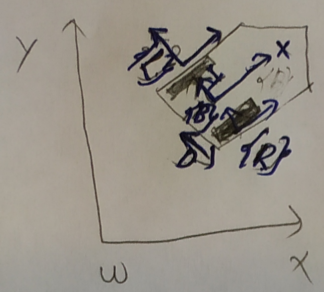

$T_{BR}(0, 0, -D)$, $T_{BL}(0,0,D)$., $T_{RB}(0,0,D)$, $T_{LB}(0,0,-D)$

$$A_{RB} = \begin{bmatrix} 1 & 0 & 0 \\ -D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad V_R = A_{RB} V_B.$$

$$\Rightarrow \begin{bmatrix} \dot\theta \\ V_{xR} \\ V_{yR} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ -D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \dot\theta \\ V_x \\ V_y \end{bmatrix} \Rightarrow \begin{bmatrix} \dot\theta \\ V_{xR} \\ V_{yR} \end{bmatrix} = \begin{bmatrix} \dot\theta \\ -D\dot\theta + V_x \\ V_y \end{bmatrix}$$

|||ly for the left wheel.

$$\Rightarrow \begin{bmatrix} \dot\theta \\ V_{xL} \\ V_{yL} \end{bmatrix} = \begin{bmatrix} \dot\theta \\ D\dot\theta + V_x \\ V_y \end{bmatrix}$$

For a conventional wheel,

$V_{xL} = r\dot\phi_L$, $V_{xR} = r\dot\phi_R$, $y_{xL} = 0$ $y_{xR} = 0$, (where r is the radius of the wheel)

$$\Rightarrow \begin{bmatrix} \dot\theta \\ r\dot\phi_L \\ 0 \end{bmatrix} = \begin{bmatrix} \dot\theta \\ -D\dot\theta + V_x \\ V_y \end{bmatrix}, \quad \begin{bmatrix} \dot\theta \\ r\dot\phi_R \\ 0 \end{bmatrix} = \begin{bmatrix} \dot\theta \\ D\dot\theta + V_x \\ V_y \end{bmatrix}$$

Rearranging to get equations for $\dot{\phi}_L$ & $\dot{\phi}_R$

$$\begin{bmatrix} \dot{\phi}_L \\ \dot{\phi}_R \end{bmatrix} = \frac{1}{\gamma}\begin{bmatrix} -D & 1 & 0 \\ D & 1 & 0 \end{bmatrix} \begin{bmatrix} \dot{\theta} \\ V_x \\ V_y \end{bmatrix}$$

$$U = H\dot{\gamma} \Rightarrow \gamma = H^{+}U.$$

$$H^{+} = (H^T H)^{-1} H^T$$

$$= \left(\frac{1}{\gamma^2}\begin{bmatrix} -D & D \\ 1 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} -D & 1 & 0 \\ D & 1 & 0 \end{bmatrix} \right)^{-1} \frac{1}{\gamma} \times \begin{bmatrix} -D & D \\ 1 & 1 \\ 0 & 0 \end{bmatrix}$$

$$= \left(\frac{1}{\gamma^2}\begin{bmatrix} 2D^2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 0. \end{bmatrix} \right)^{-1} \frac{1}{\gamma} \times \begin{bmatrix} -D & D \\ 1 & 1 \\ 0 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} \frac{\gamma^2}{2D^2} & 0 & 0 \\ 0 & \gamma^2/2 & 0 \\ 0 & 0 & 0 \end{bmatrix} \frac{1}{\gamma} \times \begin{bmatrix} -D & -D \\ 1 & 1 \\ 0 & 0 \end{bmatrix}$$

$$H^{+}. = \begin{bmatrix} -\gamma/2D. & \gamma/2D \\ \gamma/2 & \gamma/2 \\ 0 & 0. \end{bmatrix}$$