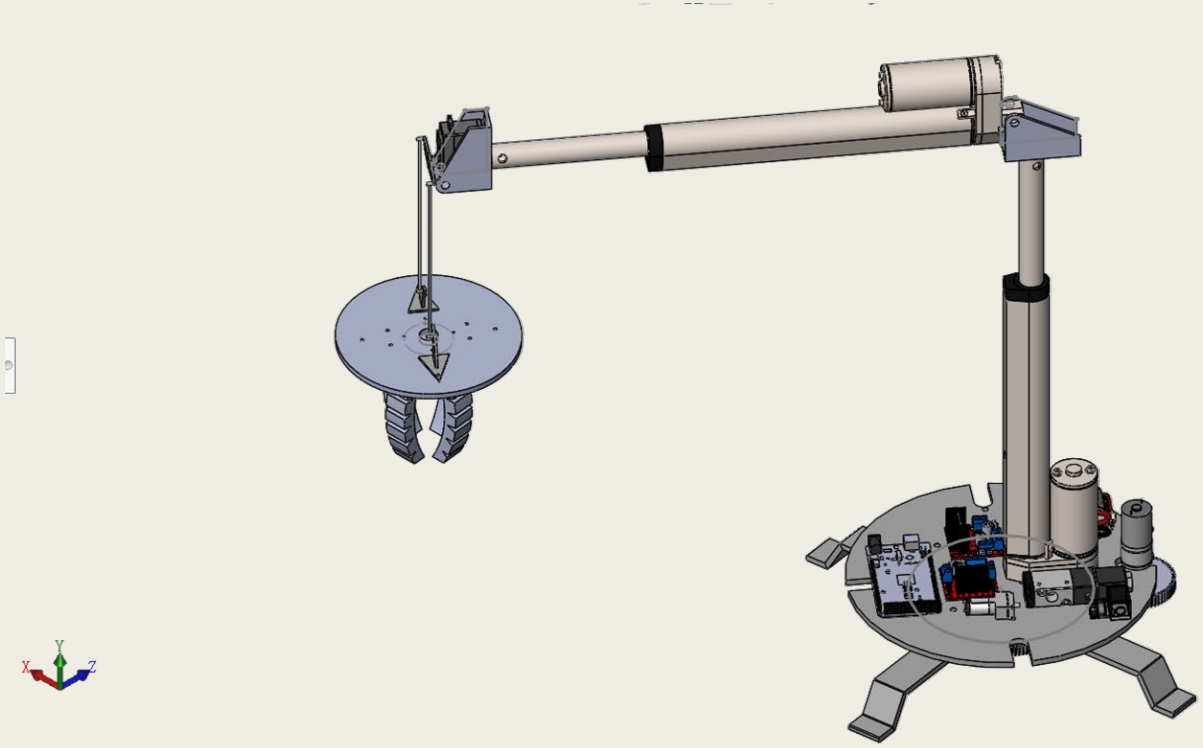


DESIGN OF COMPONENTS

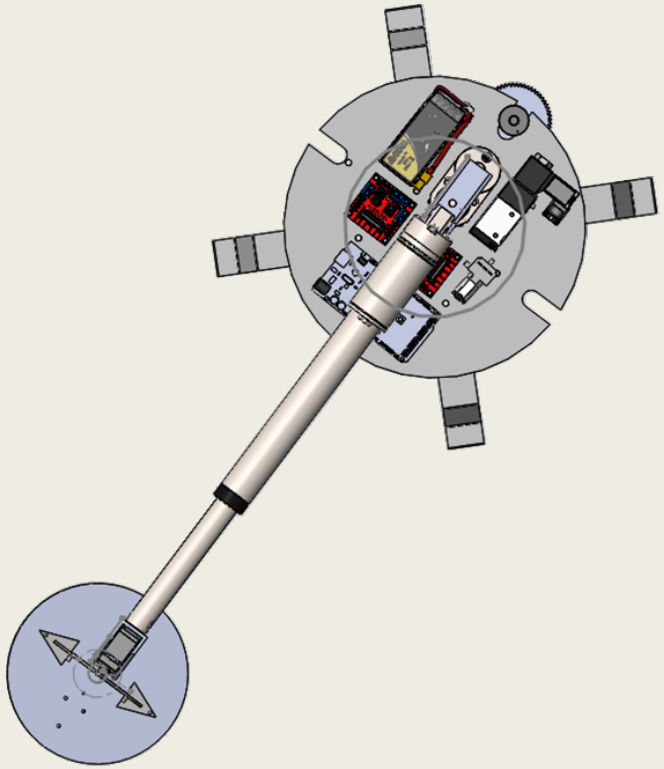
Left View



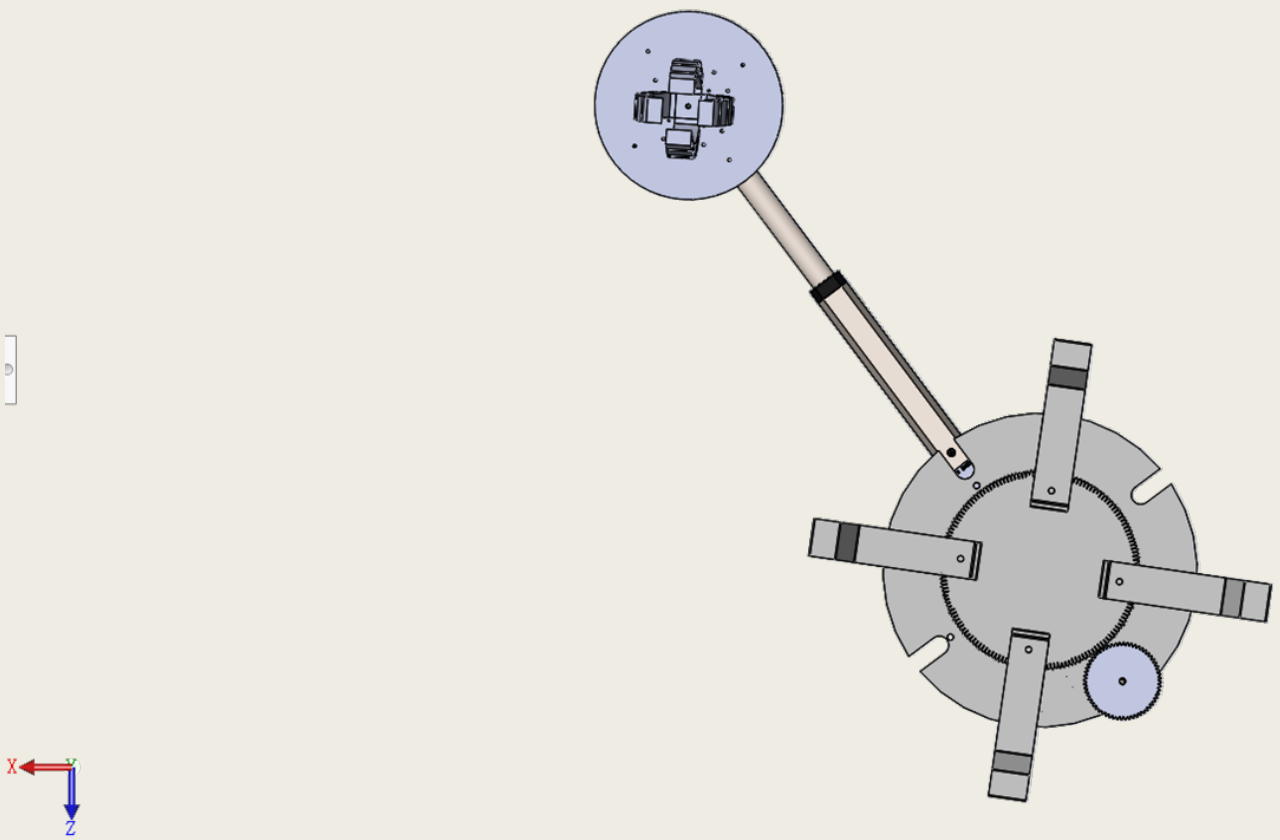
Top-right View



Top View



Bottom View

