



D-H Parameters

i	d_{i-1}	a_{i-1}	d_i	θ_i
1	0	0	d	0
2	0	L_1	0	θ_2
3	0	L_2	0	θ_3
4	0	L_3	0	θ_4

Transformation matrix

$${}_{\text{O}_4}^{\text{T}} = \begin{bmatrix} C_{234} & -S_{234} & 0 & C_2(C_3L_3 + L_2) - S_2S_3L_3 + C_1L_1 \\ S_{234} & C_{234} & 0 & S_2(C_3L_3 + L_2) + C_2S_3L_3 \\ 0 & 0 & 1 & d \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Let $L_1 = 0.154 \text{ m}$ $C_{234} = \cos(\theta_2 + \theta_3 + \theta_4)$

$$L_2 = 0.36 \text{ m}$$

$$L_3 = 0.26$$

$$S_{234} = \sin(\theta_2 + \theta_3 + \theta_4)$$

$${}_{\text{O}_4}^{\text{T}} = \begin{bmatrix} C_{234} & -S_{234} & 0 & C_2(0.26C_3 + 0.36) - 0.26S_2S_3 + 0.154C_1 \\ S_{234} & C_{234} & 0 & S_2(0.26C_3 + 0.36) - 0.26C_2S_3 \\ 0 & 0 & 1 & d \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Calculations

$$L_1 = 154 \text{ cm}$$

$$L_2 = 360 \text{ cm}$$

$$L_3 = 260 \text{ cm}$$

$${}^{i-1}T = \begin{bmatrix} \cos_i & -\sin_i & 0 & a_{i-1} \\ \sin_i \cos_{i-1} & \cos_i \cos_{i-1} & -\sin_{i-1} & -\sin_{i-1} d_i \\ \sin_i \sin_{i-1} & \cos_i \sin_{i-1} & \cos_{i-1} & \cos_{i-1} d_i \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

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

$${}^1T = \begin{bmatrix} \cos_1 & -\sin_1 & 0 & L_1 \\ \sin_1 & \cos_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^2T = \begin{bmatrix} \cos_2 & -\sin_2 & 0 & L_2 \\ \sin_2 & \cos_2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^3T = \begin{bmatrix} \cos_3 & -\sin_3 & 0 & L_3 \\ \sin_3 & \cos_3 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^0T = \begin{bmatrix} \cos_2 & -\sin_2 & 0 & L_1 \\ \sin_2 & \cos_2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^2T = \begin{bmatrix} \cos_3 \cos_4 - \sin_3 \sin_4 & -\cos_3 \sin_4 - \sin_3 \cos_4 & 0 & L_3 L_3 + L_2 \\ \sin_3 \cos_4 + \cos_3 \sin_4 & -\sin_3 \sin_4 + \cos_3 \cos_4 & 0 & \sin_3 L_3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$0_2^T = \begin{bmatrix} C_2 \\ S_2 \\ 0 \\ 0 \end{bmatrix} \quad \begin{bmatrix} -S_2 & 0 & 1 & 0 \\ C_2 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$0_4^T = \begin{bmatrix} C_{34} \\ S_{34} \\ 0 \\ 0 \end{bmatrix} \quad \begin{bmatrix} -S_{34} & 0 & C_3 l_3 + L_2 \\ C_{34} & 0 & S_3 l_3 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$0_4^T = \begin{bmatrix} C_2 C_{34} - S_2 S_{34} \\ S_2 C_{34} + C_2 S_{34} \\ 0 \\ 0 \end{bmatrix} \quad \begin{bmatrix} -C_2 S_{34} - S_2 C_{34} & 0 & C_2(C_3 l_3 + L_2) - S_2 S_3 l_3 + L_1 \\ -S_2 S_{34} + C_2 C_{34} & 0 & S_2(C_3 l_3 + L_2) + C_2 S_3 l_3 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$0_4^T = \begin{bmatrix} C_{234} \\ S_{234} \\ 0 \\ 0 \end{bmatrix} \quad \begin{bmatrix} -S_{234} & 0 & C_2(C_3 l_3 + L_2) - S_2 \times S_3 l_3 + C_1 L_1 \\ C_{234} & 0 & S_2(C_3 l_3 + L_2) + C_2 \times S_3 l_3 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$