Practice 1

<u>Desire a contrller (PD) for the MAV to rotate in different angles ignoring the location of the body.</u>

<u>Matlab result:</u>

In order to get the inertia and thrust contrains to the MAV, we could find the parameters of Crazyflie 2.1, According to the https://www.bitcraze.io/products/crazyflie-2-1/ .

- Takeoff weight: 27g
- Size (WxHxD): 92x92x29mm (motor-to-motor and including motor mount feet)
- Max recommended payload weight: 15 g

Now, we could know that $M \approx 0.027\,kg$, $Trust_{\max} \approx Mg + 2\times Payload = 0.56N$, to simplify I also set Max $Torque_x = 0.56N$, $I_{xx} = I_{yy} = M(\frac{W}{2})^2 \approx 5.5\times 10^{-7}\,kg\cdot m^2$

$$I_{zz} = M\left((\frac{W}{2})^2 + (\frac{H}{2})^2\right) \approx 1.1\times 10^{-6}\,kg\cdot m^2$$

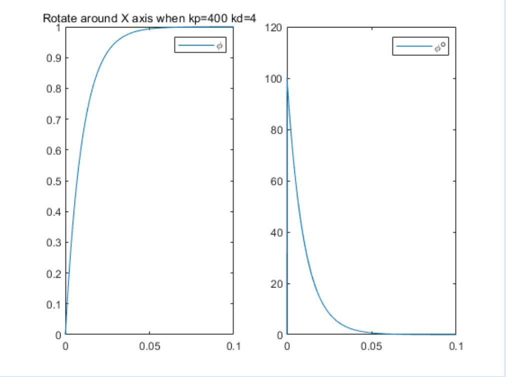
Dynamics:

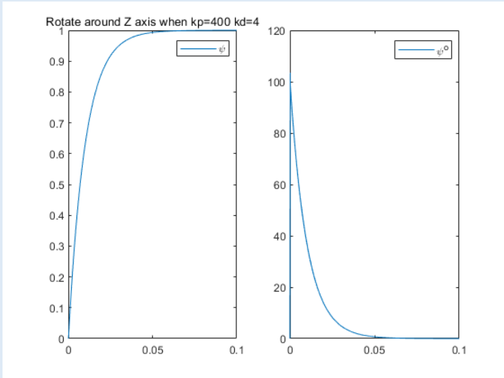
$$\dot{\omega} = I^{-1}\left(\tau - \omega \times I\omega\right)$$

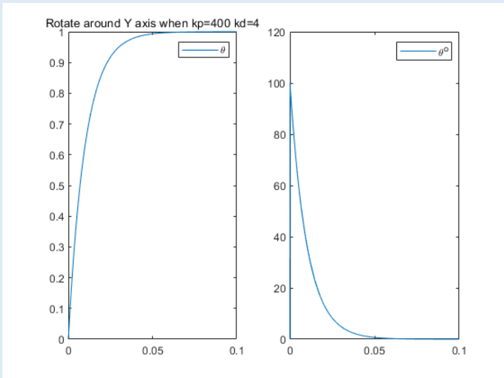
Controller:

$$\tau = -K_p e - K_d \dot{e}$$

$$\text{where, } e = \begin{bmatrix} \varphi - \varphi^d \\ \theta - \theta^d \\ \psi - \psi^d \end{bmatrix}$$





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function    PDforRotation()
clc;
clear all; close all;
x0 = [0;0;0;0;0;0];  % x0 is the intial state of the system

tspan=[0; 0.1]; % simulation time
[t,x] = ode45(@sys_dynamics,tspan,x0);

  % plot the simulation data
figure;
% subplot(1,2,1);plot(t,x(:,1));  legend('\phi');title('Rotate around  X axis when kp=400 kd=4');
% subplot(1,2,2);plot(t,x(:,4));  legend('\phi^{o}');
% subplot(1,2,1);plot(t,x(:,2));  legend('\theta');title('Rotate around  Y axis when  kp=400 kd=4');
% subplot(1,2,2);plot(t,x(:,5));  legend('\theta^{o}');
subplot(1,2,1);plot(t,x(:,3));  legend('\psi');title('Rotate around  Z axis when kp=400 kd=4');
  subplot(1,2,2);plot(t,x(:,6));  legend('\psi^{o}');
% figure;  plot(t,x(:,1),t,x(:,2),t,mod(x(:,3),pi*2)); legend('\phi','\theta','\psi'); title('angle');
% figure(2);  plot(t,x(:,4),t,x(:,5),t,x(:,6)); legend('\phi^{.}','d\theta^{.}','d\psi^{.}');  title('angular velocity');
end

function dx=sys_dynamics(t,x)
I=[5.5*10^(-7) 0 0;0 5.5*10^(-7) 0;0 0 11*10^(-7)];
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```
dx=zeros(6,1);
dx(1)=x(4);
dx(2)=x(5);
dx(3)=x(6);

dx(4:6)=I\(controller(x)-cross(x(4:6),I*x(4:6)));
end


function u=controller(inputX)
desirex=[0;0;1;0;0;0];
deltax=inputX-desirex;
u=zeros(3,1);

% kpx=400;
% kdx=4;
% u(1)=-kpx*deltax(1)-kdx*deltax(4);
% if abs(u(1))>0.56
%       u(1)=u(1)*0.56/abs(u(1));
% end

% kpy=400;
% kdy=4;
% u(2)=-kpy*deltax(2)-kdy*deltax(5);
% if abs(u(2))>0.56
%       u(2)=u(2)*0.56/abs(u(2));
% end

kpz=400;
kdz=4;
u(3)=-kpz*deltax(3)-kdz*deltax(6);
if abs(u(3))>0.56
    u(3)=u(3)*0.56/abs(u(3));
end
end
```