Rover Models

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1 Model

The input channels for the controller will be denoted $u_1 \in [-\pi, \pi]$ and $u_0 \in [-\pi, \pi]$ for steering and throttle, respectively

$$\begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\psi} \\ \dot{v_x} \\ \dot{\delta} \end{bmatrix} = \begin{bmatrix} v_x(\cos\psi - \frac{l_r}{l}\sin\psi\tan\delta) \\ v_x(\sin\psi + \frac{l_r}{l}\cos\psi\tan\delta) \\ \frac{v_x}{l}\tan\delta \\ \frac{F_{rx} - m_o\frac{\tan\delta}{\cos^2\delta}(k_{st}(\delta_{des}-\delta))v_x}{m + m_o\tan^2\delta} \\ k_{st}(\delta_{des} - \delta) \end{bmatrix} \tag{1}$$

where:

$$\delta_{des} = f(u_1)$$
$$F_{rx} = f(u_0, v_x)$$

2 Vehicle Parameters

Param	Value	Unit
m	7.780	kg
m_o	2.972	kg
I_z	0.2120	$kg\,m^2$
l	0.3302	m
l_r	0.12	m

$m_o = \frac{m l_r^2 + I_z}{l^2}$

3 Steering Input

The map from wheel angle to input can be approximated by a line:

$$\delta_{des} = 0.224314009055080 u_1 - 0.008867066788855 \quad (2)$$

The control gain on the wheel angle is modeled as proportional:

$$k_{st} = 4.300730919846748 \quad (3)$$

4 Throttle Input

4.1 Steering Channel The channel inputs can be mapped to a velocity setpoints with the following approximation:

$$v_{des} = -10.445339156721717 u_0 - 3.584452482313747 \quad (4)$$

This map seems to be a good fit for input values in the interval $u_0 \in [-0.525, -0.4] \mapsto v_{des} \in [1.899, 0.594]$ m/s. Note that it is not good for commands greater than -0.4. There is a dead-zone in the motor for the rover.

4.2 Driving Force $F_{rx} = c_{m1} + c_{m2}\, u_0 + c_{m3}\, v_x + c_{m4}\, v_x\, u_0 + c_{m5}\, v_x^2 + c_{m6}\, u_0^2 + c_{m7}\, v_x\, u_0^2$

Const	Value	Unit
c_{m1}	x	N
c_{m2}	x	N
c_{m3}	x	$\frac{N\,s}{m}$
c_{m4}	x	$\frac{N\,s}{m}$
c_{m5}	x	$\frac{N\,s^2}{m^2}$
c_{m6}	x	N
c_{m7}	x	$\frac{N\,s}{m}$