ECE 5397/6397: Introduction to Robotics, Spring 2016

HW #2 due Feb. 16

Discrete Grading Policy. 5 points for each: 2 points for trying, 3 points if partial answer, 5 point if correct.

For each forward kinematic equation

$$A_i = Rot_{z,\theta_i} Trans_{z,d_i} Trans_{x,r_i} Rot_{x,\alpha_i}$$

$$= \begin{bmatrix} c_{\theta_i} & -s_{\theta_i} c_{\alpha_i} & s_{\theta_i} s_{\alpha_i} & r_i c_{\theta_i} \\ s_{\theta_i} & c_{\theta_i} c_{\alpha_i} & -c_{\theta_i} s_{\alpha_i} & r_i s_{\theta_i} \\ 0 & s_{\alpha_i} & c_{\alpha_i} & d_i \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

1. Consider the following manipulator, list DH parameters and mark joint variables in the table, and derive the forward kinematic equations using DH convention.

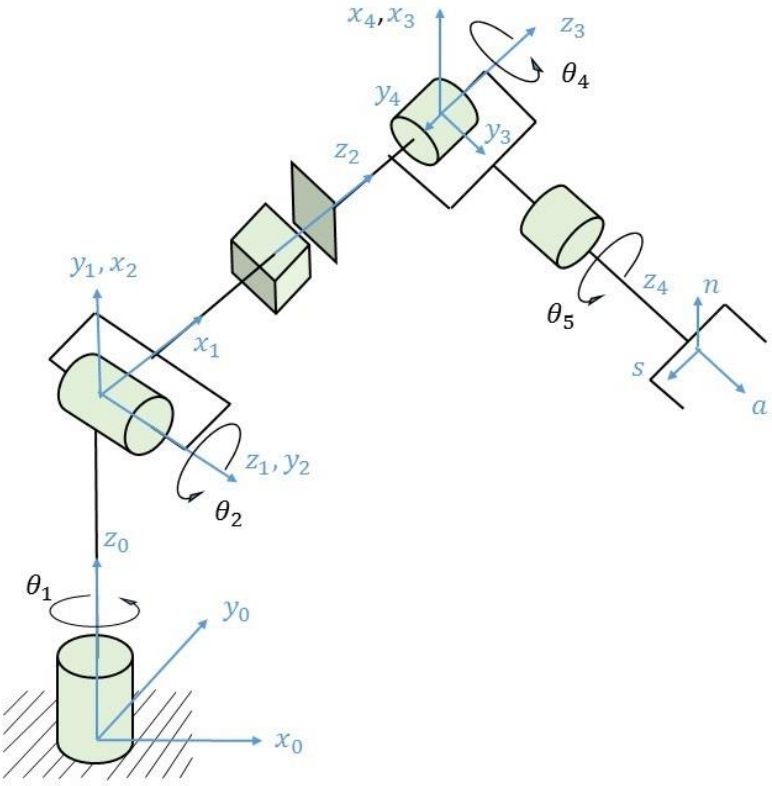

Figure 1.

Link	α_i	r_i	d_i	θ_i
1	$\pi/2$	0	d_1	θ_1^*
2	$\pi/2$	0	0	θ_2^*
3	0	0	d_3^*	0
4	$3\pi/2$	0	0	θ_4^*
5	0	0	0 (d_5)	θ_5^*

Table 1.

2. Consider the following manipulator, finish each coordinate frame in Figure 2, list DH parameters and mark joint variables in the table, and derive the forward kinematic equations using DH convention.

