EECE 5552-Assistive Robotics
Assignment 3

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***Due by 09:50 AM Eastern Time, Tuesday, Oct 13**

Problem 1

(a) Consider the 3 DoF robotic arm shown below.

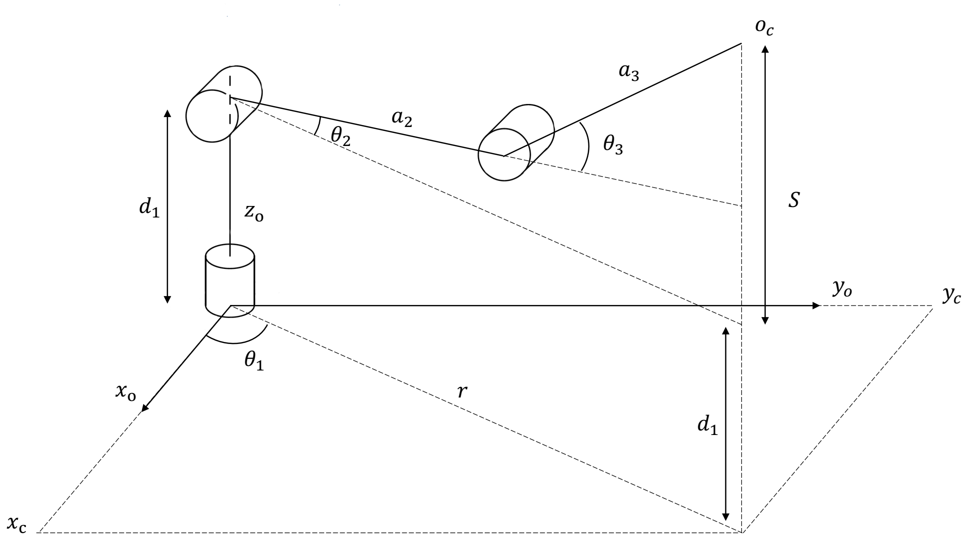

Figure 1: Problem 1-a.

What are θ_1, θ_2, θ_3 if x_c, y_c, z_c are given?

(b) What are θ_1, θ_2, θ_3 when $x_c = y_c = 0$?

(c) If there is an offset $d \neq 0$, what is θ_1? How many solutions exist?

Problem 2

Consider the robot shown below. The corresponding DH parameters are given.

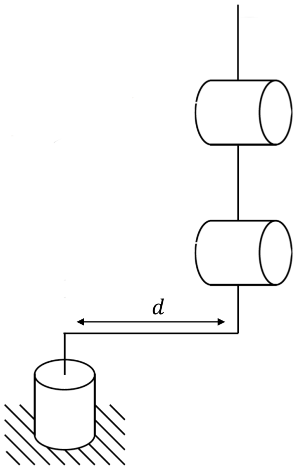

Figure 2: Problem 1-c.

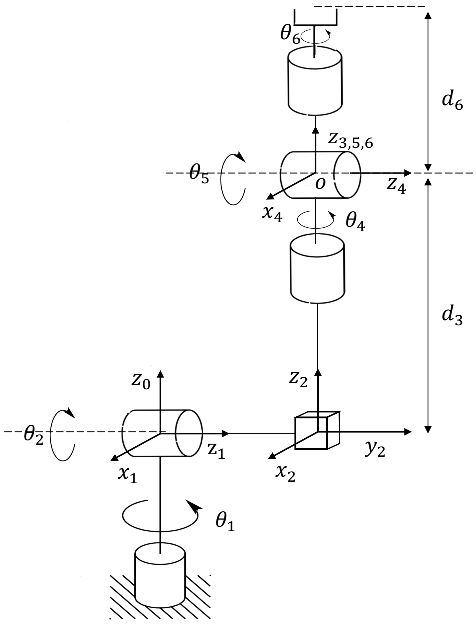

Figure 3: Problem 2.

link	d_i	a_i	α_i	θ_i
1	0	0	-90	θ_1
2	d_2	0	90	θ_2
3	d_3	0	0	0
4	0	0	-90	θ_4
5	0	0	90	θ_5
6	d_6	0	0	θ_6

(a) What are A_i, $i \in \{1, 2, 3, 4, 5, 6\}$? What is $T_6^o = A_1A_2A_3A_4A_5A_6$?

(a) In order to describe the velocity kinematics of the end effector, we seek expressions of the form

$$v_n^0 = J_v\dot{q}$$
$$w_n^0 = J_w\dot{q}$$

Where J_v and J_w are 3×6 matrices, and

$$q = (\theta_1, \theta_2, d_3, \theta_4, \theta_5, \theta_6)$$

Note that joint 3 is prismatic and $O_3 = O_4 = O_5$ as a consequence of the spherical (universal) wrist and the frame assignment. Denoting this common origin by O we see that the columns of the Jacobian matrix have the form:

$$J_i = \begin{bmatrix} z_{i-1} \times (o_6 - o_{i-1}) \\ z_{i-1} \end{bmatrix} \qquad i = 1, 2$$

$$J_3 = \begin{bmatrix} z_2 \\ 0 \end{bmatrix}$$

$$J_i = \begin{bmatrix} z_{i-1} \times (o_6 - o_{i-1}) \\ z_{i-1} \end{bmatrix} \qquad i = 4, 5, 6$$

Now, using A_i and J matrices from Problem 2-a, synthesize the Jacobian matrix J:

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

$$\xi = \begin{bmatrix} v_n^0 \\ w_n^0 \end{bmatrix} \qquad J = \begin{bmatrix} J_v \\ J_\omega \end{bmatrix}$$