REPORT

Homework III

Attitude Determination and Control

UZB421E - 21265

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n = 48

Gibbs Vector Representation for Small Satellite Using Quaternions

I will explain the required information in the code.

```
n=48;               %Student Number
Worbit=0.0011;      %The angular orbit velocity of satellite
Nt=3.6*10^-10;      %The disturbance torque acting on the satellite
N=54000;            %The iteration number
dt=0.1;             %The sample time
t(1)=0;             %Initial Time

%The moments of inertia of the satellite
Jx=2.1*10^-3;
Jy=2*10^-3;
Jz=1.9*10^-3;

%Initial data of the attitude angles (rad)
q1(1)=0.002*n;
q2(1)=0.001*n;
q3(1)=0.005*n;
q4(1)=sqrt(1-q1(1)^2-q2(1)^2-q3(1)^2);

%The initial data of the satellite's angular velocities
Wx(1)=0.0002+0.0001*n;
Wy(1)=0.0003+0.0001*n;
Wz(1)=0.0004+0.0001*n;


C=cell(N,1);    %cell contains all transformation matrices C
A=cell(N,1);    %cell contains all transformation matrices A


for i=1:N  %for loop to perform iteration

    %Time Increase of 0.1 s per Iteration
    t(i+1)=t(i)+dt;

    %The Angular Velocities Iteration
    Wx(i+1)=Wx(i)+(dt/Jx)*(Wz(i)*Wy(i)+Nt)*(Jy-Jz);
    Wy(i+1)=Wy(i)+(dt/Jy)*(Wx(i)*Wz(i)+Nt)*(Jz-Jx);
    Wz(i+1)=Wz(i)+(dt/Jz)*(Wx(i)*Wy(i)+Nt)*(Jx-Jy);
```

```
%The Quaternions
q1(i+1)=q1(i)-0.5*dt*(q2(i)*Wx(i)+q3(i)*Wy(i)+q4(i)*Wz(i));
q2(i+1)=q2(i)+0.5*dt*(q1(i)*Wx(i)-q4(i)*Wy(i)+q3(i)*Wz(i));
q3(i+1)=q3(i)+0.5*dt*(q4(i)*Wx(i)+q1(i)*Wy(i)-q2(i)*Wz(i));
q4(i+1)=q4(i)-0.5*dt*(q3(i)*Wx(i)-q2(i)*Wy(i)-q1(i)*Wz(i));



%The Transformation Matrix
c11(i)=q1(i)^2-q2(i)^2-q3(i)^2+q4(i)^4;
c12(i)=2*(q1(i)*q2(i)+q3(i)*q4(i));
c13(i)=2*(q1(i)*q3(i)-q2(i)*q4(i));
c21(i)=2*(q1(i)*q2(i)-q3(i)*q4(i));
c22(i)=-q1(i)^2+q2(i)^2-q3(i)^3+q4(i)^2;
c23(i)=2*(q2(i)*q3(i)-q1(i)*q4(i));
c31(i)=2*(q1(i)*q3(i)+q2(i)*q4(i));
c32(i)=2*(q2(i)*q3(i)-q1(i)*q4(i));
c33(i)=-q1(i)^2-q2(i)^2+q3(i)^2+q4(i)^2;

C{i}=[c11(i),c12(i),c13(i);c21(i),c22(i),c23(i);c31(i),c32(i),c33(i)];

%The Euler Angles
%Roll Angle
phi(i)=atan((2*(q2(i)*q3(i)+q1(i)*q4(i)))/(1-2*(q1(i)^2+q2(i)^2)));
%Pitch Angle
tetha(i)=asin(2*(q4(i)*q2(i)-q1(i)*q3(i)));
%Yaw Angle
psi(i)=atan((2*(q4(i)*q3(i)+q1(i)*q2(i)))/(1-2*(q2(i)^2+q3(i)^2)));

%The Transformation Matrix Euler angle
a11(i)=cos(tetha(i))*cos(psi(i));
a12(i)=cos(tetha(i))*sin(psi(i));
a13(i)=-sin(tetha(i));
a21(i)=-cos(phi(i))*sin(psi(i))+sin(phi(i))*sin(tetha(i))*cos(psi(i));
a22(i)=cos(phi(i))*cos(psi(i))+sin(phi(i))*sin(tetha(i))*sin(psi(i));
a23(i)=sin(phi(i))*cos(tetha(i));
a31(i)=sin(phi(i))*sin(psi(i))+cos(phi(i))*sin(tetha(i))*cos(psi(i));
a32(i)=-sin(phi(i))*sin(psi(i))+cos(phi(i))*sin(tetha(i))*sin(psi(i));
a33(i)=cos(phi(i))*cos(tetha(i));

A{i}=[a11(i),a12(i),a13(i);a21(i),a22(i),a23(i);a31(i),a32(i),a33(i)];
```

