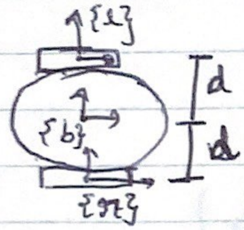
b $\qquad$ s

b' $\qquad$ s'

$T_{sb} = T_{s'b'}$.

$$T_{bb'} = \underbrace{T_{bs}}_{T_{sb}^{-1}} \underbrace{T_{ss'}}_{\text{have}} \overbrace{T_{s'b'}}^{\to T_{sb}}.$$

Kinematics of diff drive of the turtlebot.



$$A_{bl} = \begin{bmatrix} 1 & 0 & 0 \\ d & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad A_{br} = \begin{bmatrix} 1 & 0 & 0 \\ -d & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}.$$

$$V_l = A_{lb} V_b \qquad V_r = A_{rb} V_b.$$

$$V_b = \begin{bmatrix} \dot\theta_b \\ \dot x_b \\ \dot y_b \end{bmatrix} \qquad \therefore A_{lb} = \begin{bmatrix} 1 & 0 & 0 \\ -d & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad A_{rb} = \begin{bmatrix} 1 & 0 & 0 \\ d & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\therefore V_l = \begin{bmatrix} 1 & 0 & 0 \\ -d & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \dot\theta_b \\ \dot x_b \\ \dot y_b \end{bmatrix} \qquad V_r = \begin{bmatrix} 1 & 0 & 0 \\ d & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \dot\theta_b \\ \dot x_b \\ \dot y_b \end{bmatrix}$$

$$V_l = \begin{bmatrix} \dot\theta_b \\ \dot x_b - d\dot\theta_b \\ \dot y_b \end{bmatrix} \qquad V_r = \begin{bmatrix} \dot\theta_b \\ \dot x_b + d\dot\theta_b \\ \dot y_b \end{bmatrix}$$

But for conventional wheels $\dot y = 0$ & $\dot x = r\dot\phi$

$$\therefore \begin{bmatrix} \dot\theta_l \\ r\dot\phi_l \\ 0 \end{bmatrix} = \begin{bmatrix} \dot\theta_b \\ \dot x_b - d\dot\theta_b \\ \dot y_b \end{bmatrix} \qquad \begin{bmatrix} \dot\theta_r \\ r\dot\phi_r \\ 0 \end{bmatrix} = \begin{bmatrix} \dot\theta_b \\ \dot x_b + d\dot\theta_b \\ \dot y_b \end{bmatrix}$$

$$\therefore \dot\phi_l = \frac{\dot x_b - d\dot\theta_b}{r} \quad -(1) \qquad \dot\phi_r = \frac{\dot x_b + d\dot\theta_b}{r} \quad -(2).$$

$$\therefore \begin{bmatrix} \dot\phi_l \\ \dot\phi_r \end{bmatrix} = \frac{1}{r}\begin{bmatrix} -d & 1 & 0 \\ d & 1 & 0 \end{bmatrix}\begin{bmatrix} \dot\theta_b \\ \dot x_b \\ \dot y_b \end{bmatrix}$$ - ① & ② combined.

In the form of $\dot\phi = H V_b$

$V_b = H^{+} u$ where $u = \dot\phi$.

$$\begin{bmatrix} \dot\theta_b \\ \dot x_b \\ \dot y_b \end{bmatrix} = r\begin{bmatrix} \frac{-1}{2d} & \frac{1}{2d} \\ \frac{1}{2} & \frac{1}{2} \\ 0 & 0 \end{bmatrix}\begin{bmatrix} \dot\phi_l \\ \dot\phi_r \end{bmatrix}$$ - ③.

$\therefore \dot x_b = \frac{r}{2}\left(\dot\phi_l + \dot\phi_r\right)$. & $\dot\theta_b = \frac{r}{2d}\left(\dot\phi_r - \dot\phi_l\right)$

$\Delta \dot x_b = \frac{r}{2}\left(\Delta\dot\phi_l + \Delta\dot\phi_r\right)$ & $\Delta\dot\theta_b = \frac{r}{2d}\left(\Delta\dot\phi_r + \Delta\dot\phi_l\right)$.

using the integrate twist function.

$T_{bb'}$ = integrate_Twist $(\dot\theta_b, \dot x_b, \dot y_b)$. from eq ③.

$T_{bb'} = T(\Delta\dot\theta_b, \Delta\dot x_b, \Delta\dot y_b)$.

$T_{wb'} = T_{wb} T_{bb'}$ $T_{wb} \Rightarrow$ current position.