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Website: www.aero.iitb.ac.in/satlab

Readme file for dynamics.py

Attitude Determination and Control Subsystem

x_dot_BI( )

Author: Sanket Chirame
Date:
Input: Satellite object, time, state vector $[q_{BI}, \vec{\omega}_{BIB}]$
Output : Derivative of state vector w.r.t. time

1. Obtain the total torque acting on satellite. There are two types of torques, control torque and disturbance torque. These are accesed from satellite object `sat` using methods `getControl_b()` and `getDisturbance_b()` respectively. The torque vector is expressed in body frame.

2. First four components of (1×7) state vector form quaternion q_{BI} and last three components form angular velocity of body frame w.r.t. ECI frame expressed in body frame.

3. $\dot{q}_{BI} = \frac{1}{2} \begin{bmatrix} 0 & -\omega_x & -\omega_y & -\omega_z \\ \omega_x & 0 & \omega_z & -\omega_y \\ \omega_y & -\omega_z & 0 & \omega_x \\ \omega_z & \omega_y & -\omega_x & 0 \end{bmatrix} q_{BI}$
   where $\omega = \vec{w}_{BIB}$. For reference, check chapter 3 from [1].

4. $\dot{\vec{\omega}}_{BIB} = I^{-1}(\vec{\tau}_b - \vec{w}_{BIB} \times (I\, \vec{w}_{BIB}))$ [1]

5. $\dot{x} = [\dot{q}_{BI}\ , \dot{\vec{\omega}}_{BIB}]$

x_dot_BO( )

Author: Riya
Date: 5/8/18
Input: Satellite object, time, state vector
Output : Derivative of error vector w.r.t. time

1. Obtain the total torque acting on satellite. There are two types of torques, control torque and disturbance torque. These are accesed from satellite object `sat` using methods `getControl_b()` and `getDisturbance_b()` respectively. The torque vector is expressed in body frame.

2. First four components of (1×7) state vector form quaternion q_{BI} and last three components form angular velocity of body frame w.r.t. ECI frame expressed in body frame.

3. $\dot{q}_{BO} = \frac{1}{2}\begin{bmatrix} -\vec{v}^T\omega_1 \\ s\omega_1 + \vec{v}\times\omega_1 \end{bmatrix}$
   where $\omega_1 = \omega - R\omega_d\omega$ is the angular velocity of body wrt inertial frame, ω_d is the angular velocity of orbit wrt inertial frame. R is the rotation matrix corresponding to q_{BO}.

4. $J\dot{\omega_1} = -\omega \times J\omega + \tau - J[R(\omega_1 \times \omega_d + \dot{\omega_d})]))$
   where J is moment of inertia and τ is total torque.

References

[1] John L Junkins and Hanspeter Schaub. *Analytical mechanics of space systems*. American Institute of Aeronautics and Astronautics, 2009.