



D-H Parameters

$i$	$\alpha_{i-1}$	$a_{i-1}$	$d_i$	$\theta_i$
1	0	0	$d$	0
2	0	$L_1$	0	$\theta_2$
3	0	$L_2$	0	$\theta_3$
4	0	$L_3$	0	$\theta_4$

## Transformation matrix

$${}^0_4T = \begin{bmatrix} C_{234} & -S_{234} & 0 & C_2(C_3L_3+L_2) - S_2S_3L_3 + C_1L_1 \\ S_{234} & C_{234} & 0 & S_2(C_3L_3+L_2) + C_2S_3L_3 \\ 0 & 0 & 1 & d \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Let  $L_1 = 0.154 \text{ m}$        $C_{234} = \cos(\theta_2 + \theta_3 + \theta_4)$   
 $L_2 = 0.36 \text{ m}$        $S_{234} = \sin(\theta_2 + \theta_3 + \theta_4)$   
 $L_3 = 0.26$

$${}^0_4T = \begin{bmatrix} C_{234} & -S_{234} & 0 & C_2(0.26C_3 + 0.36) - 0.26S_2S_3 + 0.154C_1 \\ S_{234} & C_{234} & 0 & S_2(0.26C_3 + 0.36) - 0.26C_2S_3 \\ 0 & 0 & 1 & d \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

# Calculations

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

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

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

$${}^{i-1}T_i = \begin{bmatrix} c\theta_i & -s\theta_i & 0 & a_{i-1} \\ s\theta_i c\alpha_{i-1} & c\theta_i c\alpha_{i-1} & -s\alpha_{i-1} & -s\alpha_{i-1}d_i \\ s\theta_i s\alpha_{i-1} & c\theta_i s\alpha_{i-1} & c\alpha_{i-1} & c\alpha_{i-1}d_i \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^0T_1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^1T_2 = \begin{bmatrix} c\theta_2 & -s\theta_2 & 0 & L_1 \\ s\theta_2 & c\theta_2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^2T_3 = \begin{bmatrix} c\theta_3 & -s\theta_3 & 0 & L_2 \\ s\theta_3 & c\theta_3 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^3T_4 = \begin{bmatrix} c\theta_4 & -s\theta_4 & 0 & L_3 \\ s\theta_4 & c\theta_4 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^0T_2 = \begin{bmatrix} c_2 & -s_2 & 0 & L_1 \\ s_2 & c_2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^2T_4 = \begin{bmatrix} c_3c_4 - s_3s_4 & -c_3s_4 - s_3c_4 & 0 & c_3L_3 + L_2 \\ s_3c_4 + c_3s_4 & -s_3s_4 + c_3c_4 & 0 & s_3L_3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^0_2T = \begin{bmatrix} c_2 & -s_2 & 0 & L_1 \\ s_2 & c_2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^2_4T = \begin{bmatrix} c_{34} & -s_{34} & 0 & c_3 l_3 + L_2 \\ s_{34} & c_{34} & 0 & s_3 l_3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^0_4T = \begin{bmatrix} c_2 c_{34} - s_2 s_{34} & -c_2 s_{34} - s_2 c_{34} & 0 & c_1 (c_3 l_3 + L_2) - s_2 s_3 l_3 + L_1 \\ s_2 c_{34} + c_2 s_{34} & -s_2 s_{34} + c_2 c_{34} & 0 & s_2 (c_3 l_3 + L_2) + c_2 s_3 l_3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^0_4T = \begin{bmatrix} c_{234} & -s_{234} & 0 & c_2 (c_3 l_3 + L_2) - s_2 \times s_3 l_3 + c_1 L_1 \\ s_{234} & c_{234} & 0 & s_2 (c_3 l_3 + L_2) + c_2 \times s_3 l_3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$