Chapter 4/5 Homework 3

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Problem 1. Derive the Jacobian for your previous RRP robot symbolically.

Solution

$$J = \begin{pmatrix} -d_3\,\cos(\theta_2)\,\sin(\theta_1) & -d_3\,\cos(\theta_1)\,\sin(\theta_2) & \cos(\theta_1)\,\cos(\theta_2) \\ d_3\,\cos(\theta_1)\,\cos(\theta_2) & -d_3\,\sin(\theta_1)\,\sin(\theta_2) & \cos(\theta_2)\,\sin(\theta_1) \\ 0 & d_3\,\cos(\theta_2) & \sin(\theta_2) \\ 0 & \sin(\theta_1) & 0 \\ 0 & -\cos(\theta_1) & 0 \\ 1 & 0 & 0 \end{pmatrix}$$

- The DH parameters for this problem were found in the previous homework assignment. Using these DH Parameters, along with equations in the textbook, I solved the forward kinematics symbolically to compute the Jacobian Matrix symbolically. This can be found in the MATLAB script titled "hw3 rrp symbolic.m".

Table 1: DH Parameters for planar RRR Robot

	θ	d	a	α
A_1	$\theta_1{}^*$	0	a_1	0
A_2	$\theta_2{}^*$	0	a_2	0
A_3	$\theta_3{}^*$	0	a_3	0

Problem 2. Derive the Jacobian for a planar RRR manipulator.

Solution

$$J = \begin{pmatrix} -L_2\,\sin(\theta_1+\theta_2)-L_1\,\sin(\theta_1)-L_3\,\sin(\theta_1+\theta_2+\theta_3) & -L_2\,\sin(\theta_1+\theta_2)-L_3\,\sin(\theta_1+\theta_2+\theta_3) & -L_3\,\sin(\theta_1+\theta_2+\theta_3) \\ L_2\,\cos(\theta_1+\theta_2)+L_1\,\cos(\theta_1)+L_3\,\cos(\theta_1+\theta_2+\theta_3) & L_2\,\cos(\theta_1+\theta_2)+L_3\,\cos(\theta_1+\theta_2+\theta_3) & L_3\,\cos(\theta_1+\theta_2+\theta_3) \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{pmatrix}$$

- Using the DH Parameters for a planar RRR robot shown in Table 1, along with equations in the textbook, I solved the forward kinematics symbolically to compute the Jacobian Matrix symbolically. This can be found in the MATLAB script titled ”hw3 rrr symbolic.m”.

Problem 3. Animate a planar RRR robot and the RRP and 7DOF robots from the previous homework assignment using any trajectory.

Solution

- I employed a quintic polynomial trajectory. See the attached .avi videos.