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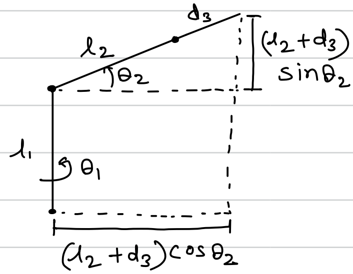
ME639 - Midsem

Q.1

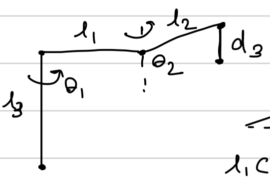
Stanford forward mechanism :→

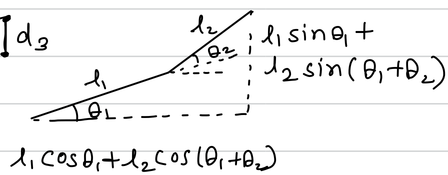
$$x = (l_2+d_3)\cos\theta_1 \cos\theta_2$$
$$y = (l_2+d_3)\sin\theta_1 \cos\theta_2$$
$$z = l_1 + (l_2+d_3)\sin\theta_2$$



Scara forward mechanism :→

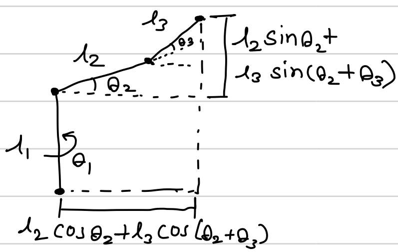
$$x = l_1\cos\theta_1 + l_2\cos(\theta_1+\theta_2)$$
$$y = l_1\sin\theta_1 + l_2\sin(\theta_1+\theta_2)$$
$$z = l_3 - d_3$$





Puma forward mechanism :→

$$x = (l_2\cos\theta_2 + l_3\cos(\theta_2+\theta_3))\cos\theta_1$$
$$y = (l_2\cos\theta_2 + l_3\cos(\theta_2+\theta_3))\sin\theta_1$$
$$z = l_1 + l_2\sin\theta_2 + l_3\sin(\theta_2+\theta_3)$$



Q. 2

a)

In the pill picking robot, soft gripper would be suitable. In this pill picking project, robot would be interacted with pills which can be irregular shaped and delicate. That's why soft gripper should be considered. Also, hard grippers use higher forces for holding whearas soft gripper can adjust its shape and grips object at lower values of forces.

b) i] Origami robots :→

These kind of robots make use of many dynamic folds to actuate the machine. In the video attached, there is a robot made of paper using Origami and it undergoes gripping movement when horizontal forces are applied on both ends.

https://www.youtube.com/watch?v=UerxNyu147g

ii] Universal Robotic gripper :→

In industry most of the robots that handel varying shaped and force sensitive objects are made up of multifingered hand. If these hands are replaced by cubes madeup of granular material which would move around the object after pressing on it to shape. Hence this gripper would be useful in gripping project.

https://www.pnas.org/content/107/44/18809

Q.3

a) length of 1^{st} link = 47 cm
length of 2^{nd} link = 51 cm

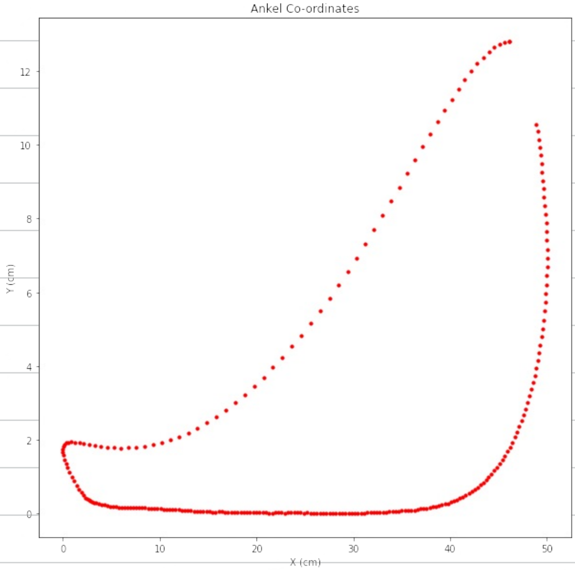
Gait Trajectory :→ Gait is person's walking pattern. And the trajectory followed by joint, ankel and hip bone during walking are included in Gait Trajectory.

Step height :→ Difference in initial height of the ankel and maximum height reached by ankel is step height.

Step length :→ It is the distance between initial position and final position of ankel during one step.

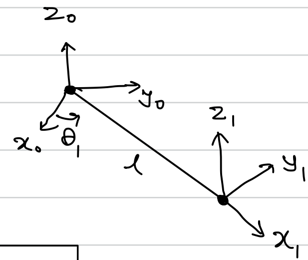
b)

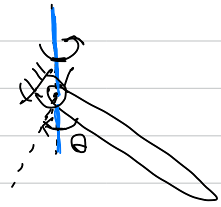
Results :→



Q.4

a) Robot with single revolute joint and a single link of length l:→





Single-link robot

DH-parameters

link	a_i	α_i	d_i	θ_i
1	l	0	0	θ_1^*

$$T_0^1 = A_0^1 = \begin{bmatrix} C_\theta & -S_\theta C_\alpha & S_\theta S_\alpha & a C_\theta \\ S_\theta & C_\theta C_\alpha & -C_\theta S_\alpha & a S_\theta \\ 0 & S_\alpha & C_\alpha & d \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} C\theta_1 & -S\theta_1 & 0 & l C\theta_1 \\ S\theta_1 & C\theta_1 & 0 & l C\theta_2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

b) Joint to behave like a virtual torsional stiffness;→

Dynamics of robot neglecting gravity,

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

Q.5

Yes, joint axes are always aligned with respect to z axis. If joint is revolute then z axis is along tha axis of rotation and if joint is prismatic then z axis is along tha axis of motion.

Q.6

No, origins are located at the intersection point of z_i and z_{i-1} axis. There are cases in which this point of intersection would not be at center of joint.

Q.7

True

Q.8

Yes. Multiplying the rotation matrices together would form the overall rotation matrix.

Q.9

Yes. Composite rotation matrix is orthogonal and has determinant ± 1. As every rotation matrix is orthogonal and multiplication of orthogonal matrices is also orthogonal. Hence, composite rotation matrix is orthogonal.
For every orthogonal matrix, determinant is 1 or -1.
So, composite rotation matrix has determinant ± 1.