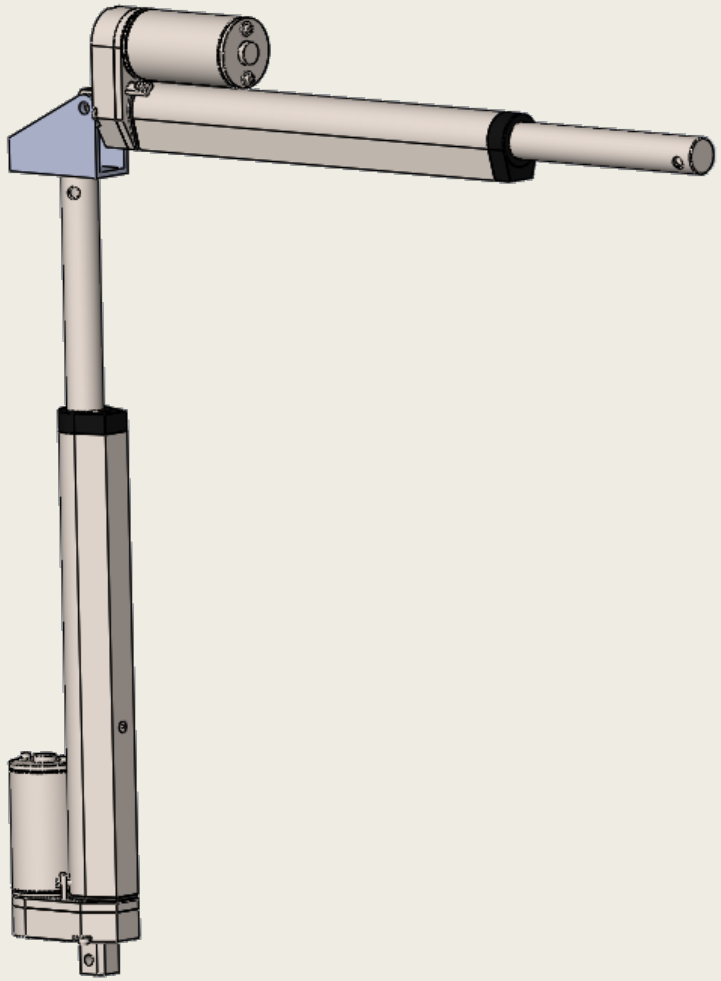


Creative Design

Horizontal & Vertical Extension

(Linear Actuator)

- **Easy to Control (L298N)**
- **Made of Aluminum and Iron**
- **Easy to be Fixed to the Platform**

