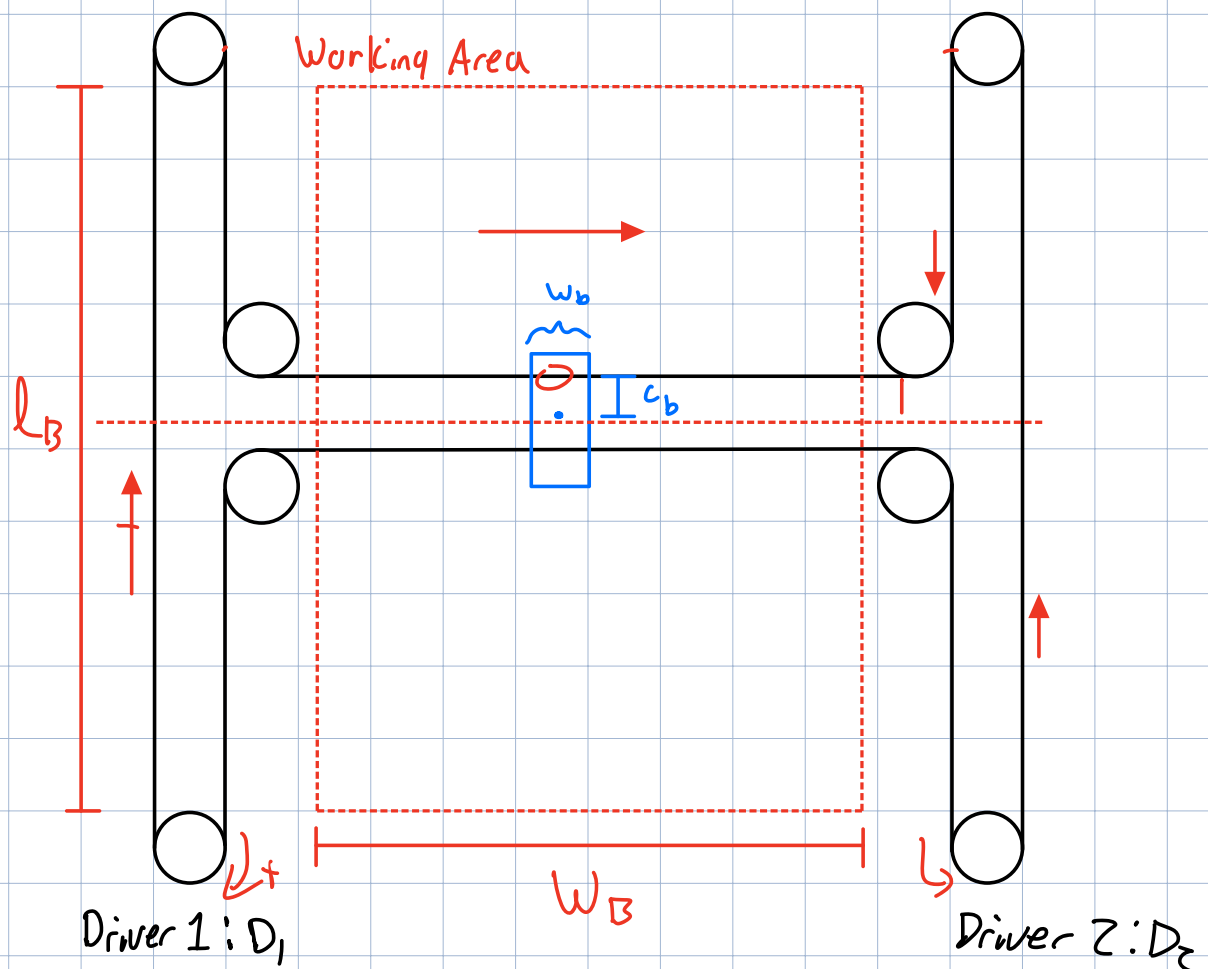
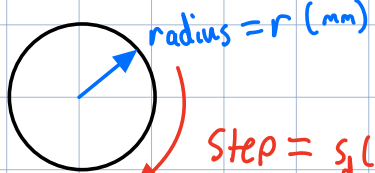


