

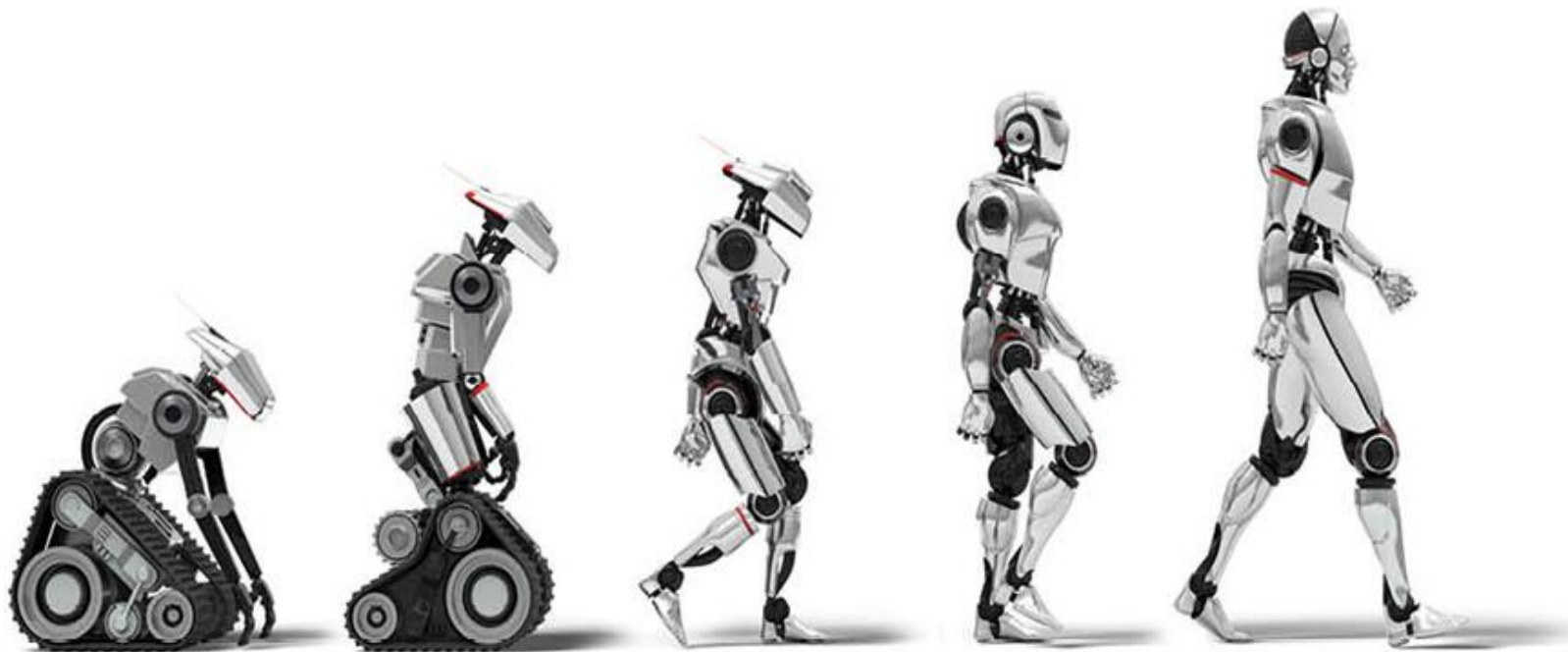


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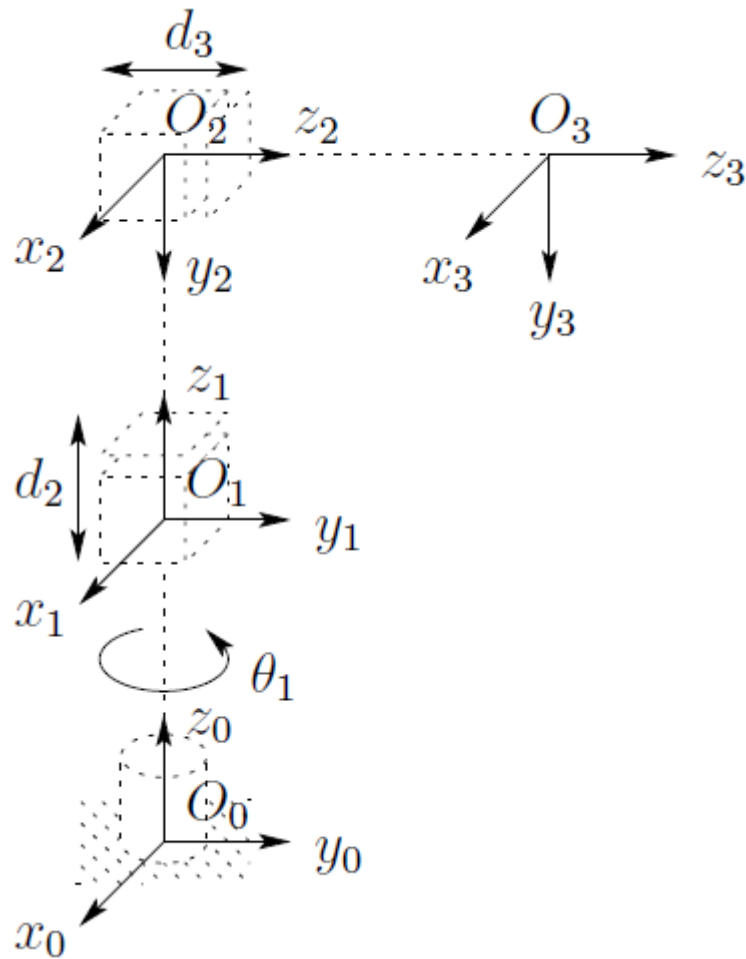
Universität Heidelberg

Fakultät für Physik und Astronomie

