MAE 6060

Homework #7

Start with your existing MATLAB/Simulink model of a spacecraft with a Kane damper. For reference, this damper is modeled as a spherical body with inertia 100 kg-m^2 and a damping coefficient c=0.001 Nm/(rad/s). Now incorporate four reaction wheels as follows:

Wheel spin axes in terms of body-fixed basis vectors $\boldsymbol{b}_i$:

$$\hat{\boldsymbol{h}}_1 = \boldsymbol{b}_1$$

$$\hat{\boldsymbol{h}}_2 = \boldsymbol{b}_2$$

$$\hat{\boldsymbol{h}}_3 = \boldsymbol{b}_3$$

$$\hat{\boldsymbol{h}}_4 = -\frac{\sqrt{3}}{3}(\boldsymbol{b}_1 + \boldsymbol{b}_2 + \boldsymbol{b}_3)$$

Maximum angular momentum magnitude: 150 Nms

Maximum torque magnitude: 2 Nm

Use the following initial conditions:

$$\boldsymbol{\omega}^{\mathrm{B/N}}(0) = \mathbf{0}$$

$$\boldsymbol{\omega}^{\mathrm{D/N}}(0) = \mathbf{0}$$

$$q(0) = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

$$\boldsymbol{h}_1(0)=0$$

$$\boldsymbol{h}_2(0)=0$$

$$\boldsymbol{h}_3(0)=0$$

$$\boldsymbol{h}_4(0)=0$$

Use Markley's PD attitude-tracking control law to model a spacecraft that performs the following slew:

$$\boldsymbol{\omega}^{\mathrm{B/N}}(t) = 0.01\left(1 - cos\,\frac{\pi t}{100}\right)(\boldsymbol{b}_1 + \boldsymbol{b}_2) \text{ for } 0<t\leq 200 \text{ seconds}$$

Model the behavior for t=0 to t=300 seconds. Show a plot of the time history of the spacecraft angular velocity in B axes, the quaternion, and the individual wheel angular-momentum scalars.