TriCopter Snono Project

Scheduling of thrusters against thrust loss

March 2025

1 Introduction

This document details key transformations and formulas used in the Snono Tricopter project from a mathematical perspective. For technical considertion, please consult the TriCopter Snono manual.

2 Equations for Thrust Loss Compensation

2.1 Motor 1 (Front)

Note on front motor servo, S_8, range: Set to be from minimum to maximum servo tilt in radians.

Note on canard servos, S_4 and S_5, ranges: These are normalized to be from -1 to 1.

Expanded form (as in code):

$$M_1 := M_1 + \left(\frac{M_1}{\cos(S_8)} - M_1\right) + \left(\frac{M_1}{\cos\left((\alpha_{can}/2)S_4\right)} - M_1\right) + \left(\frac{M_1}{\cos\left((\alpha_{can}/2)S_5\right)} - M_1\right)$$

Compact form:

$$M_1 := M_1\left(\frac{1}{\cos(S_8)} + \frac{1}{\cos\left((\alpha_{can}/2)S_4\right)} + \frac{1}{\cos\left((\alpha_{can}/2)S_5\right)} - 2\right)$$

2.1.1 Note on S_8 dead-band calculations

The following dead-band with normalization calculation is applied to obtain S_8 value from the raw estimated $\bar{S}_8$:

$$S_8 = \begin{cases} 0, & |\bar{S}_8| \leq d \\ k(\bar{S}_8 - d), & \bar{S}_8 > d \\ k(\bar{S}_8 + d), & \bar{S}_8 < -d \end{cases}$$

where $d = d_b \times S_{8,max}$ and $k = \frac{1}{1-d_b}$. The parameter d_b corresponds to the configuration parameter *FRT_TILT_SERVO_DEADBAND_NORMALIZED* and $S_{8,max}$ corresponds to *maximum_angle_deg_vtol* converted to radians. It is suggested to use the sample calculator in the following link to make sense of the deadband function used and its parameters `https://www.desmos.com/calculator/pkvpzs6qul`.

2.2 Motor 2 (Right)

Note on S_6, S_7 ranges: These are normalized to be from -1 to 1.

Expanded form (as in code):

$$M_2 := \frac{M_2}{\cos\left(\alpha_{vane} S_6\right)}$$

2.3 Motor 3 (Left)

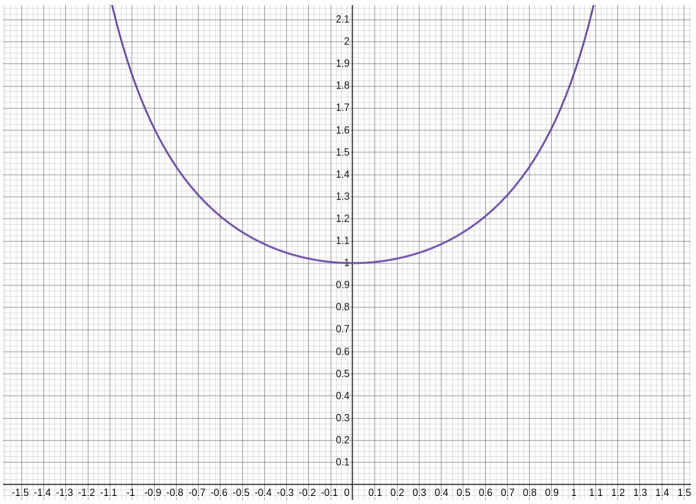
Expanded form (as in code):

$$M_3 := \frac{M_3}{\cos\left(\alpha_{vane} S_7\right)}$$

3 Reference plots for a few compensation functions

3.1 Secant (cosine reciprocal)

$$y = \frac{1}{\cos x}$$



3.2 Linear (Absolute)

$$y = 1 + |x|$$