Robotics Midsem

Task:2 Pill picking robot :

-> vacuum based gripper is not desired.

(a) Hard gripper : This type of gripper will be not suitable for application. The main reason being its rigidity.

-> we may need Expensive force sensors to sense contact force so that it doesnt damage the pills.

-> Also we need high accurate orientation control, which may be computationally expensive.

These basic points make hard gripper non feasible.

Soft gripper; This is more preferable as it has compliance & does not produce high contact force due to small positional Errors. So pill is safe and we need not require Expensive force sensors

4-b) Flexible mechanism seems to suit 1-dof requirement, it is generally hard to control it.

⊙ Paper / origami based gripper seems to be better choice, as we can design mechanisms which is 1 dof & it has ability to encapsulate the pill from all sides. Thus avoiding orientation control issue & papers are soft, so force control issue is also not there.

Interesting Links :

1) https://www.youtube.com/watch?v=byqGFH6AZuk

2) https://www.youtube.com/watch?v=gI0tzsO8xwc

3) https://www.youtube.com/watch?v=uPx8xwRpfFk

Task: 3-a

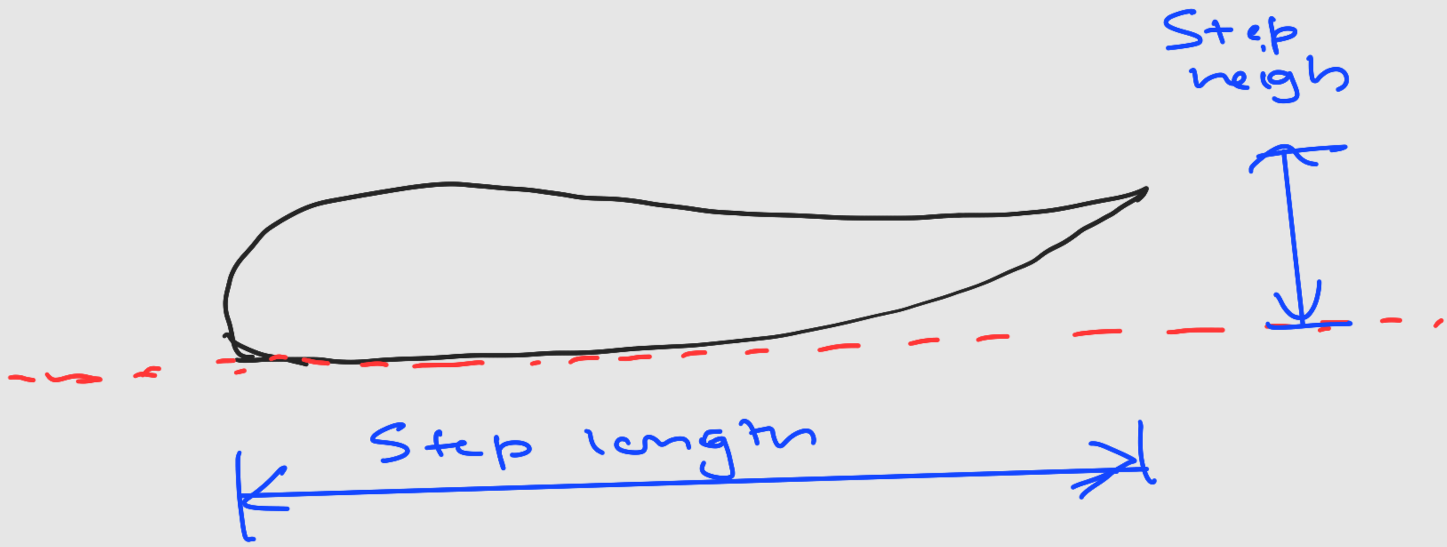
(a) Link length:

$l_1 \cong 0.4$ m [hip → knee]

$l_2 \cong 0.55$ m [knee → ankle]

Gait Trajectory

Assume the below fig to be gait Trajectory:



Gait Trajectory: It is the path tracked by ankle of one leg when person walks forward.

Step Height: Max. height person raises his ankle during one cycle of gait is step height.