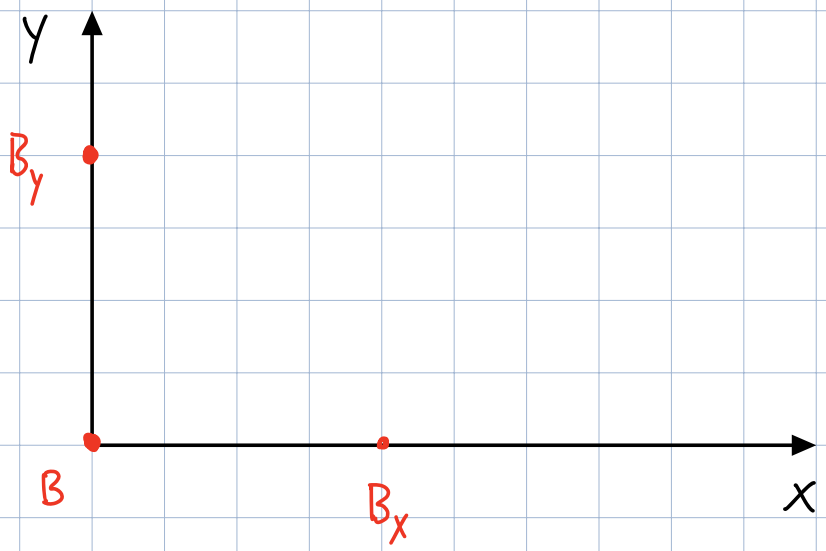
Kinematics

Driver Pulley



$$s_L = \text{Length per step} = \frac{s_d}{360\left(\frac{deg}{rad}\right)} \cdot 2\pi r$$

2 Scenarios - Lateral movement, Diagonal movement



$B \rightarrow B_x$: Horizontal movement

$$\theta_{D_1} = \theta_{D_2}$$
$$\dot{\theta}_{D_1} = \dot{\theta}_{D_2}$$

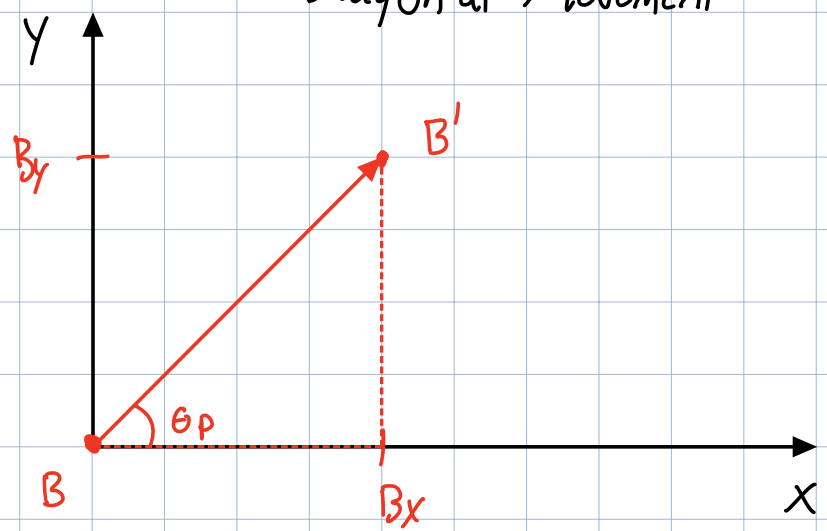
$$x = \#\text{ of steps} = \frac{B_x - B}{SL}$$

$B \rightarrow B_y$: vertical movement

$$\theta_{D_1} = -\theta_{D_2}$$
$$\dot{\theta}_{D_1} = -\dot{\theta}_{D_2}$$

$$y = \#\text{ of steps} = \frac{B_y - B}{SL}$$

Diagonal Movement



i) If $B_x > 0$ $B_y > 0$, $\dot{\theta}_{D_1} < 0$ $\dot{\theta}_{D_2} > 0$

$$|\dot{\theta}_{D_1}| < |\dot{\theta}_{D_2}|$$

If $B_x > 0$ $B_y < 0$, $\dot{\theta}_{D_1} > 0$ $\dot{\theta}_{D_2} < 0$

$$|\dot{\theta}_{D_1}| > |\dot{\theta}_{D_2}|$$

If $B_x < 0$ $B_y > 0$, $\dot{\theta}_{D_1} < 0$ $\dot{\theta}_{D_2} > 0$

$$|\dot{\theta}_{D_1}| > |\dot{\theta}_{D_2}|$$

If $Bx < 0$ $By < 0$, $\dot{\theta}_{D_1} < 0$ $\dot{\theta}_{D_2} > 0$

$$|\dot{\theta}_{D_1}| < |\dot{\theta}_{D_2}|$$

Each movement to be achieved in a fixed time, t

dx = Horizontal movement $= \left(|\dot{\theta}_{Greater}| - |\dot{\theta}_{Lesser}|\right) dt$

dy = vertical movement $= |\dot{\theta}_{Lesser}| + \frac{1}{2} dx$

$$By = S_L \cdot \int_0^t \dot{\theta}_{Lesser}\, dt + S_L \cdot \int_0^t \frac{1}{2} dx$$

$$By = (\dot{\theta}_{Lesser} \cdot S_L \cdot t)(mm) + \frac{1}{2}(\dot{\theta}_{Greater} - \dot{\theta}_{Lesser}) \cdot S_L \cdot t$$

$$By = \dot{\theta}_{Lesser} \cdot S_L \cdot t + \frac{1}{2}\dot{\theta}_{Greater} \cdot S_L \cdot t - \frac{1}{2}\dot{\theta}_{Lesser} \cdot S_L \cdot t$$

$$By = \frac{1}{2} \cdot S_L \cdot t(\dot{\theta}_{Greater} + \dot{\theta}_{Lesser})(mm)$$