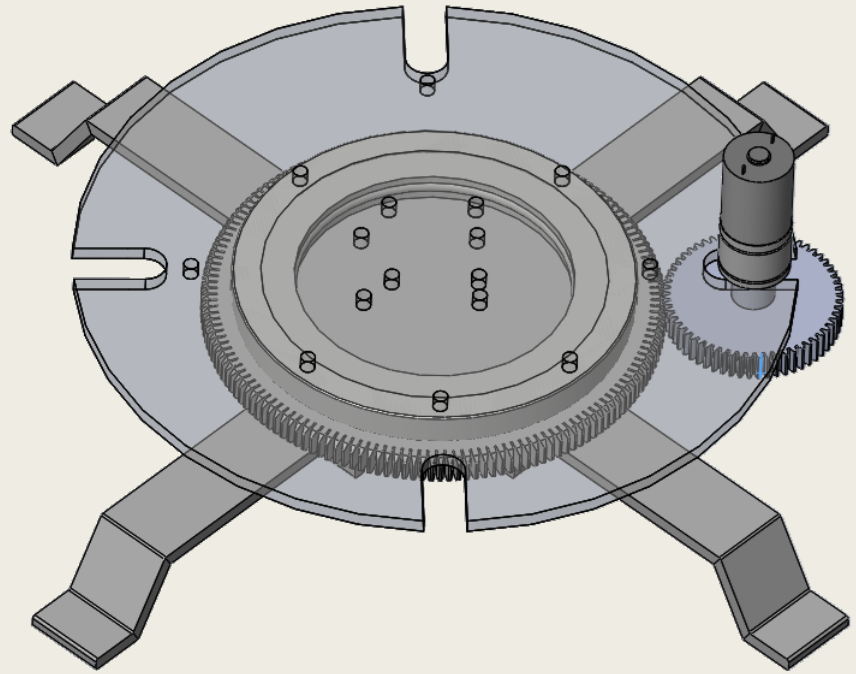


Creative Design

Revolution of Platform

(Gear & Motor)

- Simple & Reliable
- Easy to Control (DC motor)
- Carry Heavier Load

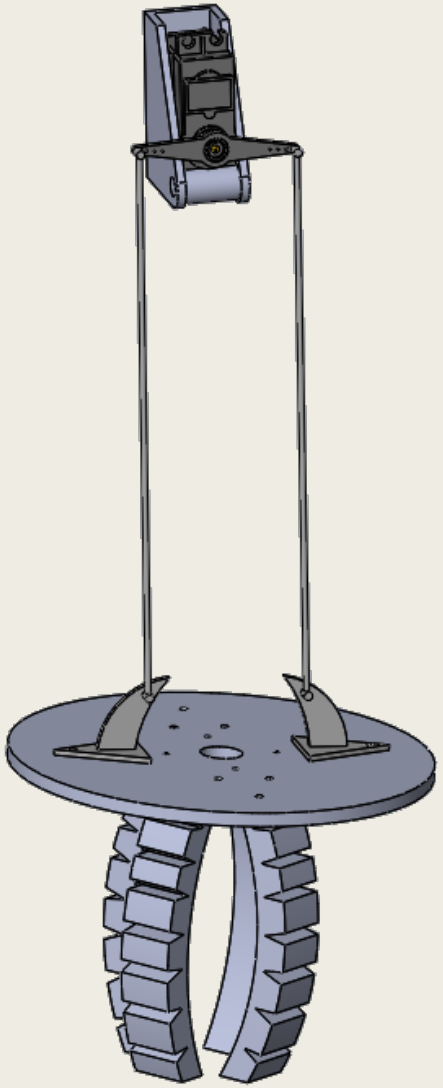


Creative Design

Rotation of Claw

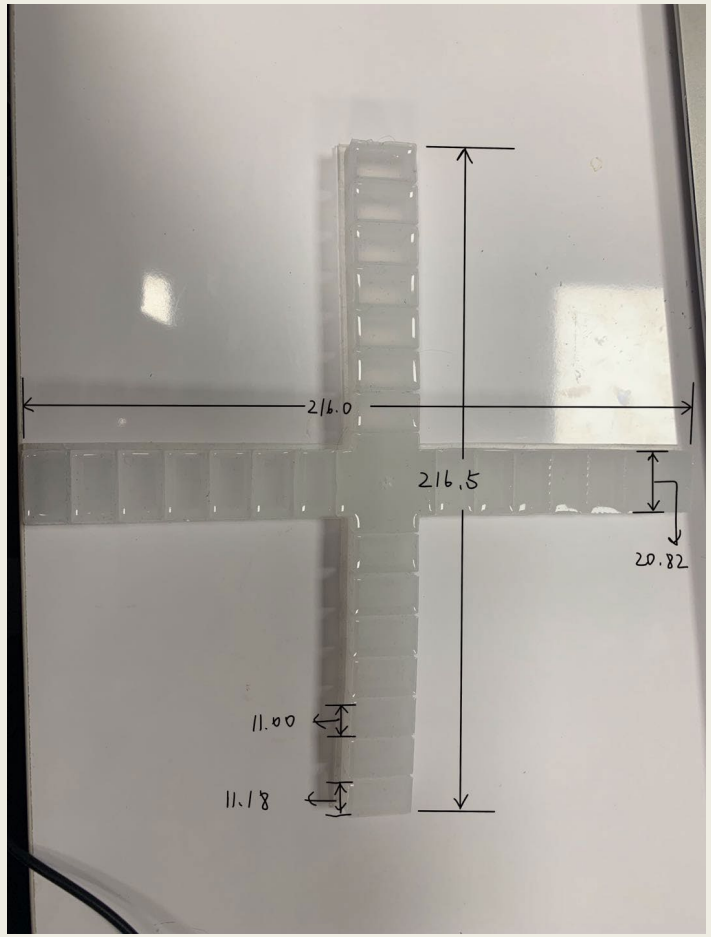
(Linkage & Joint)

- **Large Degree of Freedom (±180°)**
- **Simple & Light**
- **Easy to Control (Servo)**