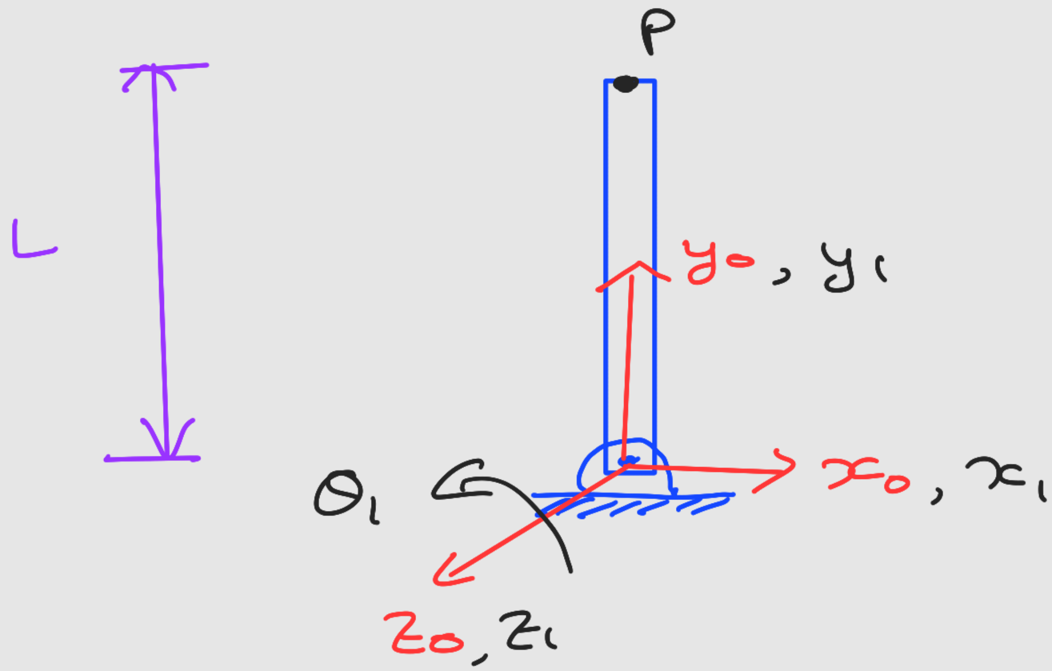
Step length: Max. distance travelled by ankle in one cycle of gait is step length.

→ The study of this parameters are important as different diseases affect the gait pattern of person.

For eg: Parkinson disease decreases step length due to issue in brain. Stroke patient has abnormal gait etc.

Task : 4

(a)



DH parameters :

	θ	α	a	d
Link : 1	$0+\theta_1$	0	0	0

From DH parameter theory

$$H_0^1 = \begin{bmatrix} C\theta_1 & -S\theta_1 & 0 & 0 \\ S\theta_1 & C\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$P_1 = \begin{bmatrix} 0 & L & 0 & 1 \end{bmatrix}^T$$

$$\therefore P_0 = H_0^1 \; P_1$$

$$\therefore P_0 = \begin{bmatrix} -LS\theta_1 \\ LC\theta_1 \\ 0 \\ 1 \end{bmatrix}$$

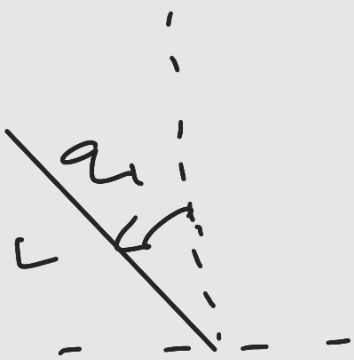
$\Downarrow$

End Effector of 1-R robot.

(b) Virtual Torsional Stiffness:

Consider it's mean position

$$q_0 = 0^\circ$$



It needs to behave like Spring about y-axis.

The dynamics of 1R robot.

can be worked out as:

$$\tau_d = ml^2 \frac{d^2 q_1}{dt^2} + mgl\sin q_1$$

dynamic torque

Now spring behavior about mean position.

$\therefore$ Error = Joint variable Error.

$$\therefore \tau_s = K(q_0 - q_1)$$

Torque to provide spring Effect.

mean position.

current angle

$\therefore$ Total Torque τ_T

$$\tau_T = \tau_d + \tau_s$$

$$= ml^2 \frac{d^2 q_1}{dt^2} + mgl \sin q_1$$

$$+ K(q_0 - q_1)$$

$\Downarrow$

Total torque applied by motor

$$\boxed{\tau = f(q)}$$

if gravity is neglected:

$$\boxed{\tau_T = ml^2 \frac{d^2 q_1}{dt^2} + K(q_0 - q_1)}$$

Task : 5 Yes

It is aligned for both revolute & prismatic

Task : 6 No

By following rules of DH convention many times it does not come on joint center.

Task : 7 Yes

$$H = \left[\begin{array}{c|c} R & d \\ \hline 0 & 1 \end{array}\right]$$

Task : 8 Yes

$$R_0^4 = R_0^1 \, R_1^2 \, R_2^3 \, R_3^4 .$$

but multiplied in reverse manner.
(right to left)

Task : 9 Yes. It will be orthogonal. Actually by mathematical definition it is "orthonormal".

Task : 1 D :

$$\dot{x} = J \dot{q}$$

$$\therefore \dot{q} = J^{-1} \dot{x}$$