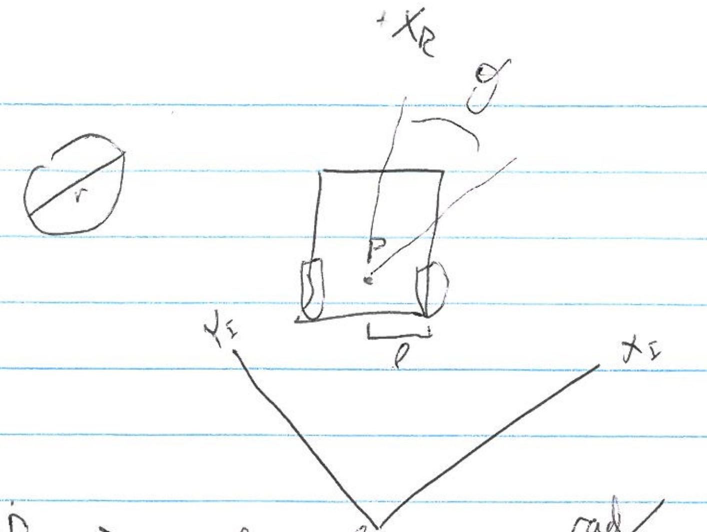


$\dot{\varphi}_1$ $\dot{\varphi}_2$ → speeds of wheels in rad/sec.

$$\xi_I = \begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{bmatrix} = f(l, r, \theta, \dot{\varphi}_1, \dot{\varphi}_2)$$

$\dot{x}_{r_1} = \frac{1}{2} r \dot{\varphi}_1$ $\dot{x}_{r_2} = \frac{1}{2} r \dot{\varphi}_2$

Differential Drive ⇒ simply add

consider • both forward

• equal & opposite

$\dot{y}_r = 0$

rotational velocity of just rotating wheel 1 = right wheel

$\dot{\varphi}_2 = 0$ ⇒ spins around wheel 2

Forward spin ⇒ counter clockwise rotation at P

ω_1 = rotational velocity at P ⇒ wheel moving along arc of circle at radius $2l$

$\omega_1 = \frac{r\dot{\varphi}_1}{2l}$ = angular velocity at P from wheel 1

$\omega = \frac{d\theta}{dt} =$ ~~[illegible]~~ $\omega = \frac{v}{r}$

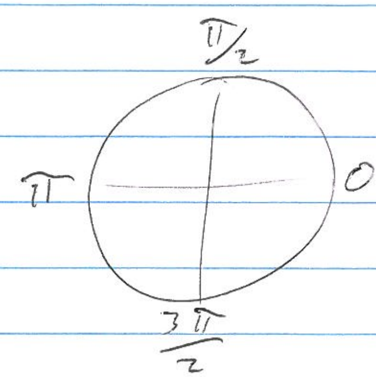
also $\omega = 2\pi f$ where f = frequency

$$\omega_2 = \frac{-r\dot{\varphi}_2}{2l}$$

ξ

x_i upper case: Ξ

$$\dot{\xi}_R = R(\theta)\,\dot{\xi}_I$$



$$R(\theta) = \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\dot{\xi}_R = R\left(\tfrac{\pi}{2}\right)\dot{\xi}_I = \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} \dot{y} \\ -\dot{x} \\ \dot{\theta} \end{bmatrix}$$

$$\dot{\xi}_R = R(\pi)\,\dot{\xi}_I = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} -\dot{x} \\ -\dot{y} \\ \dot{\theta} \end{bmatrix}$$

$\dot{\xi}_R = R(\theta)\dot{\xi}_I$

$$\dot{\xi}_I = R(\theta)^{-1} \begin{bmatrix} \frac{r\dot{\varphi}_1}{2} + \frac{r\dot{\varphi}_2}{2} \\ 0 \\ \frac{r\dot{\varphi}_1}{2l} + \frac{-r\dot{\varphi}_2}{2l} \end{bmatrix}$$

$$R(\theta)^{-1} = \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

example: $\theta = \frac{\pi}{2}$, $r = 1$, $l = 1$
$\dot{\varphi}_1 = 4$, $\dot{\varphi}_2 = 2$

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

$\Rightarrow$ speed 3 in y, rotating w/ speed 1

what if diameter of left wheel = 2
right = 3
$l = 5$ $\theta = \pi/4$, $\dot{\varphi}_1 = \dot{\varphi}_2 = 6$
instantaneous v?

$$\dot{\xi}_I = \begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{-1}{\sqrt{2}} & 0 \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \frac{18}{2} + \frac{12}{2} \\ 0 \\ \frac{18}{10} - \frac{12}{10} \end{bmatrix} = \begin{bmatrix} \frac{15}{\sqrt{2}} - \frac{15}{\sqrt{2}} \\ \frac{15}{\sqrt{2}} + \frac{15}{\sqrt{2}} \\ \frac{3}{5} \end{bmatrix}$$