MANUFACTURING AND ASSEMBLY

Soft Gripper



prepolymer is liquid before processing

Use Open Mold to form the shape

L-Shape Support

Connect with two linear actuators

Drilling holes at the bottom

Aluminum Sticks

Ductile, shape to a certain form

Sheet Metalworking

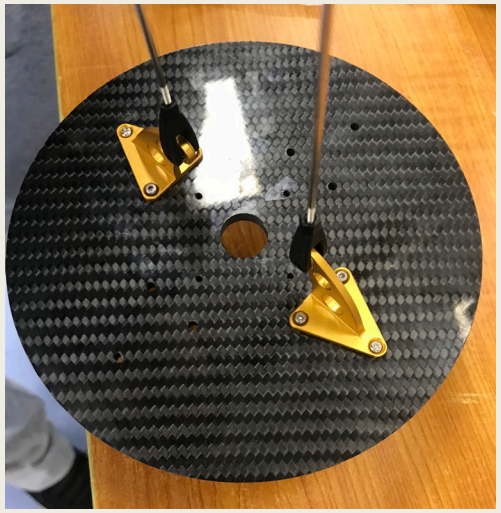
Material Selection

a. **Soft gripper**—prepolymer should be liquid, light—silica gel

b. **Plate**—high strength, light—carbon filter board

c. **Stick**—expandable, light—Aluminum

d. **L-shaped support**—high strength, large Young's modulus—Steel



Deceleration Motor

XD-37GB520 12V 100r/min

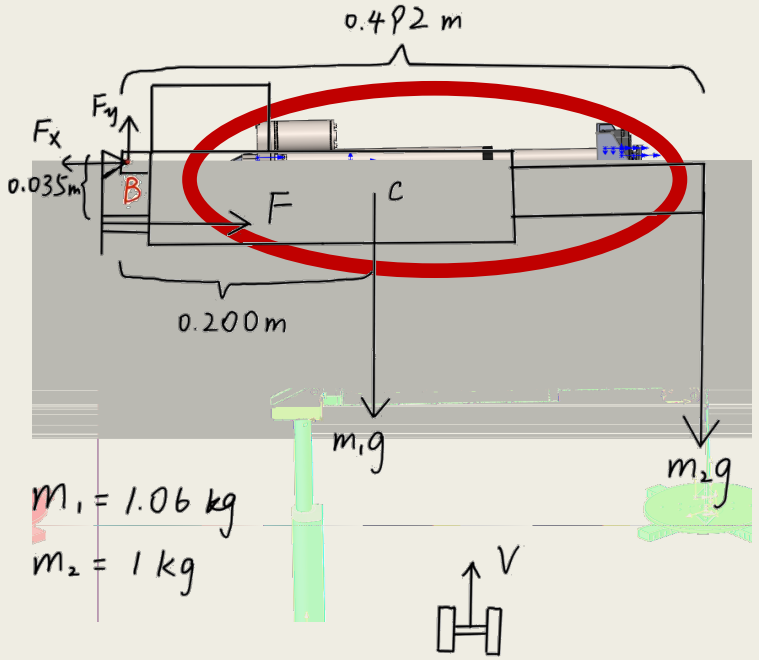
Moderate speed, large torque

Torque is 0.477 Nm, revolution speed for big plate is about 20r/min

ANALYSIS AND TEST

Shear force for the horizontal actuator.

B: pin
C: mass center of the actuator
m_2: The maximum load exerted to the actuator
We know that the moment about B should be 0.



$$M_1 = 0.2 * 1.06 * 9.8 = 2.078[\mathrm{N \cdot m}]$$

$$M_2 = 0.492 * 1 * 9.8 = 4.822[\mathrm{N \cdot m}]$$

$$M_2 + M_1 = 0.035 * \mathrm{F}$$

$$F_x = F = 197.14[\mathrm{N}]$$

$$V = \frac{1}{2}\sqrt{F_x^2 + (m_1 g + m_2 g)^2} = 99.1[N]$$

$$\tau = \frac{v}{A} = \frac{99.1}{\pi * 0.004 * 0.004} = 1.97\mathrm{MPa}$$

Shear force for the horizontal actuator.

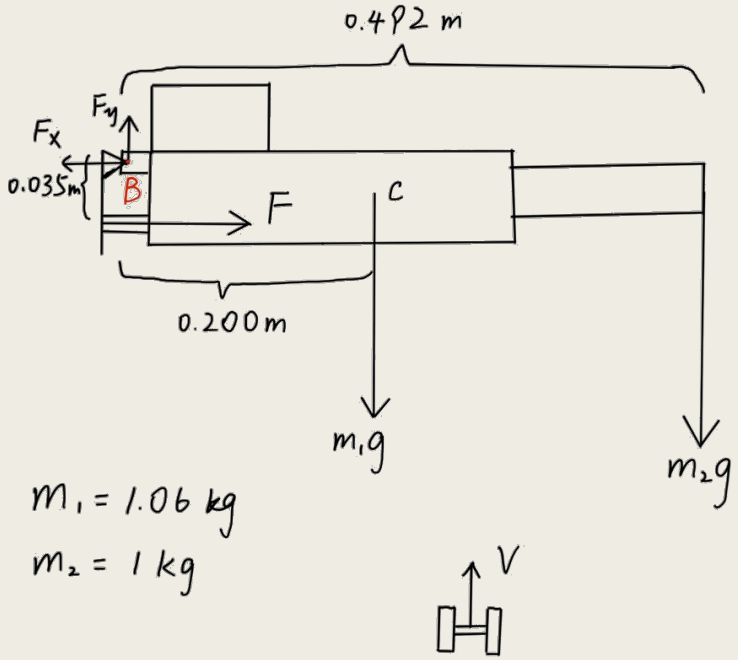
The material of the pin is steel.
We find that

$$\tau_f = 240\text{MPa}$$

$$\frac{\tau_f}{\tau} = \frac{240}{1.97}$$

$$=121.8>>1$$

It's very safe.

