

Twist to wheel Velocity:

$$V_i = A_{i0} \cdot V_0$$

Wheel 1: $\begin{bmatrix} \dot{\phi}_1 \\ v_{x1} \\ v_{y1} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ -D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \dot{\phi} \\ v_x \\ v_y \end{bmatrix} = \begin{bmatrix} \dot{\phi} \\ -D\dot{\phi} + v_x \\ v_y \end{bmatrix} = \begin{bmatrix} \dot{\phi} \\ r\dot{\phi}_1 \\ 0 \end{bmatrix} \quad /:r \quad (1)$

Wheel 2: $\begin{bmatrix} \dot{\phi}_2 \\ v_{x2} \\ v_{y2} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \dot{\phi} \\ v_x \\ v_y \end{bmatrix} = \begin{bmatrix} \dot{\phi} \\ D\dot{\phi} + v_x \\ v_y \end{bmatrix} = \begin{bmatrix} \dot{\phi} \\ r\dot{\phi}_2 \\ 0 \end{bmatrix} \quad /:r$

or

$$\dot{\phi}_1 = \frac{1}{r} [-D \ 1 \ 0] \begin{bmatrix} \dot{\phi} \\ v_x \\ v_y \end{bmatrix} = -\frac{D}{r} \dot{\phi} + \frac{1}{r} v_x \quad (2)$$

$$\dot{\phi}_2 = \frac{1}{r} [D \ 1 \ 0] \begin{bmatrix} \dot{\phi} \\ v_x \\ v_y \end{bmatrix} = \frac{D}{r} \dot{\phi} + \frac{1}{r} v_x$$

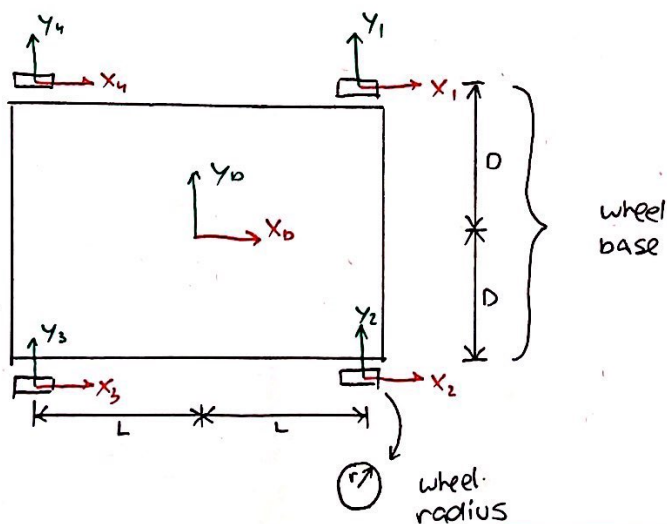
Wheel velocity to Twist:

From (1):

$$\begin{aligned} v_{x1} &= r\dot{\phi}_1 \\ v_{x2} &= r\dot{\phi}_2 \end{aligned} \Rightarrow v_x = \frac{v_{x1} + v_{x2}}{2} = r \frac{\dot{\phi}_1 + \dot{\phi}_2}{2}$$

From (2):

$$\begin{aligned} \dot{\phi}_1 &= -r \left(\frac{\dot{\phi}_1 - v_{x1}}{D} \right) \\ \dot{\phi}_2 &= r \left(\frac{\dot{\phi}_2 - v_{x2}}{D} \right) \end{aligned} \Rightarrow \dot{\phi} = \frac{\dot{\phi}_1 + \dot{\phi}_2}{2} = r \left(\frac{\dot{\phi}_2 - \dot{\phi}_1}{2D} \right)$$



* In our case - 2 wheels differential drive robot

$$L = 0.$$

Wheel Angle to wheel velocity:

$$\dot{\Phi}_i = \frac{\Delta \Phi_i}{\Delta t} \Rightarrow \dot{\Phi}_i = \Delta \Phi_i$$

$\Delta t = 1$
one time
step

Wheel velocity to wheel Angle

$$\Phi_{i,t} = \dot{\Phi}_i \cdot \Delta t + \Phi_{i,t-1} \Rightarrow \Phi_{i,t} = \dot{\Phi}_i + \Phi_{i,t-1}$$

$\Delta t = 1$
one time
step

Update Configuration (in update odometry functions):

$q_b = q_b(x_b, y_b, \phi_b)$ - configuration in $\{b\}$ frame

T_{wb} - transformation from frame $\{w\}$ to frame $\{b\}$

$T_{bb'}$ - transformation from frame $\{b\}$ to frame $\{b'\}$

$T_{wb'} = T_{wb} \cdot T_{bb'}$ - transformation from $\{w\}$ to $\{b'\}$