$$Bx = \left(|\dot{\theta}_{Greater}| - |\dot{\theta}_{Lesser}|\right) S_L \cdot t$$

$$\dot{\theta}_{Greater} \cdot S_L \cdot t = Bx + \dot{\theta}_{Lesser} \cdot S_L \cdot t$$

$$\dot{\theta}_{Greater} = \frac{Bx}{S_L \cdot t} + \dot{\theta}_{Lesser}$$

$$B_y = \frac{1}{2} \cdot S_L \cdot t \left(\frac{B_x}{S_L \cdot t} + 2\dot{\theta}_{Lesser} \right)$$

$$B_y = \frac{1}{2} B_x + \dot{\theta}_{Lesser} \cdot S_L \cdot t$$

$$\boxed{\dot{\theta}_{Lesser} = \frac{B_y - \frac{1}{2} B_x}{S_L \cdot t}}$$

$$\dot{\theta}_{Greater} = \frac{B_x}{S_L \cdot t} + \frac{B_y - \frac{1}{2} B_x}{S_L \cdot t}$$

$$\boxed{\dot{\theta}_{Greater} = \frac{B_y + \frac{1}{2} B_x}{S_L \cdot t}}$$

Each movement w/ fixed $|\dot{\theta}_{Greater}|$

$$\dot{\theta}_{Greater} = \text{constant}$$

$$B_y = \dot{\theta}_{Lesser} \cdot S_L \cdot t + \frac{1}{2} (\dot{\theta}_{Greater} - \dot{\theta}_{Lesser}) \cdot S_L \cdot t$$

$$B_y = \frac{1}{2} \cdot S_L \cdot t (\dot{\theta}_{Greater} + \dot{\theta}_{Lesser}) \ (mm)$$

$$\dot{\theta}_{Lesser} = \frac{\tau B_y}{S_L \cdot t} - \dot{\theta}_{Greater}$$

$$B_x = (\dot{\theta}_{Greater} - \dot{\theta}_{Lesser}) S_L \cdot t$$

$$t = \frac{B_x}{\dot{\theta}_{Greater} S_L - \dot{\theta}_{Lesser} S_L}$$

$$\dot{\theta}_{Lesser} = \frac{\tau B_y \cdot S_L \cdot (\dot{\theta}_{Greater} - \dot{\theta}_{Lesser})}{B_x \ S_L} - \dot{\theta}_{Greater}$$

$$\dot{\theta}_{Lesser} = \dot{\theta}_{Greater} \left(\tau \frac{B_y}{B_x} - 1\right) - \tau \frac{B_y}{B_x} \dot{\theta}_{Lesser}$$

$$\left(\tau \frac{B_y}{B_x} + 1\right) \dot{\theta}_{Lesser} = \dot{\theta}_{Greater} \left(\tau \frac{B_y}{B_x} - 1\right)$$

$$\boxed{\dot{\theta}_{Lesser} = \dot{\theta}_{Greater} \frac{\left(\tau \frac{B_y}{B_x} - 1\right)}{\left(\tau \frac{B_y}{B_x} + 1\right)}}$$

$$B_y = \frac{1}{\tau} \cdot S_L \cdot t \left(\dot{\theta}_{Greater} + \dot{\theta}_{Lesser}\right)$$

$$\boxed{t = \frac{\tau B_y}{S_L (\dot{\theta}_{Greater} + \dot{\theta}_{Lesser})}}$$

Code outline

Bx_1 = x coordinate - initial position

By_1 = y coordinate - initial position

Bx_2 = Designated x-coordinate

By_2 = Designated y-coordinate

$Dx = Bx_2 - Bx_1$

$Dy = By_2 - By_1$

Lateral Movement

If $Dx = 0$ & $Dy > 0$

$\dot{\theta}_1 < 0$ $\dot{\theta}_2 > 0$

If $Dx = 0$ & $Dy < 0$

$\dot{\theta}_1 > 0$ $\dot{\theta}_2 < 0$

If $Dx > 0$ & $Dy = 0$

$\dot{\theta}_1 > 0$ & $\dot{\theta}_2 > 0$

If $Dx < 0$ & $Dy = 0$

$\dot{\theta}_1 < 0$ & $\dot{\theta}_2 < 0$

Diagonal Movement

If $D_x < 0$ & $D_y > 0$

$\dot{\theta}_1 < 0 \quad \dot{\theta}_2 > 0$

$|\dot{\theta}_1| > |\dot{\theta}_2|$

If $D_x > 0$ & $D_y > 0$

$\dot{\theta}_1 < 0 \quad \dot{\theta}_2 > 0$

$|\dot{\theta}_1| < |\dot{\theta}_2|$

If $D_x < 0$ & $D_y < 0$

$\dot{\theta}_1 > 0 \quad \dot{\theta}_2 < 0$

$|\dot{\theta}_1| < |\dot{\theta}_2|$

If $D_x > 0$ & $D_y < 0$

$\dot{\theta}_1 > 0 \quad \dot{\theta}_2 < 0$

$|\dot{\theta}_1| > |\dot{\theta}_2|$