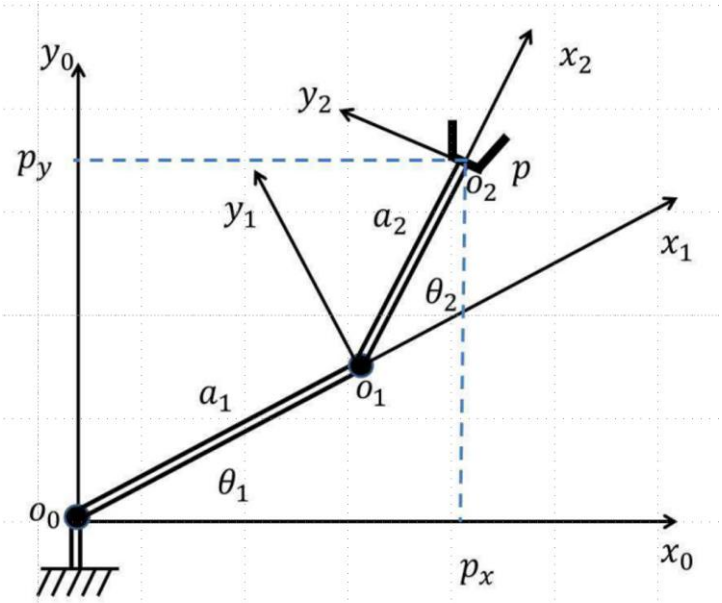
Robotics Homework #7



Find the rotational velocity of the joints that will move the end effector as described

- Case 1: Horizontally with speed 2 m/s at configuration $(\theta_1, \theta_2) = (45^o, 45^o)$
- Case 2: Vertically with speed 4 m/s at configuration $(\theta_1, \theta_2) = (45^o, 90^o)$

Note: a1=7m a2=10m

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HOMEWORK 07

CASE 1:

$$J = \begin{bmatrix} -a_1\sin\theta_1 - a_2\sin(\theta_1+\theta_2) & -a_2\sin(\theta_1+\theta_2) \\ a_1\cos\theta_1 + a_2\cos(\theta_1+\theta_2) & a_2\cos(\theta_1+\theta_2) \end{bmatrix}$$

$$= \begin{bmatrix} -7\sin 45^\circ - 10\sin(45^\circ+45^\circ) & -10\sin(45^\circ+45^\circ) \\ 7\cos 45^\circ + 10\cos(45^\circ+45^\circ) & 10\cos(45^\circ+45^\circ) \end{bmatrix}$$

$$= \begin{bmatrix} -14.950 & -10 \\ 4.950 & 0 \end{bmatrix}$$

$$J^{-1} = \frac{1}{-14.950(0) - (-10)(4.950)} \begin{bmatrix} 0 & 10 \\ -4.950 & -14.950 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0.202 \\ -0.1 & -0.302 \end{bmatrix}$$

CHECK:

$$\begin{bmatrix} -14.950 & -10 \\ 4.950 & 0 \end{bmatrix}\begin{bmatrix} 0 & 0.202 \\ -0.1 & -0.302 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \checkmark$$

$$J\begin{bmatrix} \dot\theta_1 \\ \dot\theta_2 \end{bmatrix} = \begin{bmatrix} V_x \\ V_y \end{bmatrix} \longrightarrow \begin{bmatrix} \dot\theta_1 \\ \dot\theta_2 \end{bmatrix} = J^{-1}\begin{bmatrix} V_x \\ V_y \end{bmatrix}$$

$$\begin{bmatrix} \dot\theta_1 \\ \dot\theta_2 \end{bmatrix} = \begin{bmatrix} 0 & 0.202 \\ -0.1 & -0.302 \end{bmatrix}\begin{bmatrix} 2 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ -0.2 \end{bmatrix} \approx \begin{bmatrix} 0^\circ \\ -11.46^\circ \end{bmatrix}$$

CASE 2:

$$J = \begin{bmatrix} -7\sin 45^\circ - 10\sin(45^\circ+90^\circ) & -10\sin(45^\circ+90^\circ) \\ 7\cos 45^\circ + 10\cos(45^\circ+90^\circ) & 10\cos(45^\circ+90^\circ) \end{bmatrix}$$

$$= \begin{bmatrix} -12.021 & -7.071 \\ -2.121 & -7.071 \end{bmatrix}$$

$$J^{-1} = \frac{1}{(-12.021)(-7.071) - (-7.071)(-2.121)} \begin{bmatrix} -7.071 & 7.071 \\ 2.121 & -12.021 \end{bmatrix}$$

$$= \begin{bmatrix} -0.101 & 0.101 \\ 0.030 & -0.172 \end{bmatrix}$$

CHECK:

$$\begin{bmatrix} -12.021 & -7.071 \\ -2.121 & -7.071 \end{bmatrix}\begin{bmatrix} -0.101 & 0.101 \\ 0.030 & -0.172 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \checkmark$$

$$\begin{bmatrix} \dot\theta_1 \\ \dot\theta_2 \end{bmatrix} = J^{-1}\begin{bmatrix} V_x \\ V_y \end{bmatrix} = \begin{bmatrix} -0.101 & 0.101 \\ 0.030 & -0.172 \end{bmatrix}\begin{bmatrix} 0 \\ 4 \end{bmatrix} = \begin{bmatrix} 0.404 \\ -0.688 \end{bmatrix} \approx \begin{bmatrix} 23.15^\circ \\ -39.42^\circ \end{bmatrix}$$