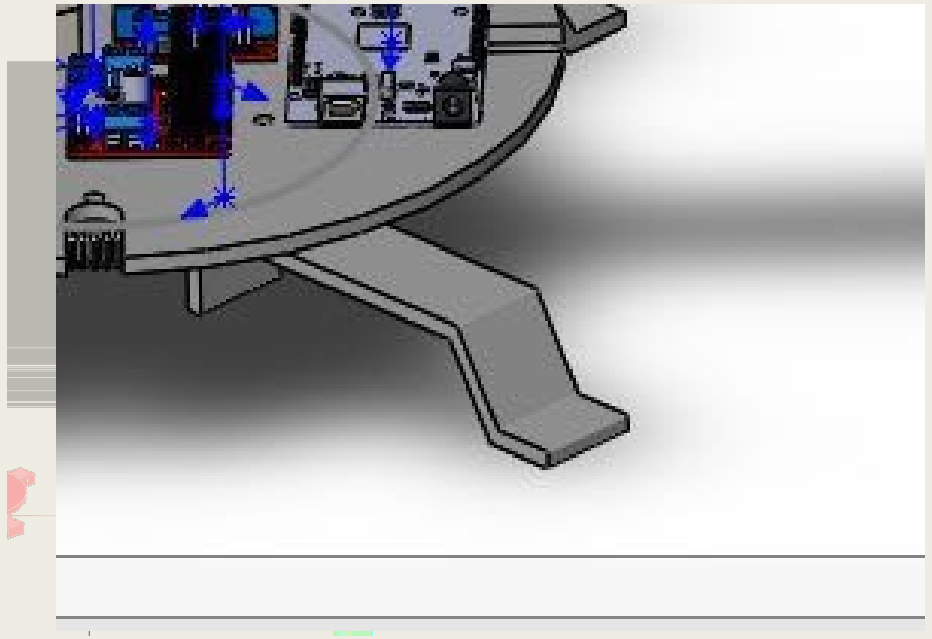


Deflection for the aluminum foots

$$S = \frac{6EI}{L^3} = \frac{6 * 80 \times 10^9 * A^2}{12 * 0.13^3} = 65544\,[\frac{N}{m}]$$

