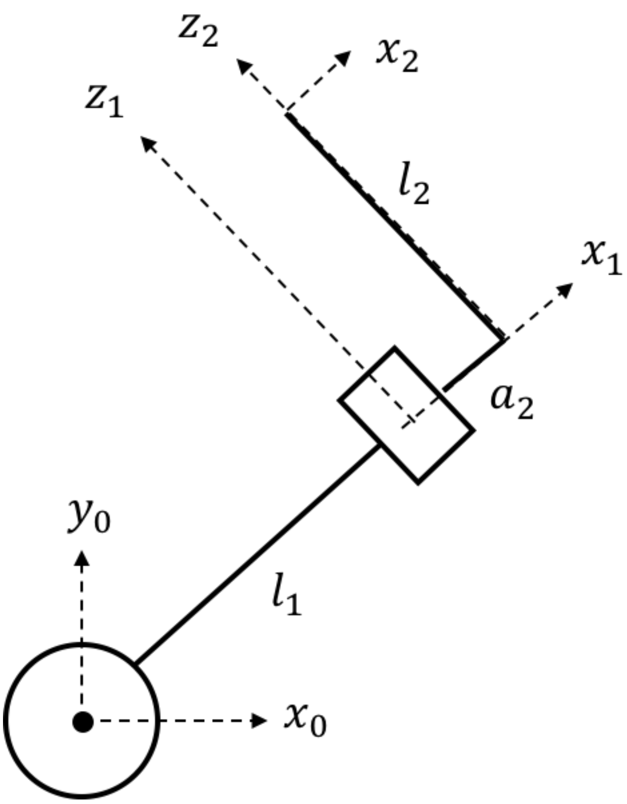
Example: Consider the following 2R manipulator, with DH frame assignment as shown.



The DH parameters can then be found to be:

i	d_i	θ_i	α_i	a_i
1	0	θ_1	$-\pi/2$	l_1
2	l_2	θ_2	0	a_2

Hence

$$ {}^0_1T = \begin{array}{c} \begin{array}{cccc} & & z_1 & o_1 \end{array} \\ \begin{bmatrix} c_1 & 0 & -s_1 & l_1c_1 \\ s_1 & 0 & c_1 & l_1s_1 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \end{array} $$

and

$$ {}^1_2T = \begin{bmatrix} c_2 & -s_2 & 0 & a_2c_2 \\ s_2 & c_2 & 0 & a_2s_2 \\ 0 & 0 & 1 & l_2 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

$$ {}^0_2T = {}^0_1T\,{}^1_2T = \begin{array}{c} \begin{array}{cccc} & & & o_2 \end{array} \\ \begin{bmatrix} c_1c_2 & -c_1s_2 & -s_1 & l_1c_1 - l_2s_1 + a_2c_2c_1 \\ s_1c_2 & -s_1s_2 & c_1 & l_1s_1 + l_2c_1 + a_2c_2s_1 \\ -s_2 & -c_2 & 0 & -a_2s_2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \end{array} $$

Hence,

$$J_\omega = [z_0 \quad z_1] = \begin{bmatrix} 0 & -s_1 \\ 0 & c_1 \\ 1 & 0 \end{bmatrix}$$

$$J_v = [z_0 \times (o_2 - o_0) \quad z_1 \times (o_2 - o_1)]$$

$$= \begin{bmatrix} -(l_1 s_1 + l_2 c_1 + a_2 c_2 s_1) & -a_2 s_2 c_1 \\ l_1 c_1 - l_2 s_1 + a_2 c_2 c_1 & -a_2 s_2 s_1 \\ 0 & -s_1(l_2 c_1 + a_2 c_2 s_1) - c_1(-l_2 s_1 + a_2 c_2 c_1) \end{bmatrix}$$

$$= \begin{bmatrix} -(l_1 s_1 + l_2 c_1 + a_2 c_2 s_1) & -a_2 s_2 c_1 \\ l_1 c_1 - l_2 s_1 + a_2 c_2 c_1 & -a_2 s_2 s_1 \\ 0 & -a_2 c_2 \end{bmatrix}$$

Jacobian, $J = \begin{bmatrix} J_v \\ J_\omega \end{bmatrix}$