Student Satellite Project
Indian Institute of Technology, Bombay
Powai, Mumbai - 400076, INDIA

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 accessed 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_{BO} and last three components form angular velocity of body frame w.r.t. orbit frame expressed in body frame.

3. $\dot{q}_{BO} = \frac{1}{2} \begin{bmatrix} -\vec{v}^T \omega_{BOB} \\ s\omega_{BOB} + \vec{v} \times \omega_{BOB} \end{bmatrix}$
where ω_{BOB} is the angular velocity of body wrt orbit frame, $\vec{v}$ is vector part of q_{BO}, s is scalar part of q_{BO}.

4. $J\dot{\omega}_{BOB} = -\omega \times J\omega + \tau - J[R(\omega_{BOB} \times \omega_d + \dot{\omega}_d)]))$
where J is moment of inertia and τ is total torque. ω is the angular velocity of body wrt ECI frame, ω_d is the angular velocity of orbit wrt inertial frame. R is the rotation matrix corresponding to q_{BO}.

References

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