$$F = \frac{mg}{4} = 0.9 * 9.8 = 9\ [N]$$

$$\delta = \frac{F}{S} = 0.14\ [mm]$$



Safe and reliable

Normal stress vs. rotation angle

m: maximum weight of the grabbed object

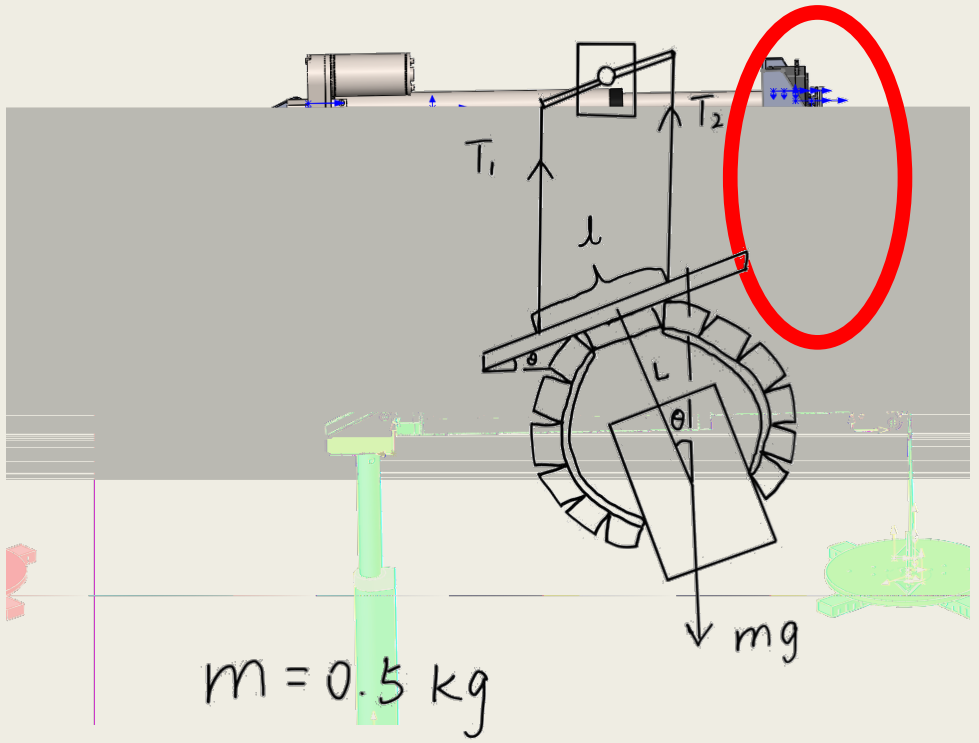
$$T_1 + T_2 = mg$$

$$T_1 l\cos\theta + mgL\sin\theta = T_2 l\cos\theta$$

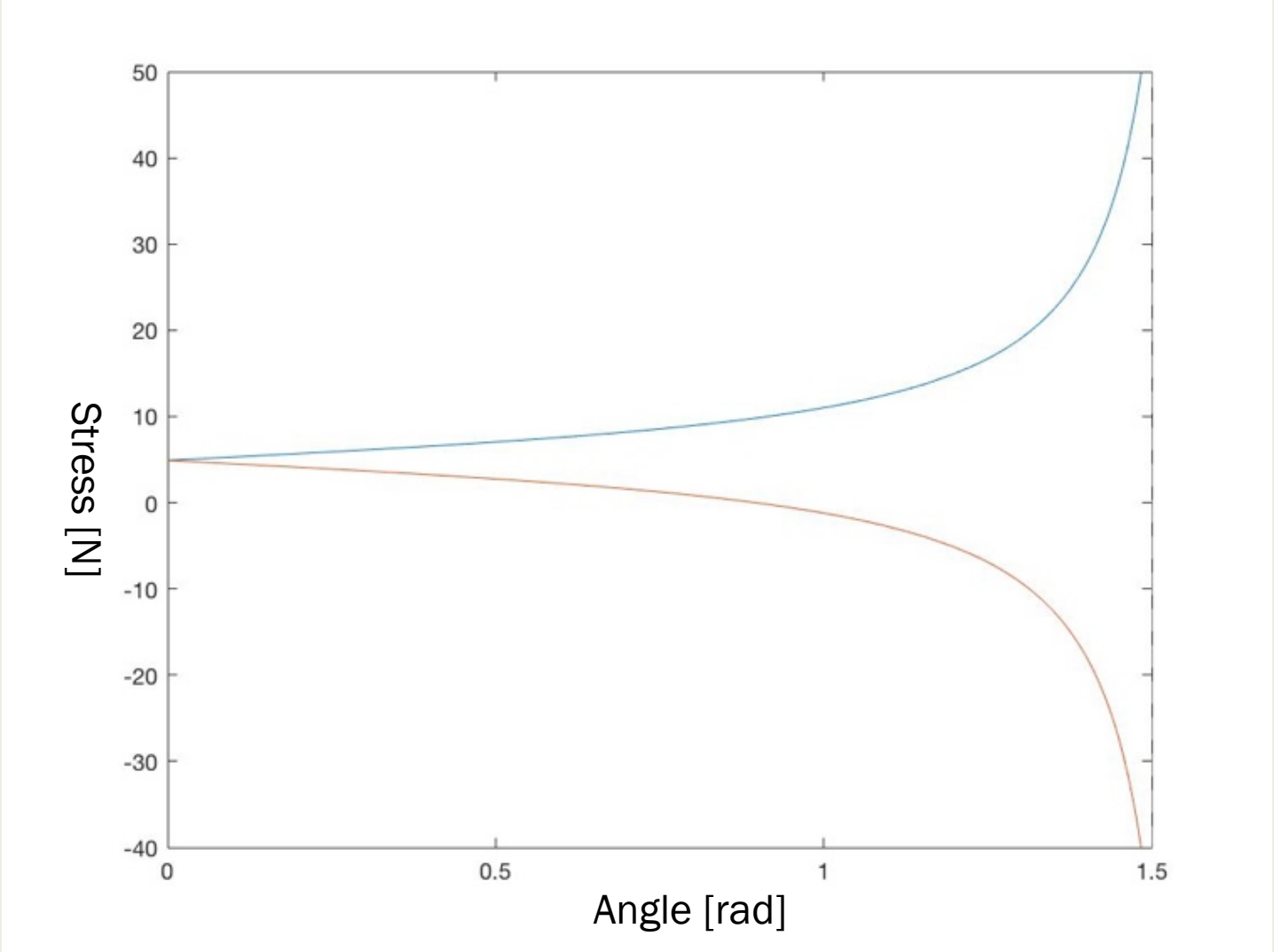
L=8cm l =2.5cm

$$T_1 = mg + \frac{8mg\sin\theta}{5\cos\theta}$$

$$T_2 = mg - \frac{8mg\sin\theta}{5\cos\theta}$$



