



DH parameters:

i	a_{i-1}	α_{i-1}	d_i	ω_i
1	0	d_0	d_1	0
2	-90	0	d_2	-90
3	-90	0	$-d_3$	0
4	0	0	0	ω_4
5	90	0	0	ω_5
6	90	0	d_6	ω_6

general transformation matrix:

$${}^{i-1}_i T = \begin{bmatrix} \cos \theta_i & -\sin \theta_i & 0 & a_{i-1} \\ \sin \theta_i \cos \alpha_{i-1} & \cos \theta_i \cos \alpha_{i-1} & -\sin \alpha_{i-1} & -\sin \theta_i d_i \\ \sin \theta_i \sin \alpha_{i-1} & \cos \theta_i \sin \alpha_{i-1} & \cos \alpha_{i-1} & \cos \theta_i d_i \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^0_1 T = \begin{bmatrix} 1 & 0 & 0 & d_0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^3_4 T = \begin{bmatrix} \cos \theta_4 & -\sin \theta_4 & 0 & 0 \\ \sin \theta_4 & \cos \theta_4 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^1_2 T = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_2 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^4_5 T = \begin{bmatrix} \cos \theta_5 & -\sin \theta_5 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ \sin \theta_5 & \cos \theta_5 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^2T_3 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & d_3 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^5T_6 = \begin{bmatrix} \cos \theta_6 & -\sin \theta_6 & 0 & 0 \\ 0 & 0 & -1 & -d_6 \\ \sin \theta_6 & \cos \theta_6 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^0T_6 = {}^0T_1 {}^1T_2 {}^2T_3 {}^3T_4 {}^4T_5 {}^5T_6$$

$${}^0T_6 = \begin{bmatrix} \cos \theta_5 \cos \theta_6 & -\sin \theta_5 \cos \theta_6 & -\sin \theta_5 & d_0 - d_3 - d_6 \cos \theta_5 \\ \cos \theta_4 \sin \theta_6 - \cos \theta_5 \cos \theta_4 \sin \theta_6 & \cos \theta_4 \cos \theta_6 + \cos \theta_5 \sin \theta_4 \sin \theta_6 & -\sin \theta_4 \sin \theta_5 & d_2 - d_6 \sin \theta_4 \sin \theta_5 \\ \sin \theta_4 \sin \theta_6 + \cos \theta_4 \cos \theta_5 \cos \theta_6 & \cos \theta_6 \sin \theta_4 - \cos \theta_4 \cos \theta_5 \sin \theta_6 & \cos \theta_4 \sin \theta_5 & d_1 + d_6 \cos \theta_4 \sin \theta_5 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

(iii.) Position of tool tip

Substituting

$$\theta_1 = 2$$

$$\theta_2 = 2$$

$$\theta_3 = 3$$

$$\theta_6 = 3$$

$$\theta_4 = \theta_5 = \theta_1 = 0$$

$$\therefore \text{position} = \begin{bmatrix} d_0 - 6 \\ 2 \\ 2 \end{bmatrix}$$

w.r.t ground, i.e., the base link