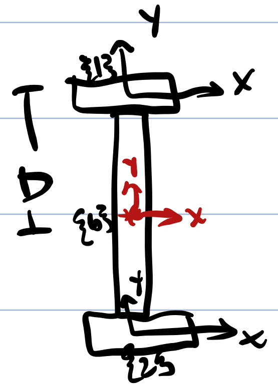
L=0



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

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

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

$V_b = \begin{bmatrix} \dot\theta \\ \dot x \\ \dot y \end{bmatrix}$, $V_1 = \begin{bmatrix} \dot\theta \\ V_{x1} \\ V_{y1} \end{bmatrix}$, $V_2 = \begin{bmatrix} \dot\theta \\ V_{x2} \\ V_{y2} \end{bmatrix}$; robot wheels & body frame have same heading

$$V_1 = A_{1b} V_b = \begin{bmatrix} \dot\theta \\ -D\dot\theta + V_{x1} \\ V_{y1} \end{bmatrix}$$

Conv wheels: $\begin{bmatrix} V_{xi} \\ V_{yi} \end{bmatrix} = \begin{bmatrix} r\dot\phi_i \\ 0 \end{bmatrix}$ ← no slip

$$V_2 = A_{2b} V_b = \begin{bmatrix} \dot\theta \\ D\dot\theta + V_{x2} \\ V_{y2} \end{bmatrix}$$

so, $\dot\theta$ is body heading $\frac{d\theta}{dt}$, $\dot\phi_i$ is wheel speed, $\frac{d\phi_i}{dt}$

Wheel 1: $\begin{bmatrix} \dot\theta \\ V_{x1} \\ V_{y1} \end{bmatrix} = \begin{bmatrix} \dot\theta \\ r\dot\phi_1 \\ 0 \end{bmatrix} = \begin{bmatrix} \dot\theta \\ -D\dot\theta + V_{x1} \\ V_{y1} \end{bmatrix}$

$$\begin{bmatrix} \dot\theta \\ \dot\phi_1 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ -\frac{D}{r} & \frac{1}{r} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \dot\theta \\ V_{x1} \\ V_{y1} \end{bmatrix}$$

Wheel 2: $\begin{bmatrix} \dot\theta \\ \dot\phi_2 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ \frac{D}{r} & \frac{1}{r} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \dot\theta \\ V_{x2} \\ V_{y2} \end{bmatrix}$

Inv Kinematics: $\begin{bmatrix} u_1 \\ u_2 \end{bmatrix} = \begin{bmatrix} \dot\phi_1 \\ \dot\phi_2 \end{bmatrix} = \frac{1}{r} \overbrace{\begin{bmatrix} -D & 1 & 0 \\ D & 1 & 0 \end{bmatrix}}^{H} \begin{bmatrix} \dot\theta \\ V_x \\ V_y \end{bmatrix}$

Forward Kinematics:

$$\mathcal{V}_b = \begin{bmatrix} \dot{\theta} \\ v_x \\ v_y \end{bmatrix} = \underset{\substack{\uparrow \\ \text{pseudo} \\ \text{inverse}}}{H^{\dagger}} u = \frac{r}{2} \begin{bmatrix} \frac{-1}{D} & \frac{1}{D} \\ 1 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

In world frame: $\dot{q} = Ad(\theta, 0, 0)\, \mathcal{V}_b$

$$\dot{q} = \begin{bmatrix} \dot{\theta} \\ \dot{x} \\ \dot{y} \end{bmatrix} = \frac{r}{2} \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta \\ 0 & \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} \frac{-1}{D} & \frac{1}{D} \\ 1 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

$$\dot{q} = \begin{bmatrix} \dot{\theta} \\ \dot{x} \\ \dot{y} \end{bmatrix} = \frac{r}{2} \begin{bmatrix} \frac{-1}{D} & \frac{1}{D} \\ \cos\theta & \cos\theta \\ \sin\theta & \sin\theta \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

$\dot{q} = \Delta q$ in unit time