Exercises Robotics 4



Exercises D-H: Three-Link Cylindrical Robot



To REMEMBER

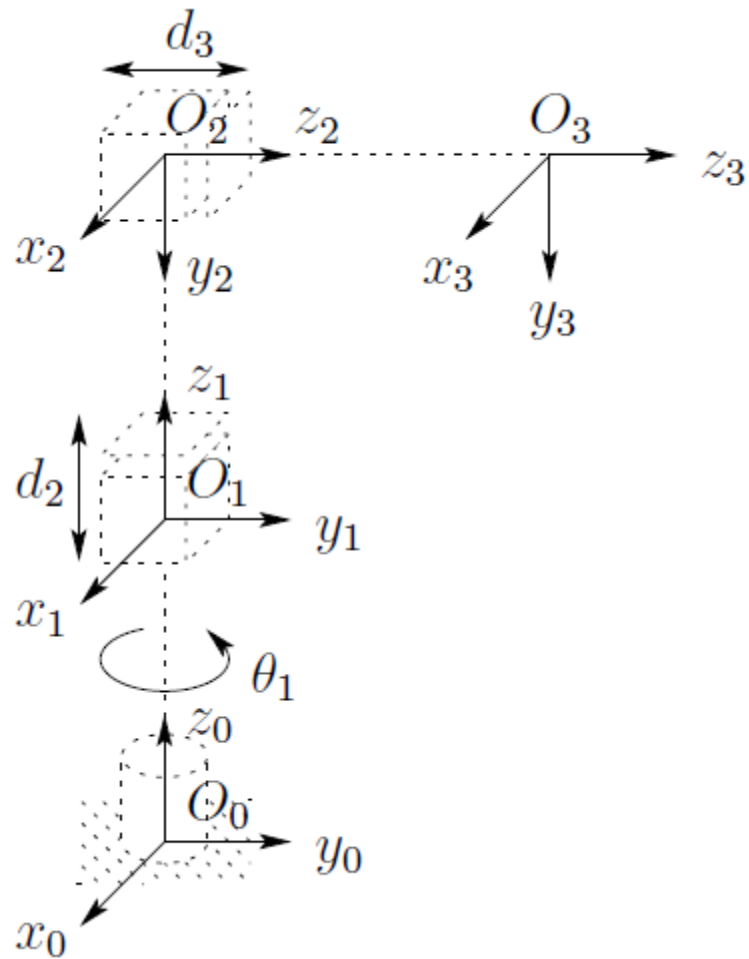
\mathbf{a}_i --> distance Z_i and Z_{i-1} along x_i

