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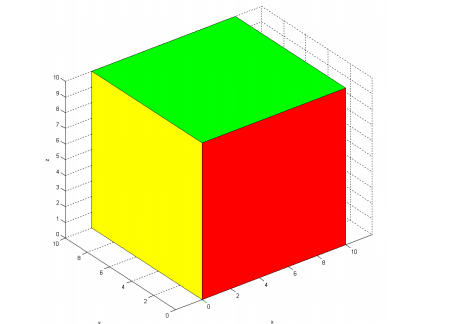
**Lab: Industrial Networks and Power Electronics Laboratory (INPEL)**

Class: MECHANICS AND CONTROL OF ROBOT MANIPULATORS

Instructor: Prof. Kang, Hee-Jun

Home Work 5

1. When the angular velocity from the Gyro sensors attached in the Rectangular object below are. Show the posture of the object at each second to 5sec.



Initial posture is described with x-y-z Euler angle (α= 10 deg, β = 10 deg, γ= 10 deg) at 0 sec

Solutions

1. We have:



We rotate this cube according to Euler X-Y-Z:



Cube is rotated follow time, position of cube at time t + 1:



Simulated by Matlab in 5 sec, we have position of cube. The result is as below:

|  |  |  |
| --- | --- | --- |
|  |  |  |
| t= 0 | t=1 | t=2 |
|  |  |  |
| t=3 | t=4 | t=5 |

Matlab code:

|  |
| --- |
| clear all  clc  %% Transformation%%%%%%%%    t = 0:1:5; %5 second  delta = 1;  a = zeros(1,11); %Alpha  b = zeros(1,11); %Beta`  g = zeros(1,11); %Gamma    a\_dot = zeros(1,11); %Velocity of Alpha  b\_dot = zeros(1,11); %Velocity of Beta  g\_dot = zeros(1,11); %Velocity of Gamma    w\_x = sin(t)/20; %Gyroscope at x coordinate  w\_y = sin(2\*t)/20; %Gyroscope at y coordinate  w\_z = cos(t)/10; %Gyroscope at z coordinate    %Compute Alpha, Beta, Gamma from data of Gyroscopes  a(1) = pi/18;  b(1) = pi/18;  g(1) = pi/18;    for i = 1:5  %Compute Jacobian matrix  E = [0, -sin(a(i)), cos(a(i))\*sin(b(i));  0, cos(a(i)), sin(a(i))\*sin(b(i));  1, 0, cos(b(i))];    W = [w\_x(i); w\_y(i); w\_z(i)];    %Compute a\_dot, b\_dot, g-dot  V = inv(E)\*W;    a\_dot(i) = V(1);  b\_dot(i) = V(2);  g\_dot(i) = V(3);    %Intergration for alpha, beta, gamma next cycle  a(i+1) = a(i) + delta\*a\_dot(i);  b(i+1) = b(i) + delta\*b\_dot(i);  g(i+1) = g(i) + delta\*g\_dot(i);  end    %Define the cubic, 4 face around  X = [0 0 0 0 0 10; 10 0 10 10 10 10; 10 0 10 10 10 10; 0 0 0 0 0 10];  Y = [0 0 0 0 10 0; 0 10 0 0 10 10; 0 10 10 10 10 10; 0 0 10 10 10 0];  Z = [0 0 10 0 0 0; 0 0 10 0 0 0; 10 10 10 0 10 10; 10 10 10 0 10 10];    xc=0; yc=0; zc=0; % coordinated of the center  L=1; % cube size (length of an edge)  alpha=0.8; % transparency (max=1=opaque)    %Draw the cubic at the initial  C= [0.1 0.5 0.8 0.8 0.1 0.9]; % color/face  s = 0;    X = L\*(X-0.5) + xc;  Y = L\*(Y-0.5) + yc;  Z = L\*(Z-0.5) + zc;    figure();  fill3(X,Y,Z,C,'FaceAlpha',alpha); % draw cube  axis equal;  AZ=-20; % azimuth  EL=25; % elevation  view(AZ,EL); % orientation of the axes    %Draw the cubic by time  for j=1:5  a11 = cos(a(j))\*cos(b(j))\*cos(g(j)) - sin(a(j))\*sin(g(j));  a21 = sin(a(j))\*cos(b(j))\*cos(g(j)) + cos(a(j))\*sin(g(j));  a31 = -sin(b(j))\*cos(g(j));    a12 = -cos(a(j))\*cos(b(j))\*sin(g(j)) - sin(a(j))\*cos(g(j));  a22 = -sin(a(j))\*cos(b(j))\*sin(g(j)) + cos(a(j))\*cos(g(j));  a32 = sin(b(j))\*sin(g(j));    a13 = cos(a(j))\*sin(b(j));  a23 = sin(a(j))\*sin(b(j));  a33 = cos(b(j));    K = [a11, a12, a13; a21, a22, a23; a31, a32, a33];    %Row 1  temp3 = [X(1,:); Y(1,:); Z(1,:)];  temp4 = K\*temp3;    X(1,:) = temp4(1,:);  Y(1,:) = temp4(2,:);  Z(1,:) = temp4(3,:);    %Row 2  temp5 = [X(2,:); Y(2,:); Z(2,:)];  temp6 = K\*temp5;    X(2,:) = temp6(1,:);  Y(2,:) = temp6(2,:);  Z(2,:) = temp6(3,:);    %Row 3  temp7 = [X(3,:); Y(3,:); Z(3,:)];  temp8 = K\*temp7;    X(3,:) = temp8(1,:);  Y(3,:) = temp8(2,:);  Z(3,:) = temp8(3,:);  %Row 4  temp9 = [X(4,:); Y(4,:); Z(4,:)];  temp10 = K\*temp9;    X(4,:) = temp10(1,:);  Y(4,:) = temp10(2,:);  Z(4,:) = temp10(3,:);    s = 0;    X = L\*(X-s) + xc;  Y = L\*(Y-s) + yc;  Z = L\*(Z-s) + zc;    figure();    fill3(X,Y,Z,C,'FaceAlpha',alpha); % draw cube  axis equal;  AZ=-20; % azimuth  EL=25; % elevation  view(AZ,EL); % orientation of the axes  end |