

FW:

$$\begin{aligned}\dot{x} &= V \cos \theta \\ \dot{y} &= V \sin \theta \\ \dot{\theta} &= \frac{V}{L} \tan \psi \\ \dot{V} &= 1.0045 V + 2.3393 u\end{aligned}$$

BW:

$$\begin{aligned}\dot{x} &= -V \cos \theta \\ \dot{y} &= -V \sin \theta \\ \dot{\theta} &= -\frac{V}{L} \tan \psi \\ \dot{V} &= \dots\end{aligned}$$

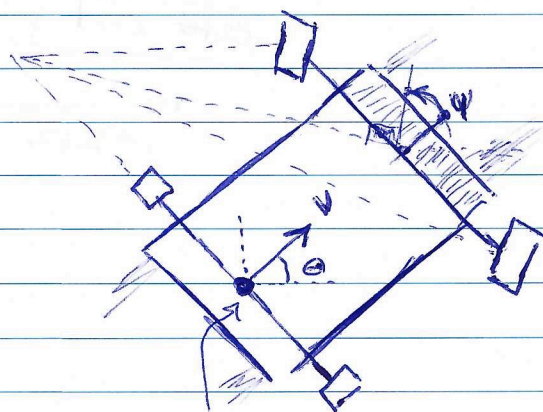
$L = 18.5$

inputs:

ψ : steering angle (radians)
 u : speed m [-1, 1]

state s:

x, y : coordinates (meters)
 θ : orientation (radians)
 V : speed (velocity) (m/s)



(x, y, theta, V) - frame

FW/BW: (best) ✓

$$\dot{x} = V \cos \theta$$

$$\dot{y} = V \sin \theta$$

$$\dot{\theta} = \frac{V}{L} \tan \psi$$

$$\dot{V} = 1.0045 V + 2.3393 u \quad (\text{FW}) \quad u \in [0.45, 1.0]$$

$$1.0348 V + 3.9010 u \quad (\text{BW}) \quad u \in [-0.45, -0.7]$$

$$\dot{V} = aV + bu$$

(See next page for a, b) →

Step-response Ident

$$TF = \frac{K}{Ts - 1}$$

$$\Leftrightarrow \dot{x} = ax + bu$$

FW: $K = 2.3288$, $T = 0.9955 \Leftrightarrow a = 1.0045, b = 2.3393$

BW: $K = 3.763$, $T = 0.9564 \Leftrightarrow a = 1.0456, b = 3.9345$

BW: $K = 3.7599$, $T = 0.9664 \Leftrightarrow a = 1.0348, b = 3.9010$

* $T = \frac{1}{a}$, $K = \frac{b}{a}$

BW: input u applied negative (<0)

Single-integrator model identification:

$$\dot{y} = ay + bu \quad \begin{array}{l} y: \text{out} \\ u: \text{in} \end{array}$$

FT: $sY = aY + bU$

$$(s-a)Y = bU$$

$$\left(\frac{s}{-a} + 1\right)Y = \frac{b}{a}U$$

$$\frac{Y}{U} = \frac{\overset{\rightarrow K}{-b/a}}{\underset{\rightarrow T}{\frac{1}{-a}s + 1}}$$

$$\Rightarrow \begin{array}{l} K = -b/a = b = -aK \\ T = -\frac{1}{a} \end{array}$$

$$\Rightarrow \boxed{a = \frac{-1}{T}}$$

$$\boxed{b = \frac{K}{T}}$$

$$\boxed{T = 0.0083}$$

	K	T	a	b
0.45	1.9353	0.90916	-1.0999	2.1287
0.50	2.2458	0.8942	{	{
0.55	2.8922	0.8508		
0.60	3.0332	0.8642		
0.65	3.1274	0.8419		
0.70	3.7112	0.8822		
→ 0.45	1.6392	1.3008	{	{
0.50	2.5998	0.9882		
0.55	2.8032	0.9640		
0.60	3.1457	0.9741		
0.65	3.6170	0.9481		
0.70	3.6391	0.9285		
0.0	1.5	0.25	← Try/err recorded d	