Overview

- Anti-windup (AW) compensator in this study is designed to work with control systems experiencing actuator saturation. While working with an existing controller, the AW compensator prevents degradation in performance during saturation and enhances the system to perform optimally after saturation [1]. In addition, the fault tolerant capability of a proposed integrated fault tolerant architecture is studied with the AW compensator.
- The model of ESTCube-2 nanosatellite is used to simulate results and numerically analyze the performance of the proposed method. ESTCube-2 is a three-unit CubeSat aimed at an in-orbit demonstration of the plasma brake and the electric solar wind sail (E-Sail) [2].

AIM

- Design an integrated AW fault-tolerant controller.
- The proposed method must ensure global asymptotic stability of the nonlinear system.

Satellite Model

The equation below represents the satellite mathematical model with Reaction Wheels (RW) as actuator

\[ J\dot{\omega}_i = T_d + T_e - \omega_i^\pi (J\omega_i + H) \]

- \( H = [h_1, h_2, h_3]^T \) is the angular momentum of the wheel
- \( T_d \) is the sum of disturbance torques acting on the satellite.
- \( T_e \) is the applied control input torque.
- \( J\dot{\omega}_i \) is the rate of angular momentum \( h \) in inertial reference frame.
- \( \omega_i^\pi \) is the skew symmetric representation of the angular velocity in inertial reference frame.
- Proposed FTC is designed based on this model with angular momentum of the wheel.

Fault Tolerant Control Architecture

Anti-Windup Structure

The closed loop system in Fig 2 indicates the output \( y \) which is controlled using the reaction wheels of the satellite. Where

\[ y_{sat} \] is the reference, \( K(s) \) is the controller, \( \tau \) is the torque input, \( \phi \) is the deadzone input, \( sat(\tau) \) is the saturated torque input.
- the state space representation of the satellite system or plant, \( G(s) \in \mathbb{RH}_{\infty} \) is given in [1]

Simulation Results

References