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Mobile Robotics

Ans1.) Robot is heading along x-axis of frame G

for multiple transform

$$X_G = \begin{bmatrix} T_{R_1}^G & T_{R_2}^G & ---- & T_{R_n}^G \end{bmatrix} \begin{bmatrix} x_{R_n} \\ y_{R_n} \\ \theta_{R_n} \\ 1 \end{bmatrix}$$

where $T_R^G = \begin{bmatrix} \cos\theta_c & -\sin\theta_c & 0 & t_{rx} \\ \sin\theta_c & \cos\theta_c & 0 & t_{ry} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

Now for first 2 seconds

$$T_{R_1}^G = \begin{bmatrix} \cos\omega t & -\sin\omega t & 0 & x_1 \\ \sin\omega t & \cos\omega t & 0 & y_1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

where $\omega = \frac{\pi}{10}$ & $t = 2$ & $x_1 = \int_0^2 v\cos\omega t\, dt$

$= \frac{20}{\pi}\sin\frac{\pi}{5}$

& $y_1 = \int_0^2 v\sin\omega t\, dt = \frac{20}{\pi}\left(1 - \cos\frac{\pi}{5}\right)$

$$T_{1,6} = \begin{bmatrix} \cos\frac{\pi}{5} & -\sin\frac{\pi}{5} & 0 & -\frac{20}{\pi}\sin\pi/5 \\ \sin\pi/5 & \cos\frac{\pi}{5} & 0 & \frac{20}{\pi}(1-\cos\frac{\pi}{5}) \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

for wkt two sec, T_{2}^{0} $\omega t = \frac{-\pi}{5}$, $x_2 = \frac{-20}{\pi}\sin\frac{\pi}{5}$

$y_2 = \frac{-20}{\pi}\left(1-\cos\frac{\pi}{5}\right)$ T_{3}^{6}, $\omega t = 0$, $x_3 = 6$ $y_3 = 0$

The last matrix $\begin{bmatrix} x_2 \\ y_3 \\ \theta_3 \\ 1 \end{bmatrix}$ $\Rightarrow$ $x_4 \Rightarrow$ xpt wrt the 4th frame

$\Rightarrow \frac{15}{\pi}\sin\frac{2\pi}{5}$

$y_4 = \frac{15}{\pi}\left(1-\cos\frac{2\pi}{5}\right)$

$\theta_4 = \frac{2\pi}{5}$ here $\omega t = \frac{2\pi}{5}$

$V = 3m/s$

$$X_{G_1} = \begin{bmatrix} \cos\frac{\pi}{5} & -\sin\pi/5 & 0 & \frac{20}{\pi}\sin\pi/5 \\ \sin\pi/5 & -\cos\pi/5 & 0 & \frac{20}{\pi}(1-\cos\pi/5 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\frac{\pi}{5} & \sin\frac{\pi}{5} & 0 & \frac{20}{\pi}\sin\frac{\pi}{5} \\ -\sin\frac{\pi}{5} & \cos\frac{\pi}{5} & 0 & -\frac{20}{\pi}(1-\cos\pi \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\times \begin{bmatrix} 1 & 0 & 0 & 6 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \frac{15}{\pi}\sin\frac{\pi}{5} \\ \frac{15}{\pi}(1-\cos\frac{2\pi}{5}) \\ \frac{2\pi}{5} \\ 1 \end{bmatrix}$$

$$X_{G_1} = \begin{bmatrix} \frac{15}{\pi}\sin\frac{2\pi}{5} + \frac{40}{\pi}\sin\frac{\pi}{5} + 6 \\ \frac{15}{\pi}\left(1-\cos\frac{2\pi}{5}\right) + \frac{40}{\pi}\left(1-\cos\frac{\pi}{5}\right) \\ 2\pi/5 \\ 1 \end{bmatrix}$$

$X_{1G_1} = 18.024$, $Y_2 = 5.730$, $\theta_4 = 72^\circ$