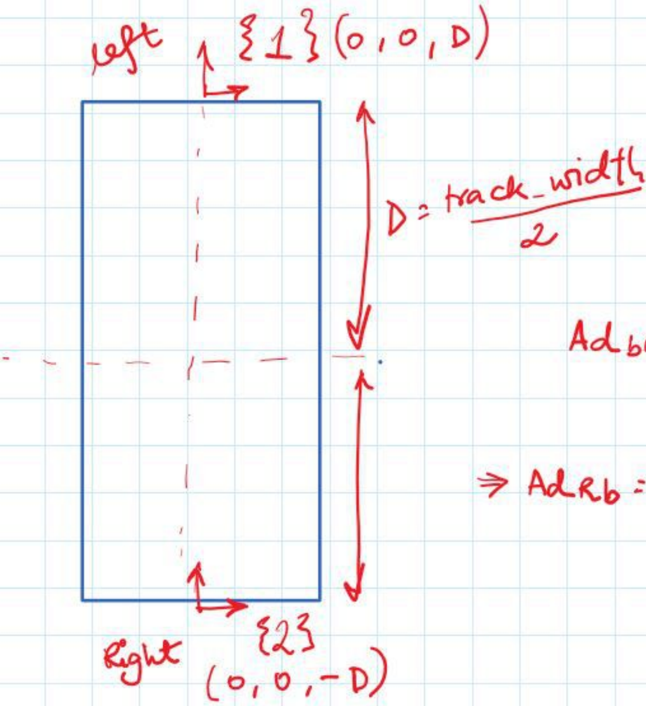

$$T_{bR} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & D \\ 0 & 0 & 1 \end{bmatrix}$$

$$T_{bL} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -D \\ 0 & 0 & 1 \end{bmatrix}$$

$$Ad_{bR} = \begin{bmatrix} 1 & 0 & 0 \\ D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \Rightarrow A_{bL} = \begin{bmatrix} 1 & 0 & 0 \\ -D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\Rightarrow Ad_{Rb} = \begin{bmatrix} 1 & 0 & 0 \\ -D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \Rightarrow A_{Lb} = \begin{bmatrix} 1 & 0 & 0 \\ D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Body Twist $V_b = \begin{bmatrix} \dot{\theta} \\ v_x \\ v_y \end{bmatrix}$

Forward Kinematics

$$\begin{bmatrix} v_{xi} \\ v_{yi} \end{bmatrix} = \begin{bmatrix} r\dot{\phi}_i \\ 0 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} \dot{\theta} \\ r\dot{\phi}_L \\ 0 \end{bmatrix} = A_{Lb} V_b = \begin{bmatrix} 1 & 0 & 0 \\ D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \dot{\theta} \\ v_x \\ v_y \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} \dot{\phi}_L \\ 0 \end{bmatrix} \begin{bmatrix} D/r & 1/r & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \dot{\theta} \\ v_x \\ v_y \end{bmatrix}$$

Similarly:

$$\begin{bmatrix} \dot{\theta} \\ r\dot{\phi}_R \\ 0 \end{bmatrix} = A_{Rb} V_b = \begin{bmatrix} 1 & 0 & 0 \\ -D & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \dot{\theta} \\ v_x \\ v_y \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} \dot{\phi}_R \\ 0 \end{bmatrix} = \begin{bmatrix} -D/r & 1/r & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} u_L \\ u_R \end{bmatrix} = H V_b \Rightarrow V_b = \begin{bmatrix} u_L \\ u_R \end{bmatrix} H^{\dagger}$$

$$H = \begin{bmatrix} -D/r & 1/r & 0 \\ D/r & 1/r & 0 \end{bmatrix} \Rightarrow H^{+} = \frac{r}{2}\begin{bmatrix} -1/D & 1/D \\ 1 & 1 \\ 0 & 0 \end{bmatrix}$$

$$\therefore \begin{bmatrix} \dot{\theta} \\ v_x \\ v_y \end{bmatrix} = \frac{r}{2}\begin{bmatrix} -1/D & 1/D \\ 1 & 1 \\ 0 & 0 \end{bmatrix}\begin{bmatrix} \Delta\phi_L \\ \Delta\phi_R \end{bmatrix}$$

$$\Rightarrow \dot{\theta} = \left(-\frac{\Delta\phi_L}{D} + \frac{\Delta\phi_R}{D}\right)\frac{r}{2}$$

$$\Rightarrow v_x = (\Delta\phi_L + \Delta\phi_R)\frac{r}{2}$$

$$\Rightarrow v_y = 0$$

$T_{bb'} = T(\Delta\phi_b, \Delta x_b, \Delta y_b) \rightarrow$ integrate twist (V_b) —— (i)

$$q' = q + \Delta q$$

$$\Delta q = A(\theta, 0, 0)\,\Delta q_b$$

$q_b = \begin{bmatrix} \Delta\theta_b \\ \Delta x_b \\ \Delta y_b \end{bmatrix}$ from eq^n (i)

Inverse Kinematics

$$u = H V_b$$

$$= \begin{bmatrix} -D/r & 1/r & 0 \\ D/r & 1/r & 0 \end{bmatrix}\begin{bmatrix} \theta \\ x \\ y \end{bmatrix}$$

$$\Delta\phi_L = \frac{-D}{r}\theta + \frac{x}{r}$$

$$\Delta\phi_R = \frac{D\theta}{r} + \frac{x}{r}$$