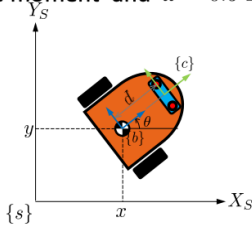


- Find the speed of the origin of the camera frame $\{c\}$ with respect to $\{s\}$. Let $d = 0.3$ m. The G.C. of the robot is moving at $v = 1$ m/s of linear speed along the direction of 45° at the moment and $\omega = 0.5$ rad/s in $\{s\}$.



$$\dot{p}_s = \hat{\omega} p^s + (v - \hat{\omega} q)$$

$$= v + \hat{\omega}(p^s - q)$$

$$v = \begin{bmatrix} v \cos 45^\circ \\ v \sin 45^\circ \end{bmatrix} = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ 1 \end{bmatrix}, \quad \hat{\omega} = \begin{bmatrix} 0 & -\omega \\ \omega & 0 \end{bmatrix} = \begin{bmatrix} 0 & -0.5 \\ 0.5 & 0 \end{bmatrix}$$

$$p^s - q = \begin{bmatrix} d \cos \theta \\ d \sin \theta \end{bmatrix} = 0.3 \begin{bmatrix} \cos \theta \\ \sin \theta \end{bmatrix}$$

$$\dot{p}^s = \begin{bmatrix} \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{bmatrix} + \begin{bmatrix} 0 & -0.5 \\ 0.5 & 0 \end{bmatrix} 0.3 \begin{bmatrix} \cos \theta \\ \sin \theta \end{bmatrix} = \begin{bmatrix} 0.707 - 0.15 \sin \theta \\ 0.707 + 0.15 \sin \theta \end{bmatrix} \text{ m/s}$$

The instantaneous center of rotation is:

$$-\hat{\omega}^{-1}K = -\hat{\omega}^{-1}(\dot{q} - \hat{\omega}q) = q - \hat{\omega}^{-1}\dot{q}$$

$$= \begin{bmatrix} x \\ y \end{bmatrix} - \begin{bmatrix} 0 & -\omega \\ \omega & 0 \end{bmatrix}^{-1} \begin{bmatrix} \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{bmatrix}$$

$$= \begin{bmatrix} x \\ y \end{bmatrix} - \frac{1}{\omega^2} \begin{bmatrix} 0 & \omega \\ -\omega & 0 \end{bmatrix} \frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} x \\ y \end{bmatrix} - \begin{bmatrix} 0 & \frac{1}{0.5} \\ -\frac{1}{0.5} & 0 \end{bmatrix} \frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} x - \sqrt{2} \\ y + \sqrt{2} \end{bmatrix}$$