Normal stress vs. rotation angle



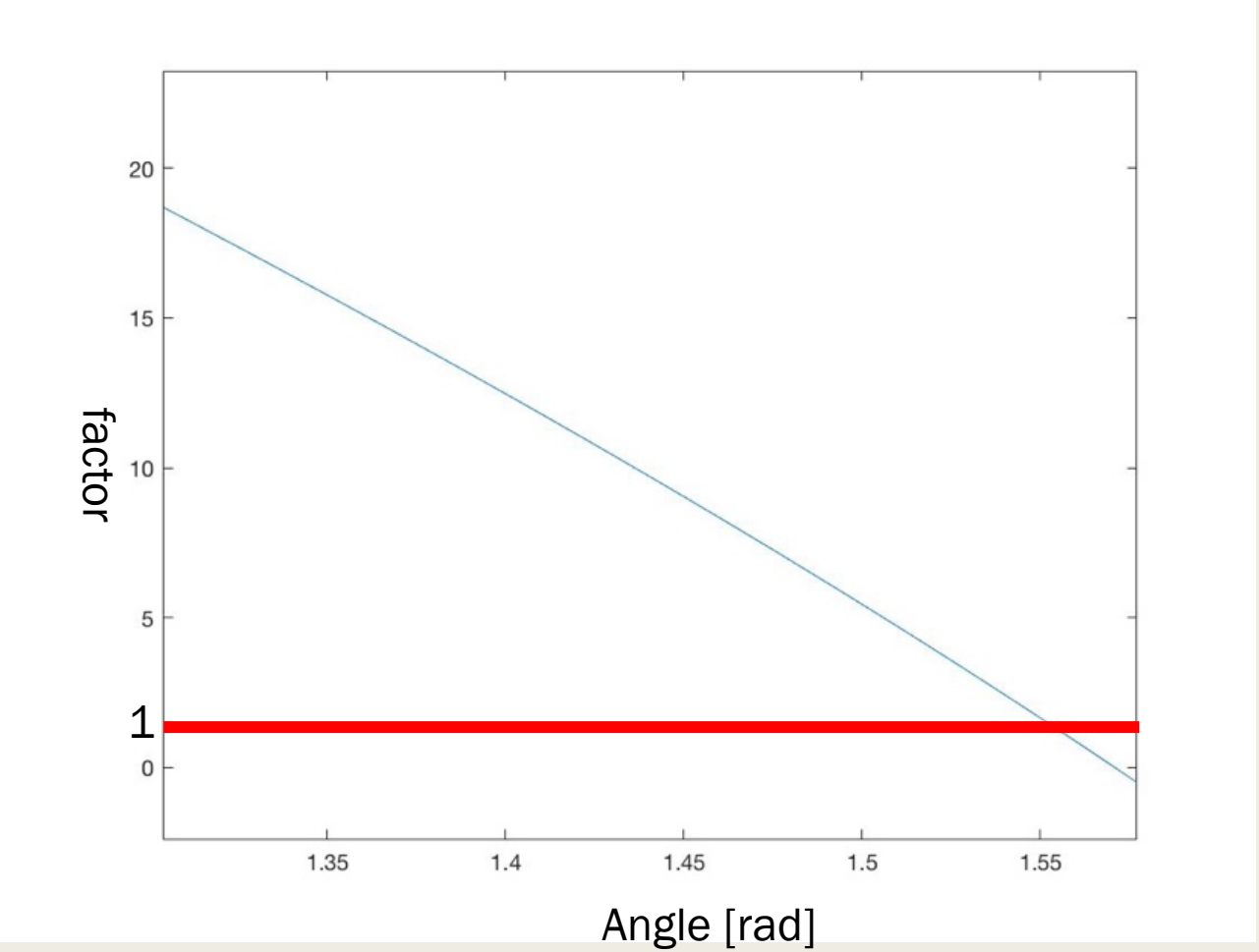
Normal stress vs. rotation angle

$$A = \pi r^2 = 3.14 \times 10^{-6}\ [m^2]$$

$$\sigma = \frac{T}{A} \qquad \sigma_f = 200\text{MPa}$$

$$\frac{\sigma_f}{\sigma_s} = \frac{200M * A}{T}$$

θ_{max}=1.56 = 89°

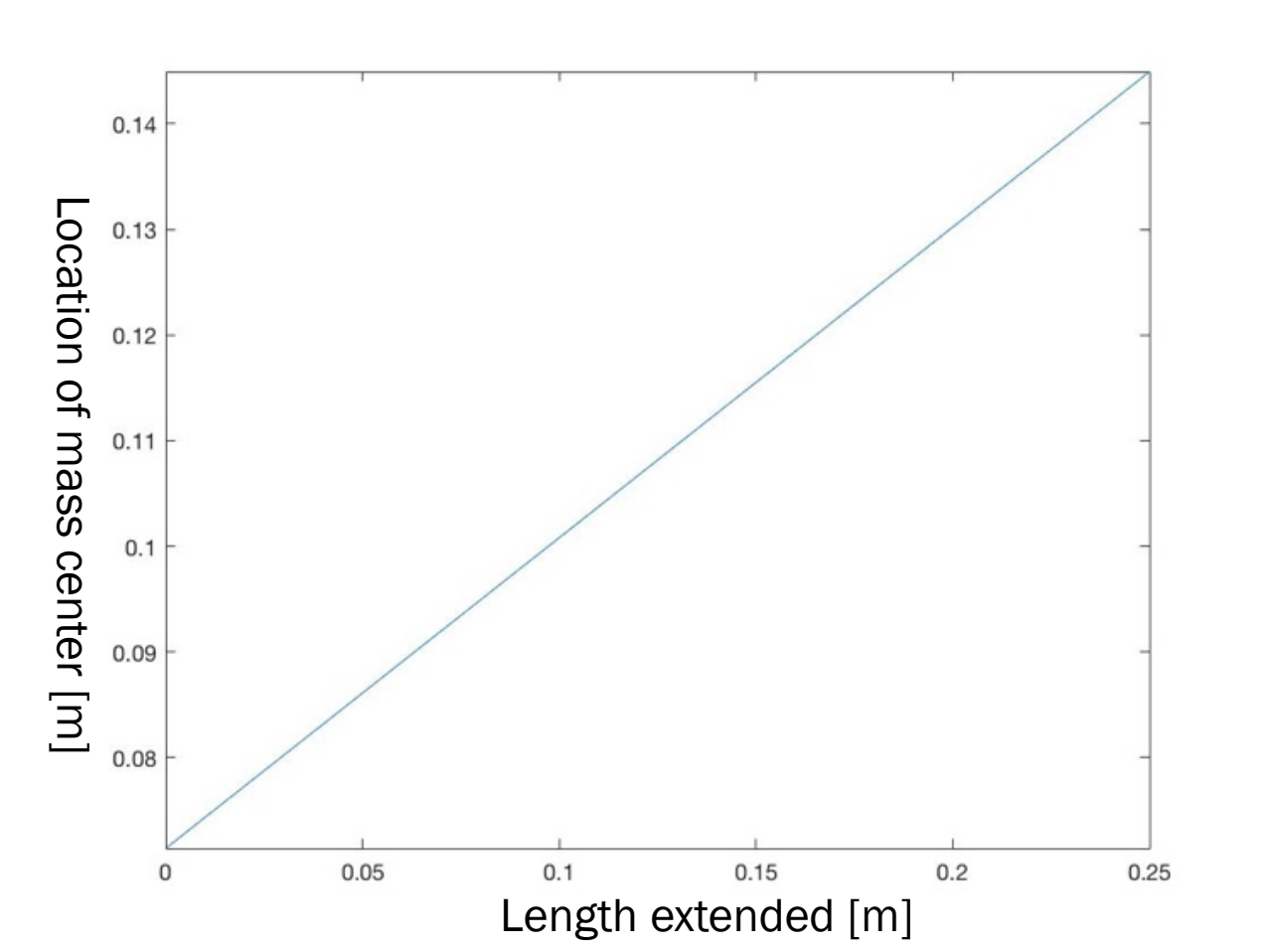


Location of mass center

$$l = \frac{-0.04 * 1 * 9.8 + 0.16 * 1.06 * 9.8 + (0.16 + x) * 9.8 - 0.125 * 0.375 * 9.8}{3.4 * 9.8}$$

