Autonomous Vehicle Simulation (AVS) Laboratory, University of Colorado

Basilisk Technical Memorandum

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REACTION WHEEL ANGULAR MOMENTUM DUMPING MANAGEMENT MODULE

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Status: Initial Document draft
Scope/Contents
This module reads in the Reaction Wheel (RW) speeds, determines the net RW momentum, and then determines the amount of angular momentum that must be dumped. A separate thruster firing logic module called `thrMomentumDumping` will later on compute the thruster on cycling.

Rev:	**Change Description**	**By**
Draft	Initial document creation	H. Schaub
0.1	Updated the sign of ${}^{\mathcal{B}}\Delta\boldsymbol{H}$	H. Schaub

Contents

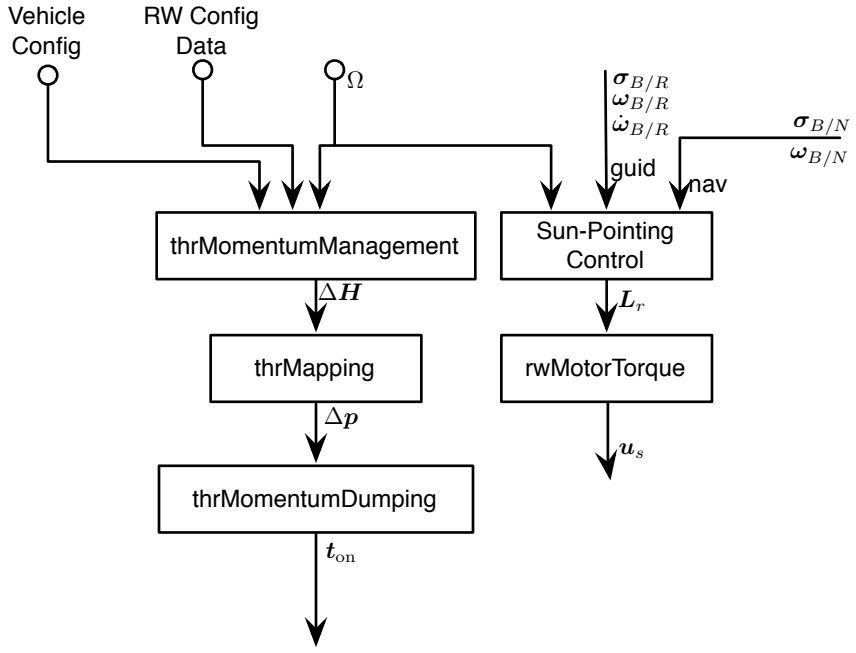

Fig. 1: Overview of the Modules Used to Perform Reaction Wheel Angular Momentum Dumping.

1 Introduction

To manage the Reaction Wheel (RW) angular momentum build-up over time, a thruster-based momentum dumping strategy is used. Figure 1 illustrates how the momentum dumping will occur simultaneously with an inertial pointing control solution. Assume the spacecraft contains N_{RW} RWs, and M_{thr} thrusters. The net RW angular momentum is given by

$$\boldsymbol{h}_s = \sum_{i=1}^{N_{\text{RW}}} \hat{\boldsymbol{g}}_{s_i} \Omega_i \tag{1}$$

where $\hat{\boldsymbol{g}}_{s_i}$ is the RW spin axis, and Ω_i is the RW speed rate about this axis. Because the inertial attitude of the spacecraft is assumed to be held nominally steady,

$$\dot{\boldsymbol{h}}_s = \frac{^{\mathcal{B}}\mathrm{d}\boldsymbol{h}_s}{\mathrm{d}t} + \boldsymbol{\omega}_{B/N} \times \boldsymbol{h}_s \approx \frac{^{\mathcal{B}}\mathrm{d}\boldsymbol{h}_s}{\mathrm{d}t} \tag{2}$$

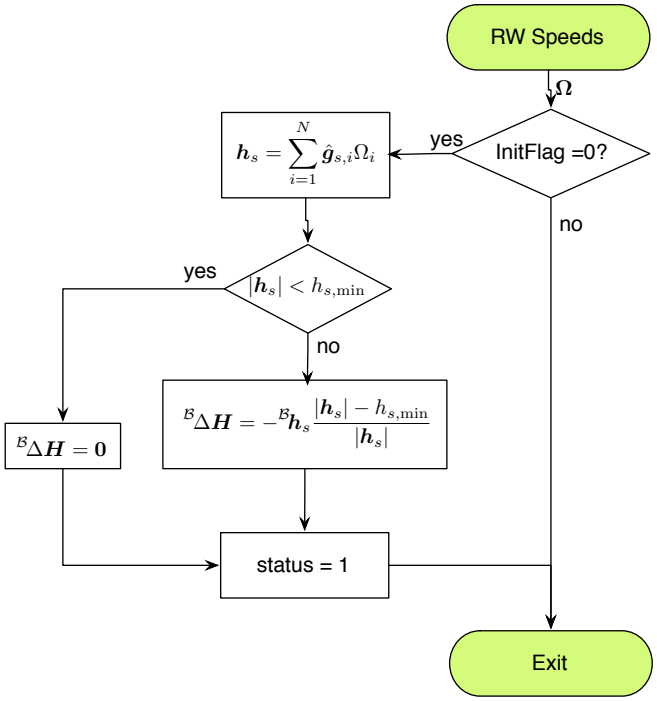

Fig. 2: Overview of the Reaction Wheel Angular Momentum Management Module.

2 `thrMomentumManagement` Module Description

Figure 2 illustrates the function of the RW angular momentum dumping management module. Let $h_{s,\text{min}}$ be lower bound that the RW momentum dumping strategy should achieve. The desired net change in inertial angular momentum is thus determined through

$$ {}^{\mathcal{B}}\Delta\boldsymbol{H} = -{}^{\mathcal{B}}\boldsymbol{h}_s \frac{|\boldsymbol{h}_s| - h_{s,\text{min}}}{|\boldsymbol{h}_s|} \tag{3} $$

This strategy requires a thruster firing solution which creates this desired ${}^{\mathcal{B}}\Delta\boldsymbol{H}$ over the duration of the momentum dumping. The goal of the RW momentum management module is to simply compute if a ${}^{\mathcal{B}}\Delta\boldsymbol{H}$ is required, or set it equal to zero if the RW momentum is too small. Not that this module will only compute ${}^{\mathcal{B}}\Delta\boldsymbol{H}$ once. Either it is zero or non-zero. To reuse this momentum management module, the reset() function must be called.

3 Module Parameters

3.1 `hs_min` Parameter

This parameter dictates the desired lower ceiling of the RW cluster angular momentum. It must be set prior to calling the routine.