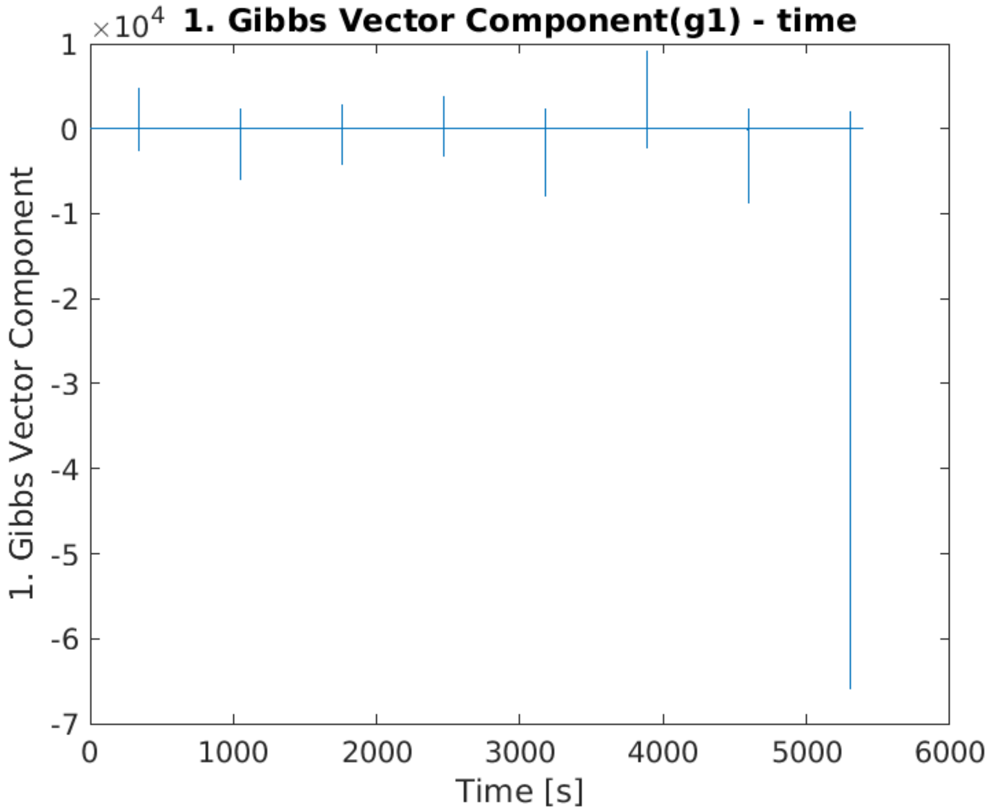
There is nothing different from the second homework so far, in the same way, I put the given data into code.

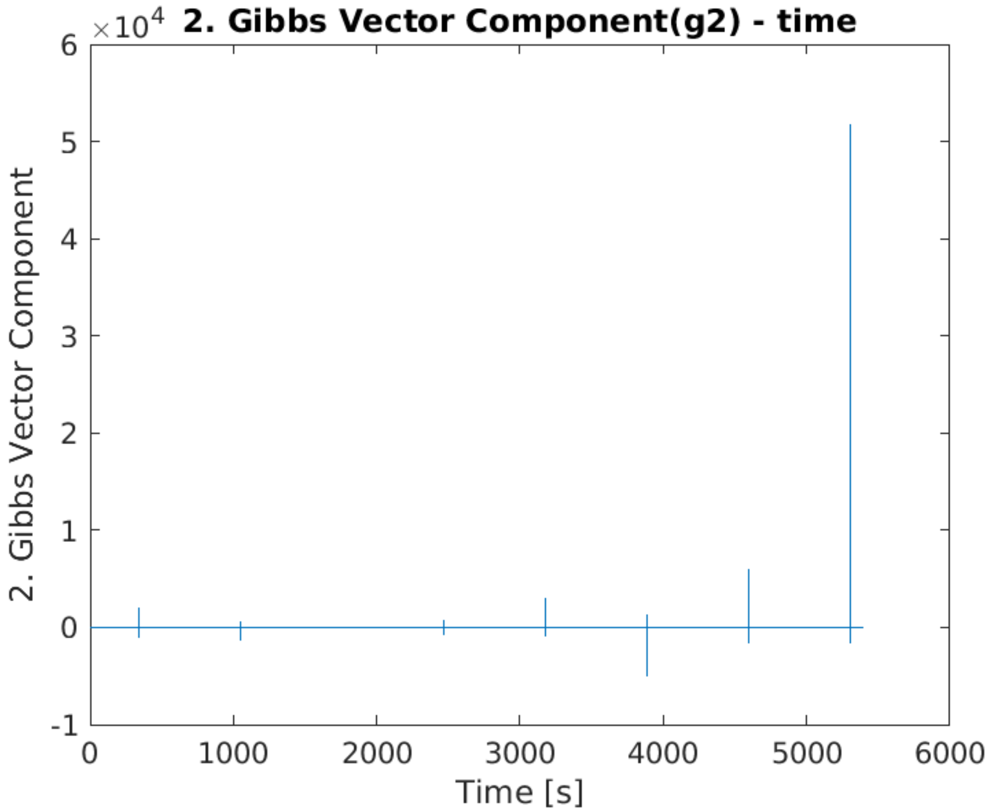
The Gibbs vector (components g ,g , 1 2 and 3 g) representation for finite rotations is defined by

