1 Homogenous Transformation

Two frames $o_0x_0y_0z_0$ and $o_1x_1y_1z_1$ are related by the homogenous transformation, which sends frame 0 to frame 1:

$$H = \begin{bmatrix} 0 & -1 & 0 & 1 \\ 1 & 0 & 0 & -1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{1}$$

A particle has velocity $v_1(t) = [3, 1, 0]^T$ relative to the frame $o_1x_1y_1z_1$. Since the velocity and the frame are both constant, to find the velocity in frame zero, it suffices to express the vector v_1 in frame 0. The inverse transformation is:

$$H^{-1} = \begin{bmatrix} 0 & 1 & 0 & -1 \\ -1 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Since v_1 is a vector, the rotation is all that we need to consider. Therefore, v_0 is:

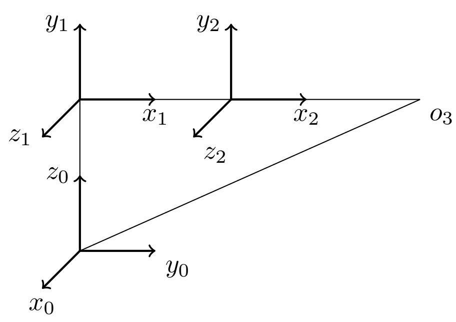
$$\begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 3 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 \\ -3 \\ 0 \end{bmatrix}$$

2 Jacobian for 3-link Elbow Manipulator

Compute the jacobian J_{11} for the 3-link elbow manipulator of Example 4.9 and show that it agrees with Equation (4.98).

From Eq. 4.58, if there are only revolute joints on a manipulator,

$$J_{v_i} = z_{i-1} \times (o_n - o_{i-1}) \tag{2}$$



Show that the determinant agrees with Equation (4.99).