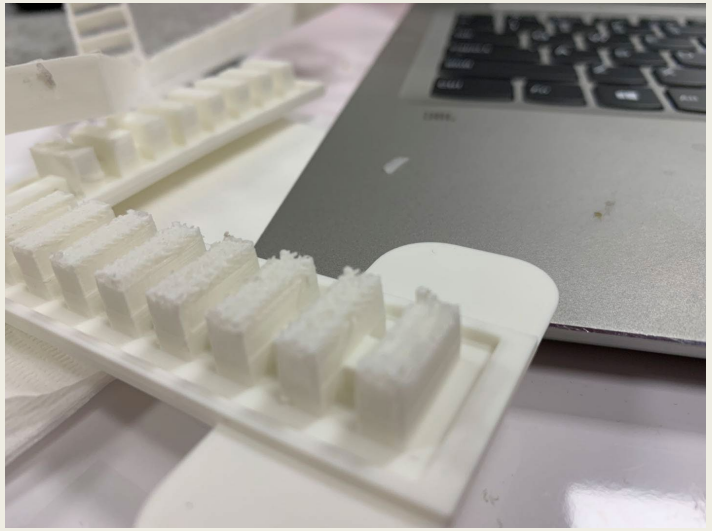
$$= \frac{0.811 + (0.16 + x) * 9.8}{33.32}$$

l < r =0.175m



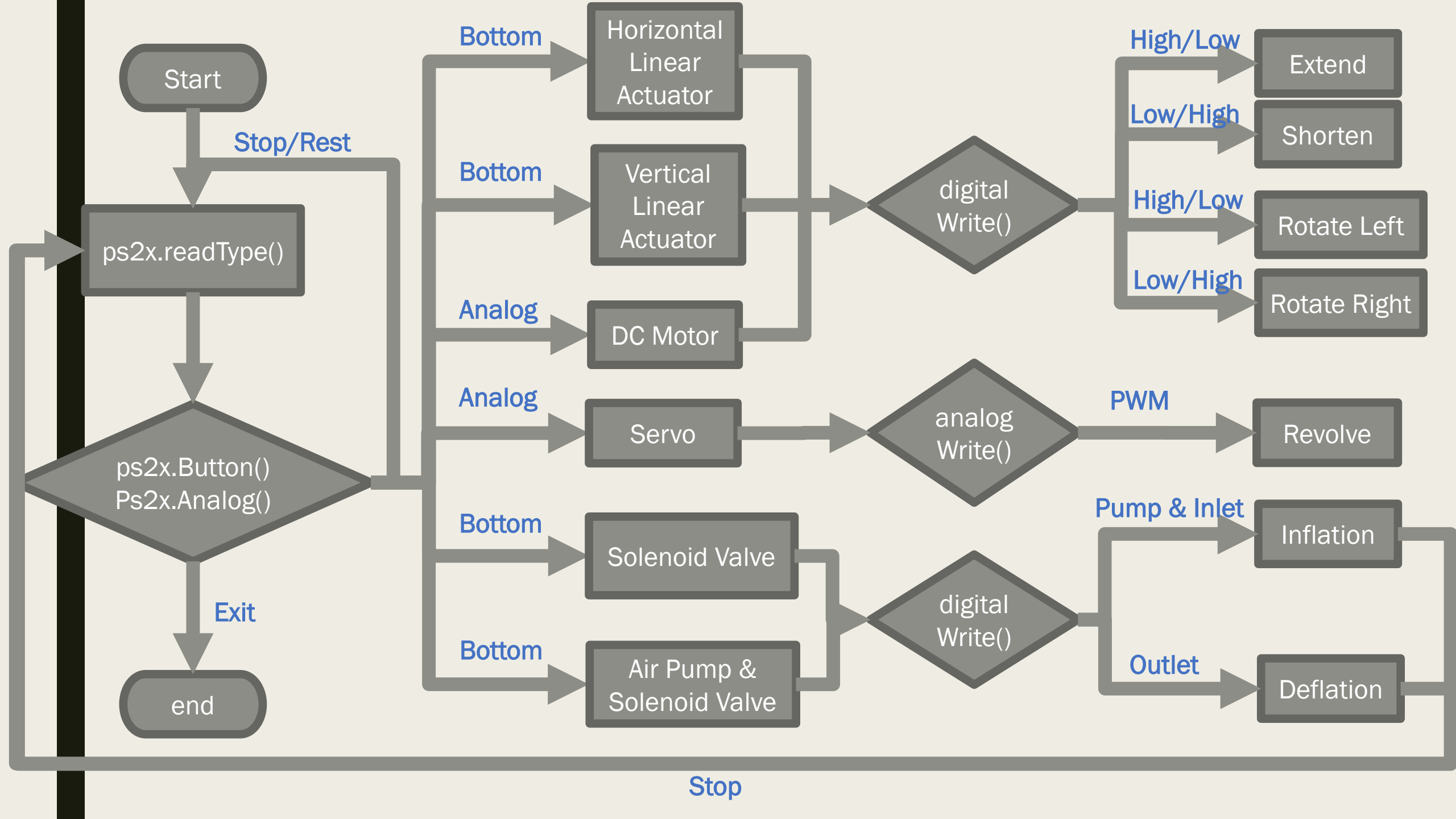
Gripper

Bad 3D print



Bad 3D print

FLOW CHART OF ARDUINO CODE


Start
Stop/Rest
ps2x.readType()
ps2x.Button()
Ps2x.Analog()
Exit
end
Bottom
Horizontal Linear Actuator
Bottom
Vertical Linear Actuator
Analog
DC Motor
Analog
Servo
Bottom
Solenoid Valve
Bottom
Air Pump & Solenoid Valve
digital Write()
analog Write()
digital Write()
High/Low
Extend
Low/High
Shorten
High/Low
Rotate Left
Low/High
Rotate Right
PWM
Revolve
Pump & Inlet
Inflation
Outlet
Deflation
Stop

Cite

- Overview of project VM250 Spring 2019.
- Soft robotics: a bioinspired evolution in robotics; Author links open overlay panelSangbaeKim[1]CeciliaLaschi[2]BarryTrimmer[3]
- Soft Robotics for Chemists[†]Dr. Filip Ilievski Dr. Aaron D. Mazzeo Dr. Robert F. Shepherd Dr. Xin Chen Prof. George M. Whitesides