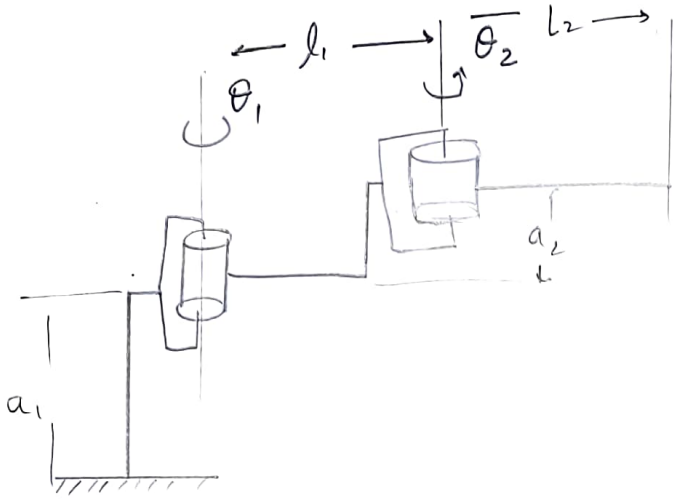
Task 0:



$l_1 = l_2 = 107\,mm.$

$a_1 = 100$

$a_2 = 64$

Note :- During coding in IDE a_1 & a_2 are assumed to be zero to reduce the system to be a planar manipulator.

DH Table after above assumption.

Link	a_i	α	d	θ
1	107	0		θ_1
2	107	0		θ_2

$$A1 = \begin{bmatrix} C_1 & -S_1 & 0 & a_1C_1 \\ S_1 & C_1 & 0 & a_1S_1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad A_2 = \begin{bmatrix} C_2 & -S_2 & 0 & a_2S_2 \\ S_2 & C_2 & 0 & a_2S_2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

T-matrix

$$T_0^1 = A_1 \; ; \; T_0^2 = A_1A_2 = \begin{bmatrix} C_{12} & -S_{12} & 0 & a_1C_1 + a_2C_{12} \\ S_{12} & C_{12} & 0 & a_1S_1 + a_2S_{12} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Case I : $\theta_1 = 45$ $\theta_2 = 90$

$$T_0^2 = \begin{bmatrix} -1/\sqrt{2} & -1/\sqrt{2} & 0 & 0 \\ 1/\sqrt{2} & -1/\sqrt{2} & 0 & 151.32 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Case 2 : $\theta_1 = 90$ $\theta_2 = 45$

$$T_0^2 = \begin{bmatrix} -1/\sqrt{2} & -1/\sqrt{2} & 0 & -75.66 \\ 1/\sqrt{2} & -1/\sqrt{2} & 0 & 182.66 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

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we have.

$$J = [J_v ; J_w]$$

where,

$$J_v = \begin{bmatrix} 107 * (-\sin\theta_1) , & 107 * (-\sin\theta_2) ; \\ 107 * \cos\theta_1 , & 107 \cos\theta_2 ; \\ 0 , & 0 \end{bmatrix}$$

$$J_w = \begin{bmatrix} 0 , & 0 ; \\ 0 , & 0 ; \\ 1 , & 1 \end{bmatrix}$$

Thus

$$J = \begin{bmatrix} -107 \cdot \sin\theta_1 & -107 \sin\theta_2 \\ 107 \cos\theta_1 & 107 \cos\theta_2 \\ 0 & 0 \\ 0 & 0 \\ 1 & 1 \end{bmatrix}$$

Issue faced in Hardware.

1. Pulleys were slipping during sudden motion.
2. Gear was slipping from shaft of motor 2.
3. Gear of shaft of motor 1 was eccentric.
4. Motor 1 was not moving blew 40 value of PWM and motor 2 was not moving blew 30 value of PWM.

Task I:

1- Due to various issues in hardware as mentioned before there were constant vibrations and end effector was not reaching the point 1.

Task 2:

1. We were not able to control the Torque through current sensor. Therefore after reaching the point we gave a constant value of PWM to both motors and recorded the force value using FSR Sensor on a seprate arduino.

Task 3:

1- Our proper code of spring force by using dynamics was not working so we made the End effector occilate b/w two points.