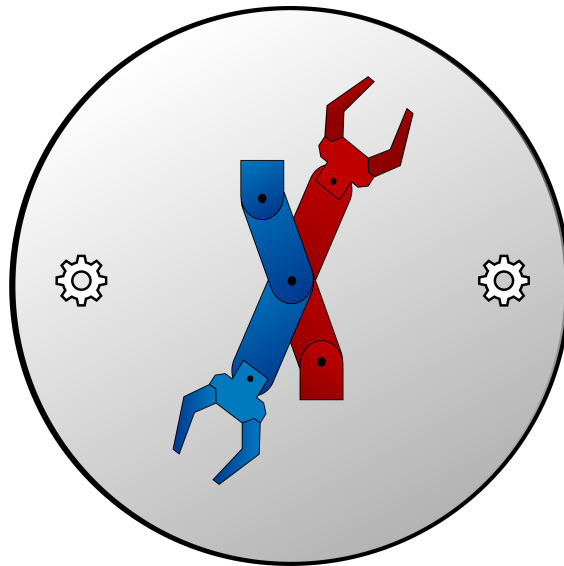


FINAL REPORT

Trey Dufrene, Alan Wallingford, David Orcutt, Ryan Warner, Zack Johnson



ME 407

Preliminary Design of Robotic Systems

Embry-Riddle Aeronautical University



Meiosis

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1 Forward Kinematics

Table 1: DH Table for 6 DOF Manipulator

DH	d_i	θ_i	a_i	α_i
1	ℓ_1	θ_1	0	$\pi/2$
2	$-d$	θ_2	ℓ_2	0
3	0	$\theta_3 + \pi/2$	0	$\pi/2$
4	$\ell_3 + \ell_4$	θ_4	0	$-\pi/2$
5	0	θ_5	0	$\pi/2$
6	ℓ_6	θ_6	0	0

Where $\ell_1 = 22.08\text{cm}$, $\ell_2 = 25\text{cm}$, $\ell_3 = 20\text{cm}$, $\ell_4 = 8\text{cm}$, $\ell_6 = 5.25\text{cm}$, and $d = 1\text{cm}$.

$$A = Rot_{z,\theta} Trans_{z,d} Trans_{x,a} Rot_{x,\alpha} \quad (1)$$

Given an arbitrary homogeneous matrix T_i^{i-1} (computed by matrix multiplication of A matrices $\rightarrow [A_1 A_2 \cdots A_{i-1} A_i]$), the orientation vector \bar{z}_i (with respect to φ , θ and ψ) and the relative joint position (displacement) vector \bar{o}_i (with respect to x , y , and z) can be obtained via the 3rd and 4th columns of the matrix respectively, as shown in Equation 2 (given β as an arbitrary rotation angle about the z -axis).

$$T_i^{i-1} = \begin{bmatrix} c_\beta & -s_\beta & z_i^\varphi & o_i^x \\ s_\beta & c_\beta & z_i^\theta & o_i^y \\ 0 & 0 & z_i^\psi & o_i^z \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (2)$$

$$A_1 = rotz(\theta_1) transz(\ell_1) rotx(\pi/2)$$

$$A_2 = rotz(\theta_2) transz(-d) transx(\ell_2)$$

$$A_1 = \begin{bmatrix} \cos(\theta_1) & 0 & \sin(\theta_1) & 0 \\ \sin(\theta_1) & 0 & -\cos(\theta_1) & 0 \\ 0 & 1 & 0 & 22.08 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} \cos(\theta_2) & -\sin(\theta_2) & 0 & 25 \cos(\theta_2) \\ \sin(\theta_2) & \cos(\theta_2) & 0 & 25 \sin(\theta_2) \\ 0 & 0 & 1 & -1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_3 = rotz(\theta_3 + \pi/2) rotx(\pi/2)$$

$$A_4 = rotz(\theta_4) transz(\ell_3 + \ell_4) rotx(-\pi/2)$$

$$A_3 = \begin{bmatrix} \cos(\theta_3 + \pi/2) & 0 & \sin(\theta_3 + \pi/2) & 0 \\ \sin(\theta_3 + \pi/2) & 0 & -\cos(\theta_3 + \pi/2) & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_4 = \begin{bmatrix} \cos(\theta_4) & 0 & -\sin(\theta_4) & 0 \\ \sin(\theta_4) & 0 & \cos(\theta_4) & 0 \\ 0 & -1 & 0 & 28 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_5 = \text{rot}z(\theta_5) \text{rot}x(\pi/2)$$

$$A_5 = \begin{bmatrix} \cos(\theta_5) & 0 & \sin(\theta_5) & 0 \\ \sin(\theta_5) & 0 & -\cos(\theta_5) & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_6 = \text{rot}z(\theta_6) \text{trans}z(\ell_6)$$

$$A_6 = \begin{bmatrix} \cos(\theta_6) & 0 & -\sin(\theta_6) & 0 \\ \sin(\theta_6) & 0 & \cos(\theta_6) & 0 \\ 0 & 0 & 1 & 5.25 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$