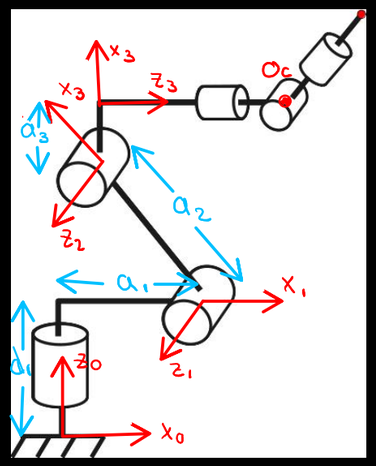
Maieutic: Body forward Kinematics



D-H parameters

	a_i	α_i	d_i	θ_i
1	a_1	$\pi/2$	d_1	θ_1^*
2	a_2	0	0	θ_2^*
3	a_3	$\pi/2$	0	θ_3^*

Homogeneous transformations

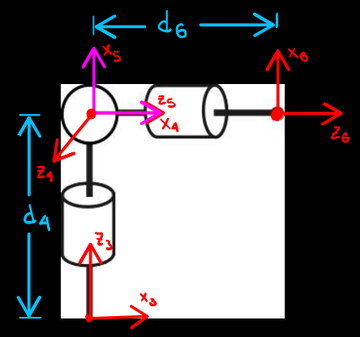
$$H_3^0 = \begin{bmatrix} c_1 & 0 & s_1 & a_1c_1 \\ s_1 & 0 & -c_1 & a_1s_1 \\ 0 & 1 & 0 & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} c_2 & -s_2 & 0 & a_2c_2 \\ s_2 & c_2 & 0 & a_2s_2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} c_3 & 0 & s_3 & a_3c_3 \\ s_3 & 0 & -c_3 & a_3s_3 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} c_1c_2 & -c_1s_2 & s_1 & a_1c_1 + a_2c_1c_2 \\ s_1c_2 & -s_1s_2 & -c_1 & a_1s_1 + a_2s_1c_2 \\ s_2 & c_2 & 0 & a_2s_2 + d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} c_3 & 0 & s_3 & a_3c_3 \\ s_3 & 0 & -c_3 & a_3s_3 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} c_1(c_2c_3 - s_2s_3) & s_1 & c_1(c_2s_3 + s_2c_3) & c_1[a_3(c_2c_3 - s_2s_3) + a_1 + a_2c_2] \\ s_1(c_2c_3 - s_2s_3) & -c_1 & s_1(c_2s_3 + s_2c_3) & s_1[a_3(c_2c_3 - s_2s_3) + a_1 + a_2c_2] \\ s_2c_3 + c_2s_3 & 0 & s_2s_3 - c_2c_3 & a_3(s_2c_3 + c_2s_3) + a_2s_2 + d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$H_3^0 = \begin{bmatrix} c_1c_{23} & s_1 & c_1s_{23} & c_1(a_1 + a_2c_2 + a_3c_{23}) \\ s_1c_{23} & -c_1 & s_1s_{23} & s_1(a_1 + a_2c_2 + a_3c_{23}) \\ s_{23} & 0 & -c_{23} & d_1 + a_2s_2 + a_3s_{23} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Maieutic: Wrist Kinematics



- D-H table:

i	a_i	α_i	d_i	θ_i
4	0	$-\pi/2$	d_4	θ_4^*
5	0	$\pi/2$	0	θ_5^*
6	0	0	d_6	θ_6^*

Homogeneous transformations:

$$H_6^3 = \begin{bmatrix} c_4 & 0 & -s_4 & 0 \\ s_4 & 0 & c_4 & 0 \\ 0 & -1 & 0 & d_4 \\ 0 & 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} c_5 & 0 & s_5 & 0 \\ s_5 & 0 & -c_5 & 0 \\ 0 & -1 & 0 & d_4 \\ 0 & 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} c_6 & -s_6 & 0 & 0 \\ s_6 & c_6 & 0 & 0 \\ 0 & 0 & 1 & d_6 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$H_6^3 = \begin{bmatrix} c_4c_5c_6 - s_4s_6 & -c_4c_5s_6 - s_4c_6 & c_4s_5 & c_4s_5d_6 \\ s_4c_5c_6 + c_4s_6 & -s_4c_5s_6 + c_4c_6 & s_4s_5 & s_4s_5d_6 \\ -s_5c_6 & s_5c_6 & c_5 & d_4 + c_5d_6 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$