\mathbf{d}_i --> distance X_i and X_{i-1} along Z_{i-1}

α_i --> angle Z_i and Z_{i-1} around x_i

θ_i --> angle X_i and X_{i-1} around Z_{i-1}

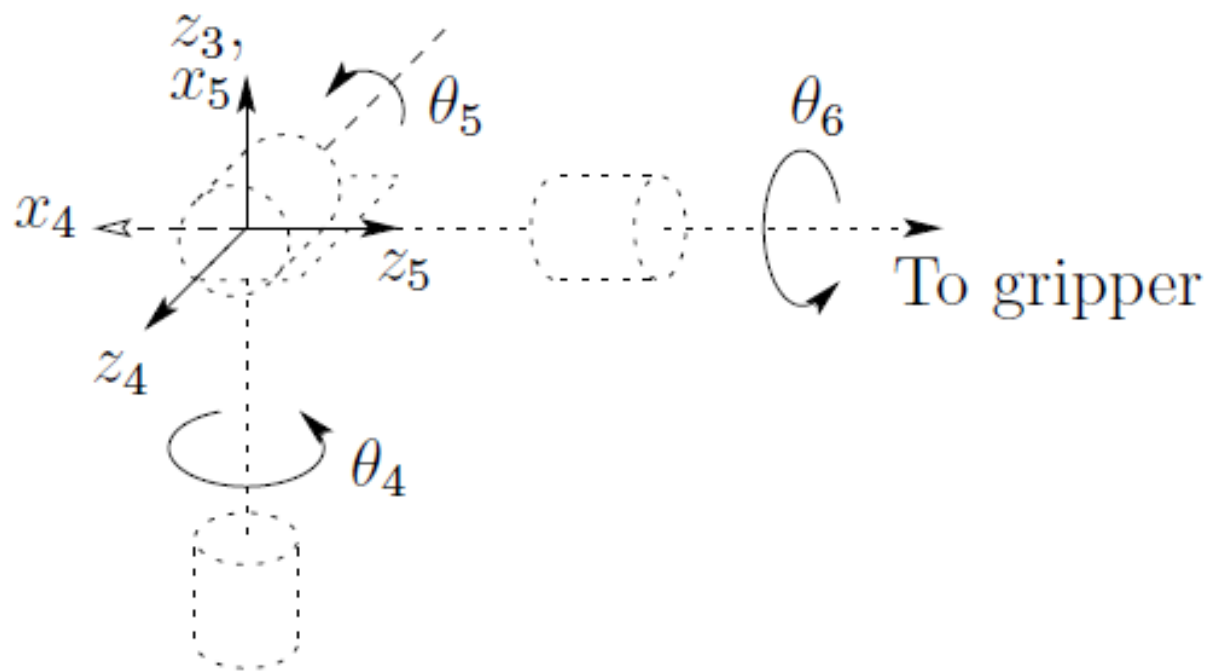
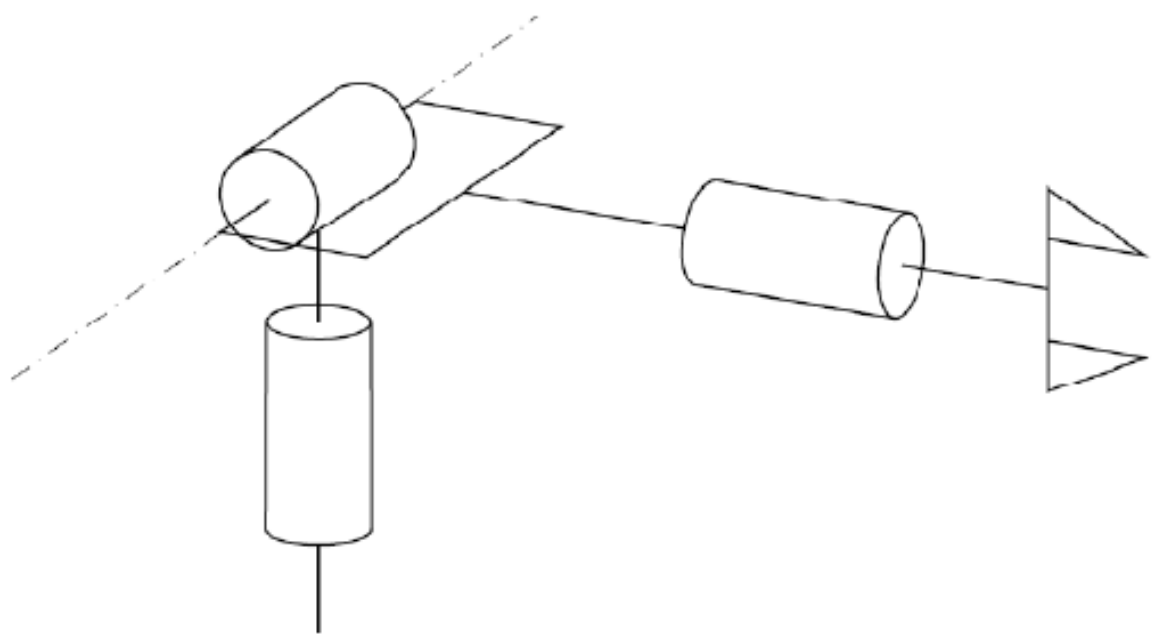
Exercises D-H: Three-Link Cylindrical Robot



