TTK4130 MODELING AND SIMULATION | ASSIGNMENT 3

ODIN ALEKSANDER SEVERINSEN | MTTK

11 Sets up the following state space:

a)

$$x = \begin{bmatrix} p^e \\ q_s^e \\ v^e \\ \omega_{es}^s \end{bmatrix}$$

, where e is earth frame, s is satellite frame.

Uses the following dynamical model:

$$\dot{p}^e = v^e$$

$$\dot{q}_s^e = \frac{1}{2} q_s^e \otimes \begin{bmatrix} 0 \\ \omega_{es}^s \end{bmatrix}$$

$$\dot{v}^e = -\frac{\kappa}{\|p^e\|^2} \cdot \left(\frac{p^e}{\|p^e\|}\right)$$

$$\dot{\omega}_{es}^s = 0 \quad \text{(constant)}$$

See the attached code. Unfortunately, this is all I was able to do...

```
function [ state_dot ] = SatelliteDynamics( t, x, parameters )

    % Code your equations here...

    % The code must return in the order you selected, e.g.:
    %    state_dot =  [velocity;
    %                  orientation_dot;
    %                  acceleration (ac);
    %                  angular acceleration (omega dot)];
    %    state     =  [position; 1:3
    %                  orientation; 4:7
    %                  velocity; 8:10
    %                  angular velocity]; 11:13

    R = quat2rot(x(4:7));

    p_dot = R*x(8:10);
    q_dot = 0.5 * quatProd(x(4:7), x(11:13));
    v_dot = R'*(-(parameters.K / norm(x(1:3))^2) * (x(1:3) /
 norm(x(1:3))));
    w_dot = zeros(3, 1);

    state_dot = [p_dot;
                 q_dot;
                 v_dot;
                 w_dot];

end
```

```
Not enough input arguments.

Error in SatelliteDynamics (line 15)
    R = quat2rot(x(4:7));
```

Published with MATLAB® R2019a

```
clear all
%close all
clc

% "parameters" allows you to pass some parameters to the
 "SatelliteDynamics" function
% f = 1 / (3600 * 24); % 1 rotation per day
% r_earth = 6356e3; % m
% r_orbit = 36e6; % m
% M_earth = 5.972e24; % kg
% G = 6.67408e-11; % m^3 kg^-1 s^-2
% m_sat = 500; % kg. Source: https://en.wikipedia.org/wiki/
Small_satellite
% l = 0.5; % m
f = 1 / 5; % 1 rotation per day
r_earth = 1; % m
r_orbit = 1; % m
M_earth = 1; % kg
G = 1; % m^3 kg^-1 s^-2
m_sat = 1; % kg. Source: https://en.wikipedia.org/wiki/Small_satellite
l = 1; % m
parameters.M = 1/6 * m_sat * l^2 * eye(3);
parameters.K = G*M_earth;
parameters.w = [0, 2*pi*f, 0]'; % The satellite pitches during
 rotation

% Define your initial state, e.g. as:
% state = [position;
%          orientation;
%          velocity;
%          angular velocity];
p0 = [0, 0, r_orbit]';
k = [0, 0, 1]';
alpha = pi/2;
q0 = [cos(alpha/2); sin(alpha/2)*k];
v0 = zeros(3, 1); %[2*pi*f*r_orbit, 0, 0]';
w0 = parameters.w;

state = [p0; q0; v0; w0];

time_final = 120; %Final time

% Simulate satellite dynamics
[time,statetraj] = ode45(@(t,x)SatelliteDynamics(t, x, parameters),
[0,time_final],state);

% Here below is a template for a real-time animation
tic; % resets Matlab clock
time_display = 0; % time displayed
% while time_display < time(end)
%     time_animate = toc; % get the current clock time
%     % Interpolate the simulation at the current clock time
```

```
%     state_animate = interp1(time,statetraj,time_animate);
%
%     figure(1);clf;hold on
%     % Use the example from "Satellite3DExample.m" to display your
 satellite
%     p = state_animate(1:3)';   % Position of the satellite
%     omega = state_animate(11:13)';  % Omega
%     q = state_animate(4:7)';
%     n = q(1);
%     e = q(2:end)';
%
%     R = eye(3) + 2*n*skew(e) + 2*skew(e)^2;
%
%     ScaleFrame = 5;   % Scaling factor for adjusting the frame size
 (cosmetic)
%     FS         = 15;  % Fontsize for text
%     SW         = 0.035; % Arrows size
%
%     MakeFrame(zeros(3,1),eye(3),ScaleFrame,FS,SW,'a', 'color', 'k')
%     MakeFrame(p,R,ScaleFrame,FS,SW,'b', 'color', 'r')
%     MakeArrow(p,R*omega,FS,SW,'$$\omega$$', 'color', [0,0.5,0])
%     DrawRectangle(p,R ,'color',[0.5,0.5,0.5]);
%     FormatPicture([0;0;2],0.5*[73.8380   21.0967   30.1493])
%
%
%     if time_display == 0
%         display('Hit a key to start animation')
%         pause
%         tic
%     end
%     time_display = toc; % get the current clock time
% end
```

Published with MATLAB® R2019a