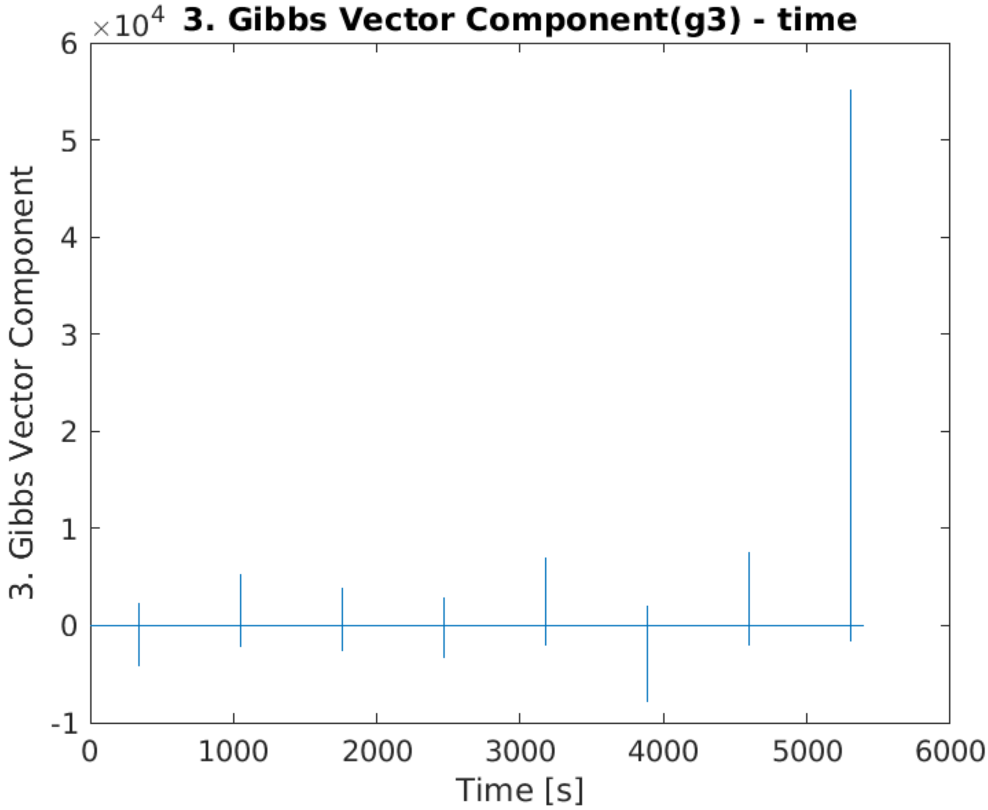
$$g_1 = q_1 / q_4 = m_1 \tan(\mu / 2)$$
$$g_2 = q_2 / q_4 = m_2 \tan(\mu / 2)$$
$$g_3 = q_3 / q_4 = m_3 \tan(\mu / 2)$$

```
    %Gibbs Vector Components
    g1(i)=q1(i)/q4(i);
    g2(i)=q2(i)/q4(i);
    g3(i)=q3(i)/q4(i);

end

%Gibbs Vector Components Graphics
figure
plot(t(1:54000),g1);
title('1. Gibbs Vector Component(g1) - time')
xlabel('Time [s]')
ylabel('1. Gibbs Vector Component')

figure
plot(t(1:54000),g2);
title('2. Gibbs Vector Component(g2) - time')
xlabel('Time [s]')
ylabel('2. Gibbs Vector Component')

figure
plot(t(1:54000),g3);
title('3. Gibbs Vector Component(g3) - time')
xlabel('Time [s]')
ylabel('3. Gibbs Vector Component')
```

Graphs of Gibbs Vector Components







3. Gibbs Vector Component(g3) - time
×10^4
6
5
4
3
2
1
0
-1
0
1000
2000
3000
4000
5000
6000
Time [s]
3. Gibbs Vector Component