Link	a_i	α_i	d_i	θ_i
1	0	0	d_1	θ_1^*
2	0	-90	d_2^*	0
3	0	0	d_3^*	0

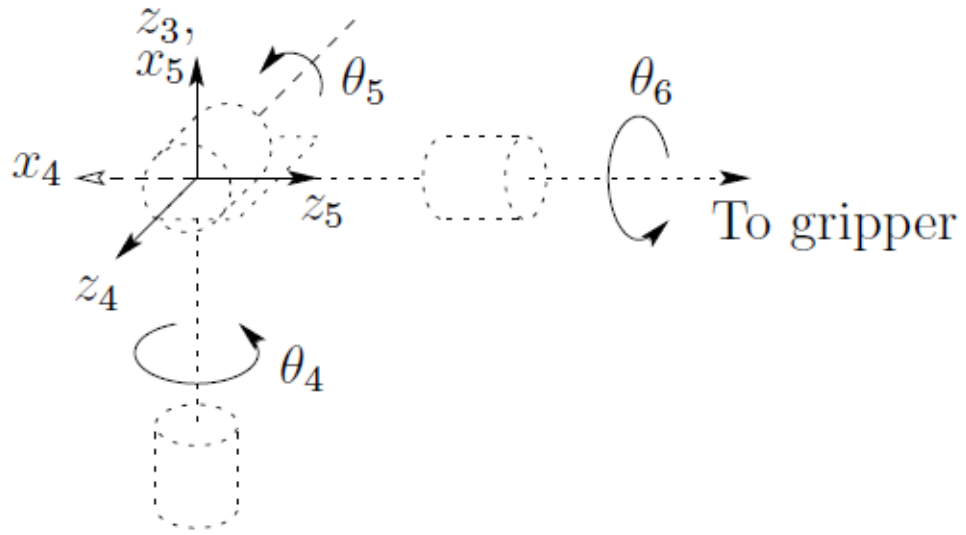
* variable

Exercises D-H: Spherical Wrist



Exercises D-H: Spherical Wrist

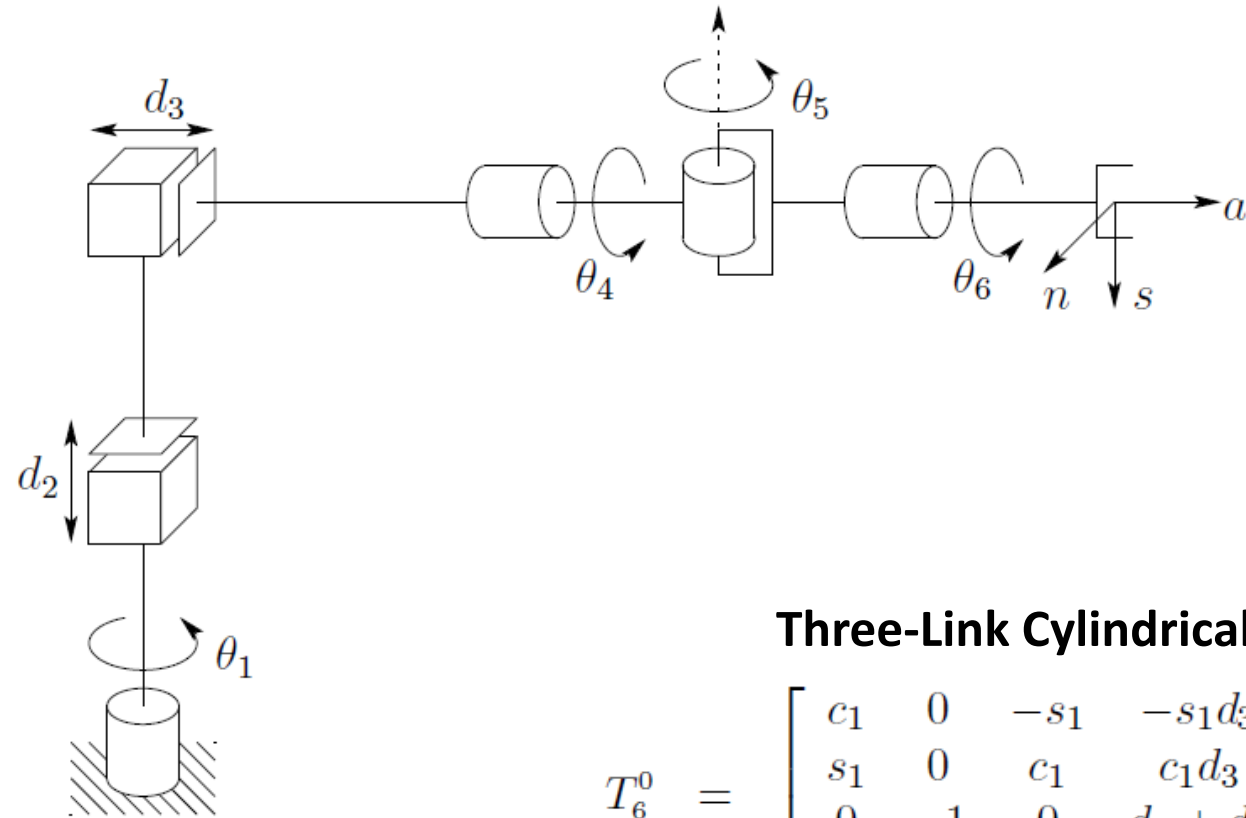
Assume in this case the base as the link 3 is not visible, and compute normally D-H.