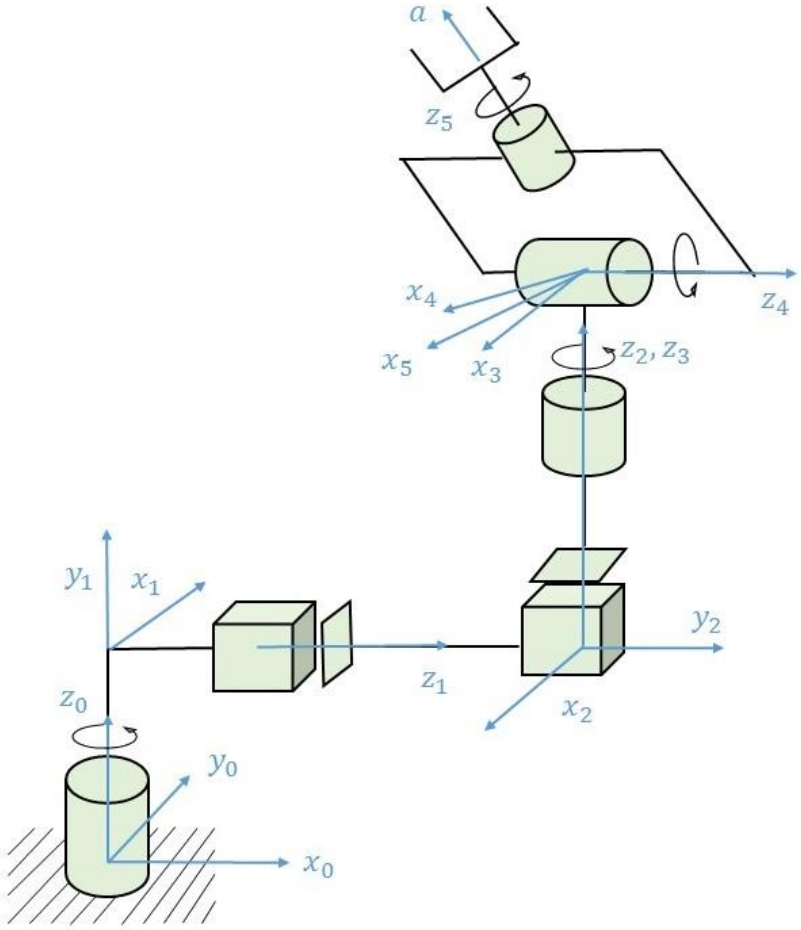

Figure 2.

Link	α_i	r_i	d_i	θ_i
1	$\pi/2$	0	d_1	θ_1^*
2	$\pi/2$	0	d_2^*	π
3	0	0	d_3^*	0
4	$3\pi/2$	0	0	θ_4^*
5	$\pi/2$	0	0	θ_5^*
6	0	0	0(d_6)	θ_6^*

Table 2.

3. Consider the following serial-parallel manipulator, and use the annotation in the figure to simply its structure by basic rotation and translation transformations. Set up coordinate frames in Figure 4, list DH parameters and mark joint variables in a table, and derive the forward kinematic equations using DH convention.

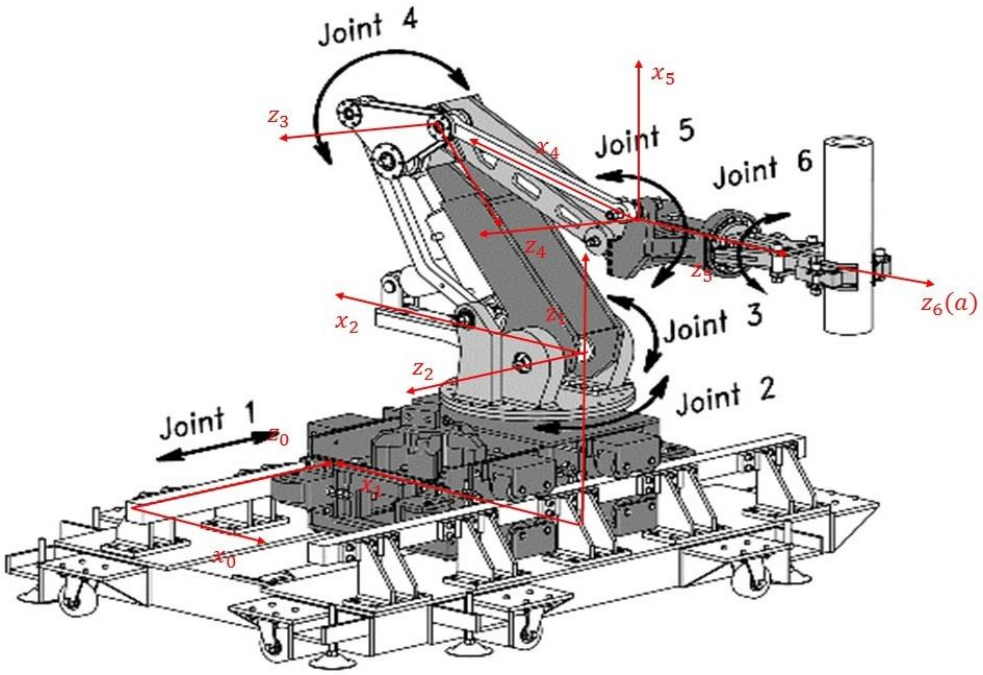

Figure 3. A serial-parallel manipulator transferring a billet (figure credit by Chu Anh My and Manukid Parnichkun)

Link	α_i	r_i	d_i	θ_i
1	$\pi/2$	r_1	d_1^*	π
2	$3\pi/2$	0	0	θ_2^*
3	0	r_3	0	θ_3^*
4	0	r_4	0	θ_4^*
5	$\pi/2$	0	0	θ_5^*
6	0	0	0(d_6)	θ_6^*

Table 3.