Spacecraft Dynamics

HW1

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Q.2

First, I wrote my own function that transforms DCM into a quaternion using the following equations.

$$q_4 = +\frac{1}{2}\sqrt{1 + Trace(A)}$$

$$q_1 = \frac{1}{4q_4}(a_{23} - a_{32})$$

$$q_2 = \frac{1}{4q_4}(a_{31} - a_{13})$$

$$q_3 = \frac{1}{4q_4}(a_{21} - a_{12})$$

Then I got 3 random DCM matrices using angle2dcm functions on MATLAB with 3 random euler angles. I converted DCM matrices to quaternions with both my function and the dcm2quat function. They were the same. Only the places of the real terms were different. Because unlike MATLAB, we put the real term on the last row while writing the quaternion.

For example:

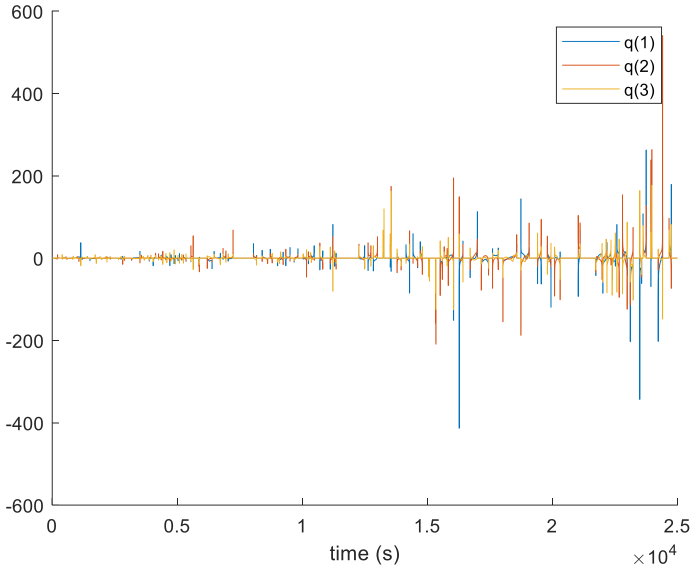
$$q_{(with\ my\ function)} = \begin{bmatrix} 0.1555 \\ -0.8493 \\ -0.0294 \\ 0.5036 \end{bmatrix}$$

$$q_{(with\ dcm2quat\ function)} = \begin{bmatrix} 0.5036 \\ 0.1555 \\ -0.8493 \\ -0.0294 \end{bmatrix}$$

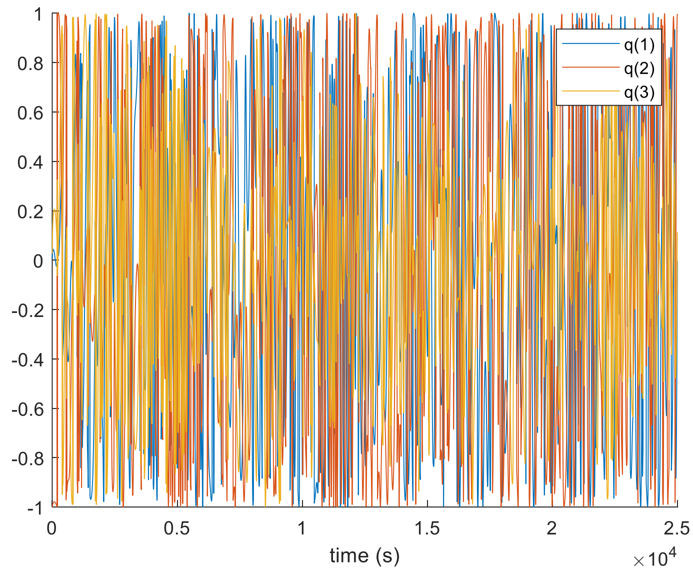
Q.3

I started with 3x3 identity matrix. Then in loop, using given data (body frame angular velocity with respect to inertial frame and resolved in the body frame), I propagated DCM matrices using kinematics equations, did integration by using Euler Method, and get DCM matrices for every second. Then, turned them to quaternions with my dcm2quat function. Finally, I plotted all the 3 quaternion terms in same figure.

However, since our quaternion vectors are not normalized, the quaternion terms in our plot have values far away from 1.



Additionaly, this is how it looks if I normalize the quaternion by dividing it by its length.



Q.4

In this question, I first used the angular velocity given to us in the quaternion rate formula and then integrated the next quaternion matrix with the Euler Method. Then I normalized the quaternions I obtained by dividing them by their lengths. Finally, I plotted the 25000 normalized quaternion values with time. Like the previous plots, these plots are very confusing and difficult to understand.