Link	a_i	α_i	d_i	θ_i
4	0	-90	0	θ_4^*
5	0	90	0	θ_5^*
6	0	0	d_6	θ_6^*

* variable

Exercises D-H: Cylindrical Manipulator with Spherical Wrist

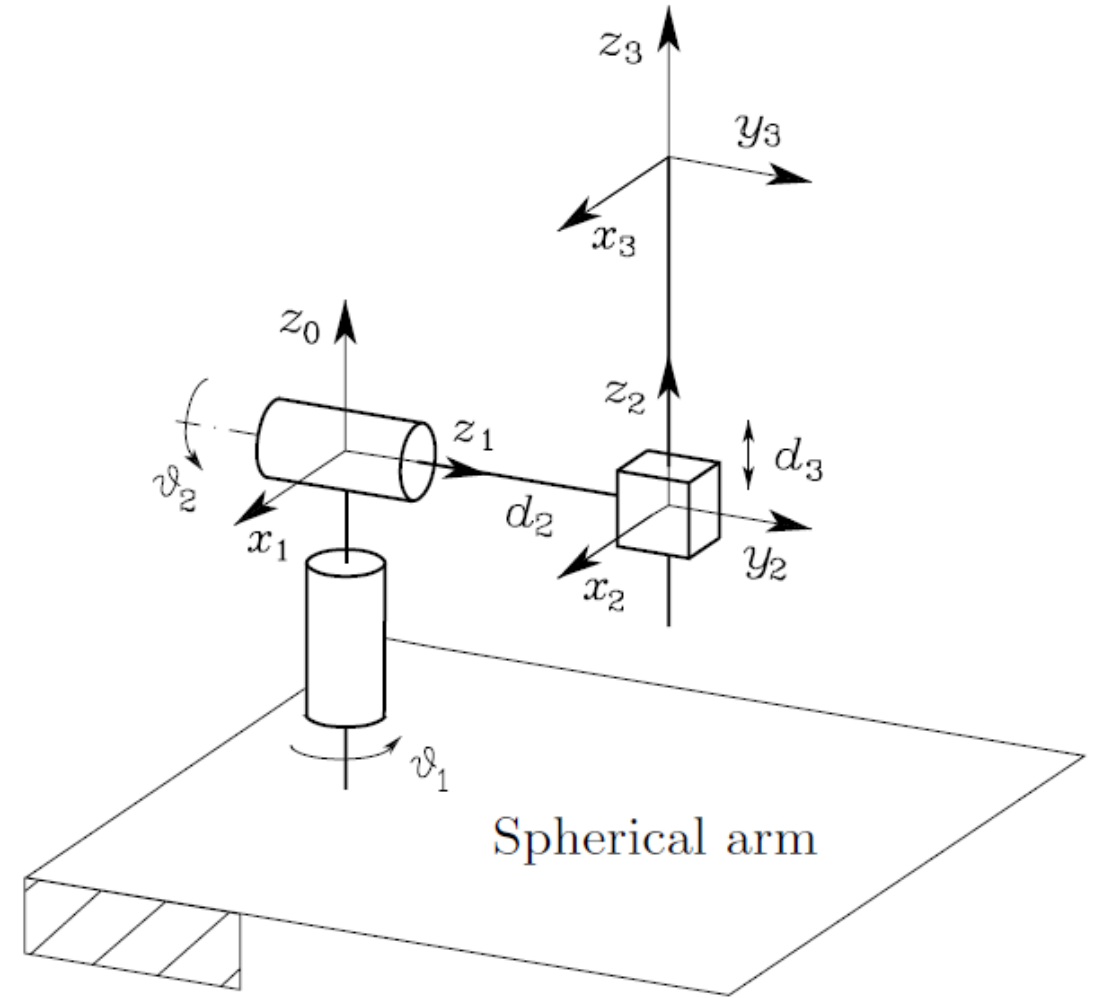
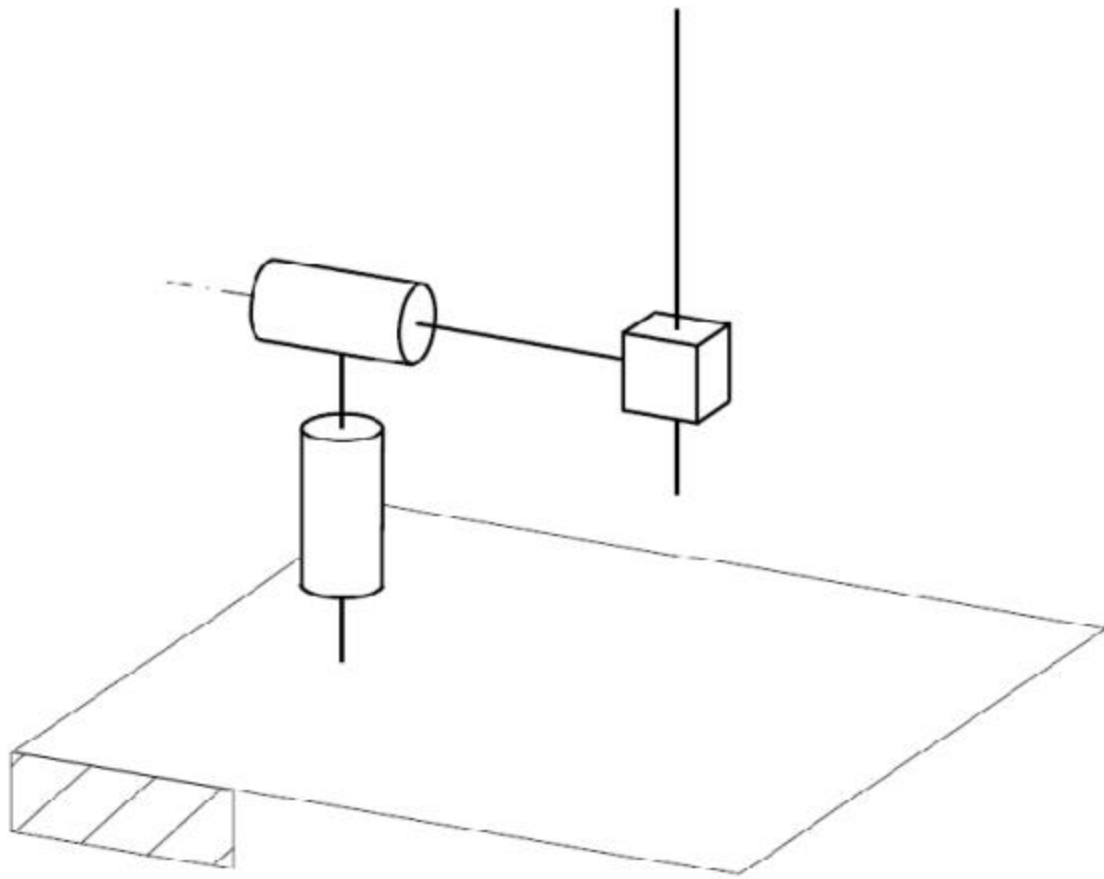


