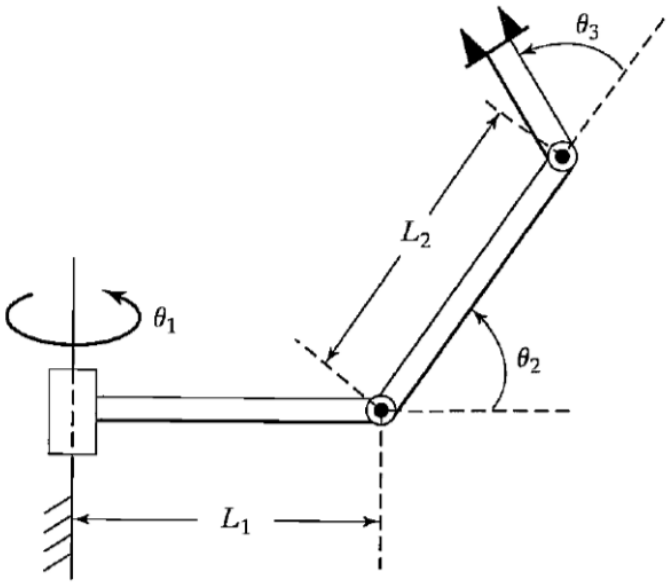
Robotics Assignment – Jacobians: Velocities and Static Forces

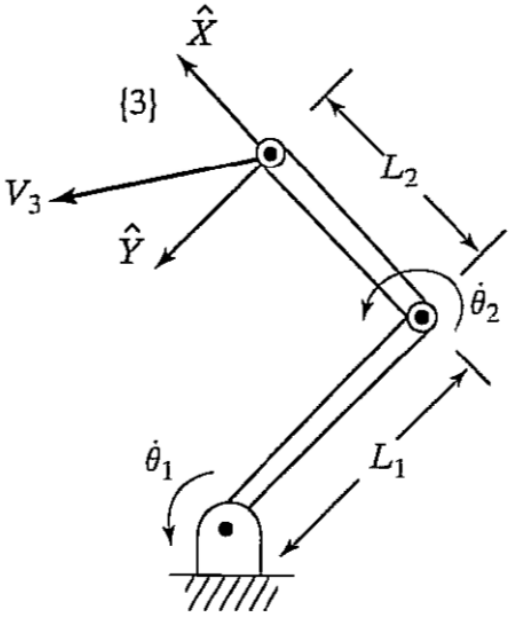
Sima Rishmawi, Birzeit University May 5, 2017

1 Find the Jacobian of the manipulator shown in the Figure. Write it in terms of frame 4 located at the tip of the hand and having the same orientation as frame 3.



2 Prove that singularities in the force domain exist at the same configurations as singularities in the position domain.

3 For the two link manipulator shown in the Figure, give the transformation that would map joint torques into a 2×1 force vector, ${}^3F$, at the hand.



4 Given:

$$ {}^{A}_{B}T = \begin{bmatrix} 0.866 & -0.500 & 0.000 & 10.0 \\ 0.500 & 0.866 & 0.000 & 0.0 \\ 0.000 & 0.000 & 1.000 & 5.0 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

if the velocity vector at the origin of A is:

$$ {}^{A}\nu = \begin{bmatrix} 0.0 \\ 2.0 \\ -3.0 \\ 1.414 \\ 1.414 \\ 0.0 \end{bmatrix} $$

5 For the manipulator of Problem 1, give a set of joint angles for which the manipulator is at a workspace-boundary singularity and another set of angles for which the manipulator is at a workspace-interior singularity.

6 A certain two-link manipulator has the following Jacobian:

$$ {}^{0}J(\Theta) = \begin{bmatrix} -l_1 s_1 - l_2 s_{12} & -l_2 s_{12} \\ l_1 c_1 + l_2 c_{12} & l_2 c_{12} \end{bmatrix} $$

Ignoring gravity, what are the joint torques required in order that the manipulator will apply a static force vector ${}^{0}F = 10\hat{X}_0$?