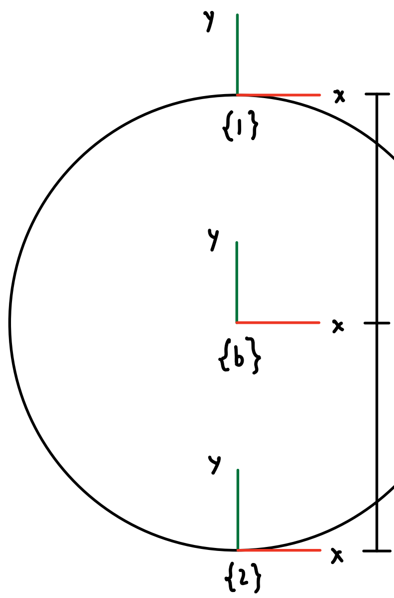

Transformation matrices:

$T_{b1}(0,0,D)$ $\qquad$ $T_{b2}(0,0,-D)$

Adjoints:

$$A_{b1} = \begin{bmatrix} 1 & 0 & 0 \\ D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad A_{b2} = \begin{bmatrix} 1 & 0 & 0 \\ -D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Inverse Adjoints:

$$A_{1b} = \begin{bmatrix} 1 & 0 & 0 \\ -D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad A_{2b} = \begin{bmatrix} 1 & 0 & 0 \\ D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Body Twist in the Wheel Frames

Left wheel:

$$V_1 = A_{1b} V_b$$

$$\begin{bmatrix} \dot{\theta} \\ v_{x1} \\ v_{y1} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ -D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \dot{\theta} \\ v_x \\ v_y \end{bmatrix} = \begin{bmatrix} \dot{\theta} \\ -D\dot{\theta} + v_x \\ v_y \end{bmatrix}$$

Right wheel:

$$V_2 = A_{2b} V_b$$

$$\begin{bmatrix} \dot{\theta} \\ v_{x2} \\ v_{y2} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \dot{\theta} \\ v_x \\ v_y \end{bmatrix} = \begin{bmatrix} \dot{\theta} \\ D\dot{\theta} + v_x \\ v_y \end{bmatrix}$$

Body Twist to Wheel Motion

Left wheel:

$$\begin{bmatrix} \dot{\theta} \\ r\dot{\phi}_1 \\ 0 \end{bmatrix} = \begin{bmatrix} \dot{\theta} \\ -D\dot{\theta} + v_x \\ v_y \end{bmatrix}$$

$$\begin{bmatrix} \phi_1 \end{bmatrix} = \begin{bmatrix} \frac{-D}{r} & \frac{1}{r} & 0 \end{bmatrix} \begin{bmatrix} \dot{\theta} \\ v_x \\ v_y \end{bmatrix}$$

Right wheel:

$$\begin{bmatrix} \dot{\theta} \\ r\dot{\phi}_2 \\ 0 \end{bmatrix} = \begin{bmatrix} \dot{\theta} \\ D\dot{\theta} + v_x \\ v_y \end{bmatrix}$$

$$\begin{bmatrix} \phi_2 \end{bmatrix} = \begin{bmatrix} \frac{D}{r} & \frac{1}{r} & 0 \end{bmatrix} \begin{bmatrix} \dot{\theta} \\ v_x \\ v_y \end{bmatrix}$$

Inverse Kinematics

$$\dot{\phi} = HV_b$$

$$\begin{bmatrix} \dot{\phi}_1 \\ \dot{\phi}_2 \end{bmatrix} = \frac{1}{r} \begin{bmatrix} -D & 1 & 0 \\ D & 1 & 0 \end{bmatrix} \begin{bmatrix} \dot{\theta} \\ v_x \\ v_y \end{bmatrix}$$

$$\dot{\phi}_1 = \frac{1}{r} (-D\dot{\theta} + v_x) \qquad (1)$$

$$\dot{\phi}_2 = \frac{1}{r} (D\dot{\theta} + v_x) \qquad (2)$$

Forward Kinematics

$$V_b = H^+ u$$

$$\begin{bmatrix} \dot{\theta} \\ v_x \\ v_y \end{bmatrix} = \frac{r}{2} \begin{bmatrix} -\frac{1}{D} & \frac{1}{D} \\ 1 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

$$\dot{\theta} = \frac{r}{2} \left(-\frac{u_1}{D} + \frac{u_2}{D} \right)$$

$$v_x = \frac{r}{2} (u_1 + u_2)$$

Set $u_1 = \dot{\phi}_1$ and $u_2 = \dot{\phi}_2$:

$$\dot{\theta} = \frac{r}{2} \left(-\frac{\dot{\phi}_1}{D} + \frac{\dot{\phi}_2}{D} \right) \qquad (3)$$

$$v_x = \frac{r}{2} (\dot{\phi}_1 + \dot{\phi}_2) \qquad (4)$$

Update Configuration:

$$\Delta q = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta \\ 0 & \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} \Delta\theta_b \\ \Delta x_b \\ \Delta y_b \end{bmatrix}$$

$$\Delta q = \begin{bmatrix} \Delta\theta_b \\ \Delta x_b \cos\theta - \Delta y_b \sin\theta \\ \Delta x_b \sin\theta + \Delta y_b \cos\theta \end{bmatrix} \qquad (5)$$

or

Compute $T_{wb'} = T_{wb} T_{bb'}$

↳ Use (3) and (4) to get the twist and integrate that twist

Assign the x component to the x of the configuration

y y

theta theta