The Forward Kinematics of the whole device is obtained by multiplying the transformation obtained in the previous examples:

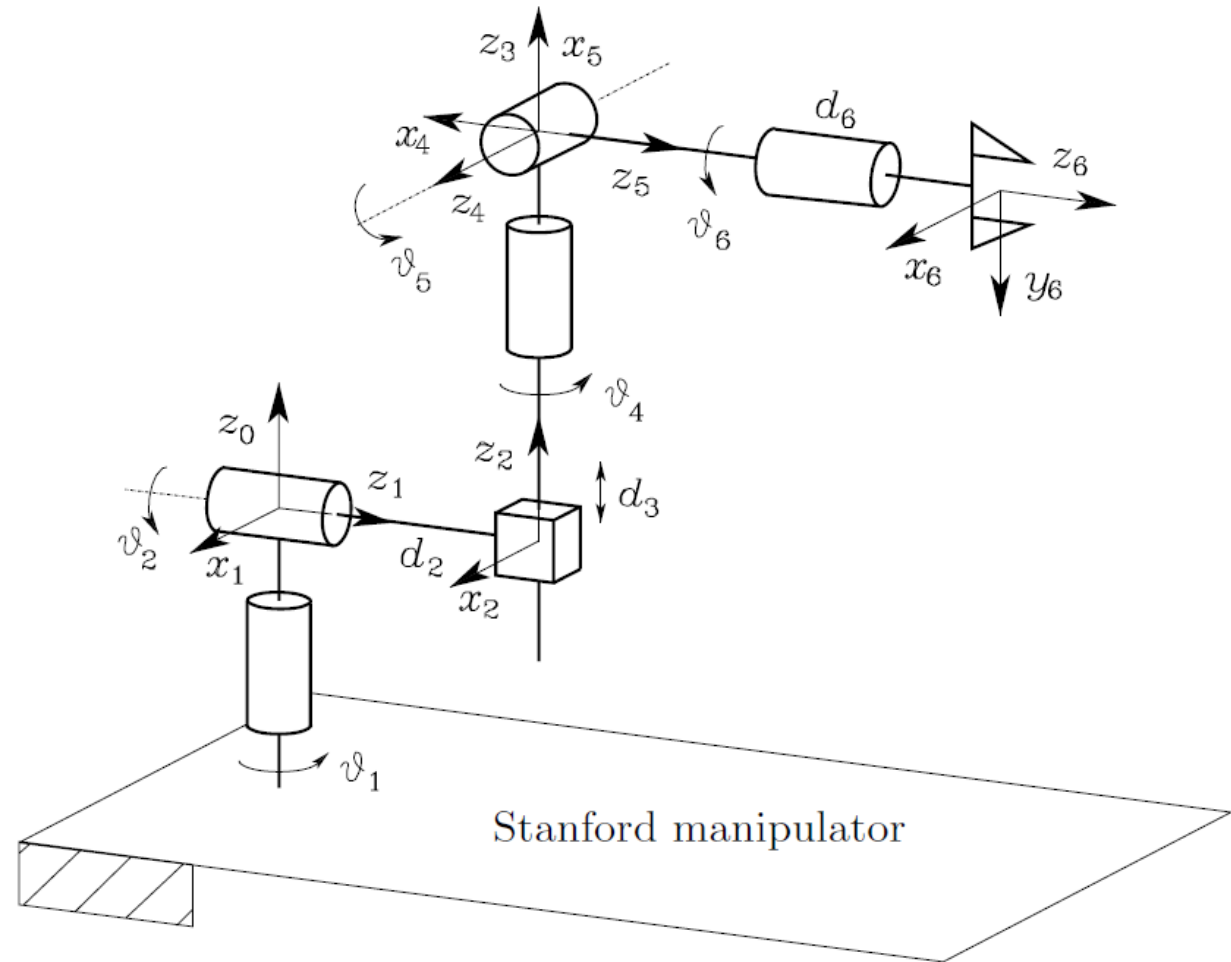
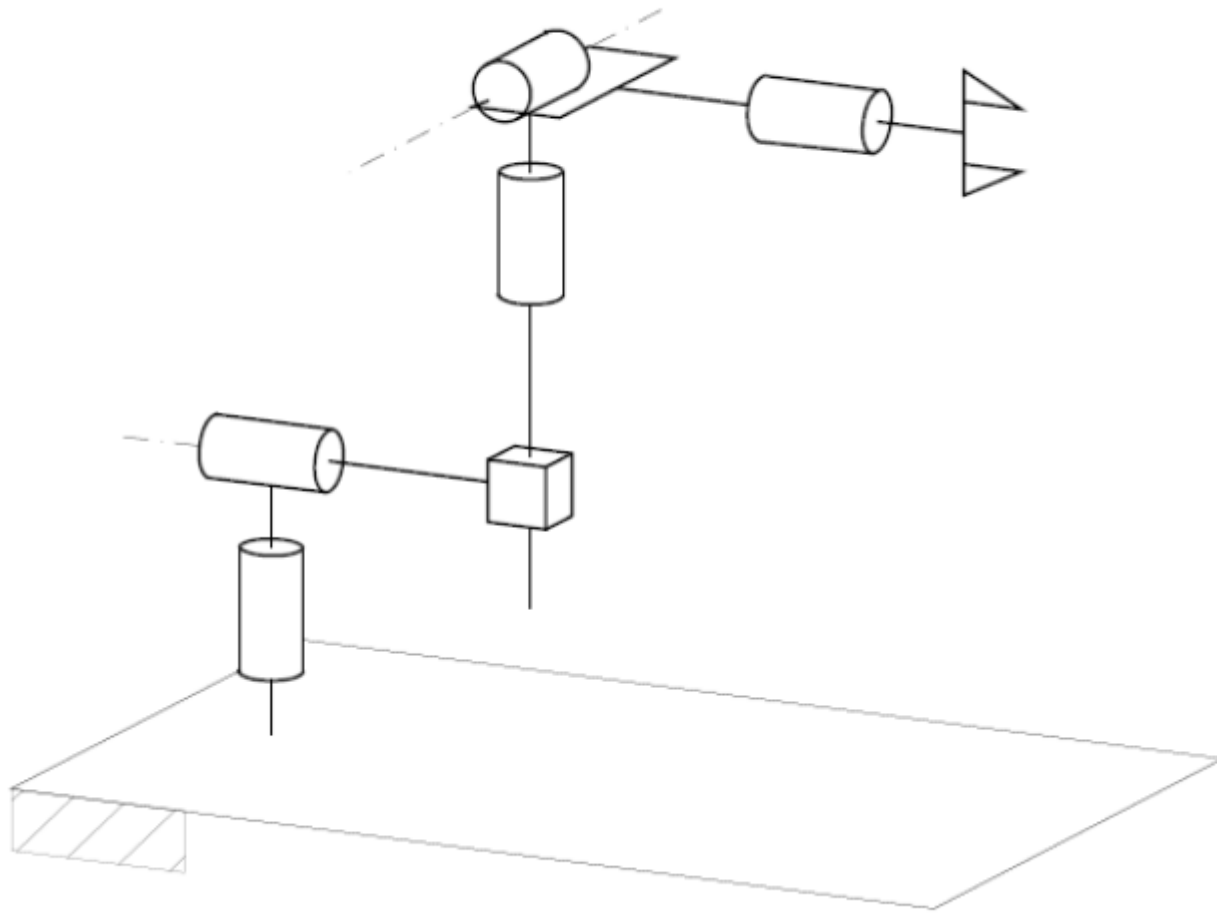
$$T_6^0 = \begin{matrix} \text{Three-Link Cylindrical Robot} & \text{Spherical Wrist} \end{matrix}$$

$$= \begin{bmatrix} c_1 & 0 & -s_1 & -s_1 d_3 \\ s_1 & 0 & c_1 & c_1 d_3 \\ 0 & -1 & 0 & d_1 + d_2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} c_4 c_5 c_6 - s_4 s_6 & -c_4 c_5 s_6 - s_4 c_6 & c_4 s_5 & c_4 s_5 d_6 \\ s_4 c_5 c_6 + c_4 s_6 & -s_4 c_5 s_6 + c_4 c_6 & s_4 s_5 & s_4 s_5 d_6 \\ -s_5 c_6 & s_5 c_6 & c_5 & c_5 d_6 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Exercises D-H: Spherical Arm



Exercises D-H: Stanford Manipulator



Thank you for your Attention!!!

