現代控制理論 HW6

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1.

$x_1\_dot=x_2$

$x_2\_dot=x_3$

$x_3\_dot=\alpha\ (x_1^2\sin(x_2)+x_2^2\sin(x_3))+(x_1+x_3^2)\cos(x_3)+u+d(t)$

令$f=x_3+2\lambda\ x_2+\lambda^2 x_1$

則f_dot

$=x_3\_dot+2\lambda\ x_2\_dot+\lambda^2 x_1\_dot$

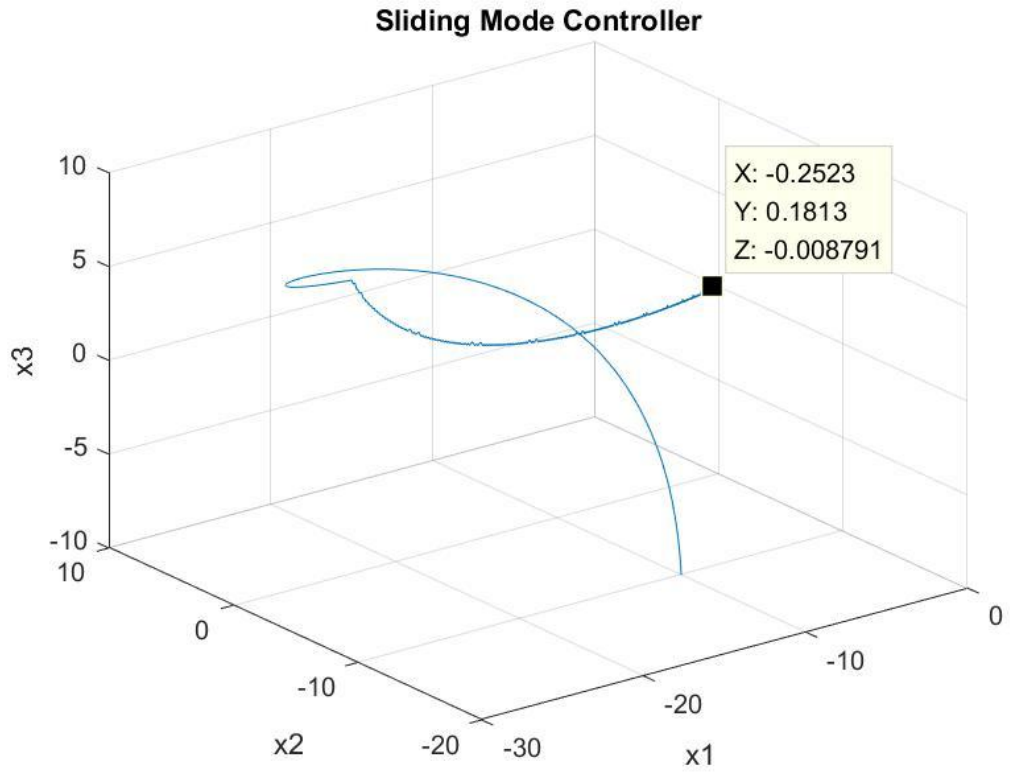
$=x_3\_dot+2\lambda\ x_3+\lambda^2 x_2$

$=\alpha\ (x_1^2\sin(x_2)+x_2^2\sin(x_3))+(x_1+x_3^2)\cos(x_3)+u+d(t)+2\lambda\ x_3+\lambda^2 x_2$

=-sign(f)*K

設計$u=-sign(f)*K-(\alpha\ (x_1^2\sin(x_2)+x_2^2\sin(x_3))+(x_1+x_3^2)\cos(x_3)+2\lambda\ x_3+\lambda^2 x_2)$

模擬結果(初值(-10,-10,-10),K=10,λ =1)：



程式碼：

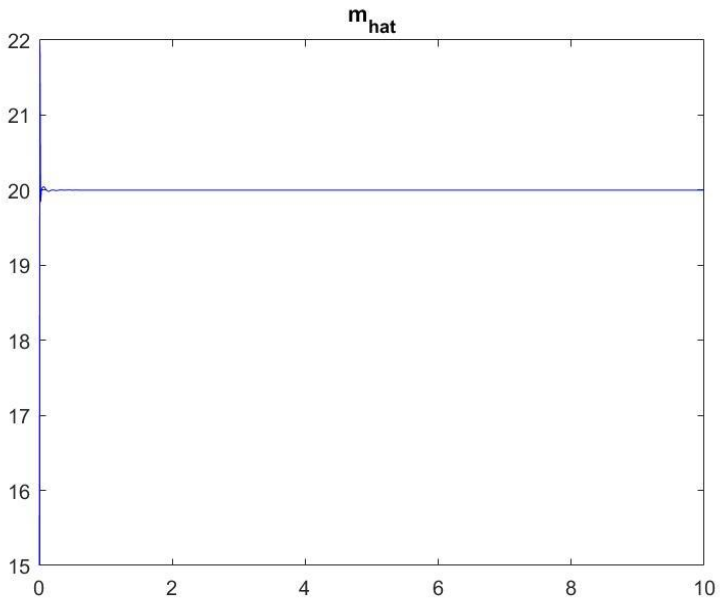
```
clc;clear;

delta=0.01;
totalTime=10;
totalStep=totalTime/delta;

x1array=[1:totalStep]*0;x2array=x1array;x3array=x1array;
x1array(1)=-10;x2array(1)=-10;x3array(1)=-10;%init condition
alpha=0.9;
K=10;lambda=1;
for i=1:totalStep
    x1=x1array(i);x2=x2array(i);x3=x3array(i);

    f=x3+2*lambda*x2+lambda^2*x1;


u=-sign(f)*K-(alpha*(x1^2*sin(x2)+x2^2*sin(x3))+(x1+x3^2)*cos(x3)+2*l
ambda*x3+lambda^2*x2);

    d(i)=0.2*sin(i)+0.1*cos(5*i+pi);
    x1_dot=x2;
    x2_dot=x3;

x3_dot=alpha*(x1^2*sin(x2)+x2^2*sin(x3))+(x1+x3^2)*cos(x3)+u+d(i);

    x1array(i+1)=x1+x1_dot*delta;
    x2array(i+1)=x2+x2_dot*delta;
    x3array(i+1)=x3+x3_dot*delta;
end

plot3(x1array,x2array,x3array);
grid on;

xlabel('x1');
ylabel('x2');
zlabel('x3');
title('Sliding Mode Controller');
```

2.

測試1：

disturbance(i)=10*(-1+rand);

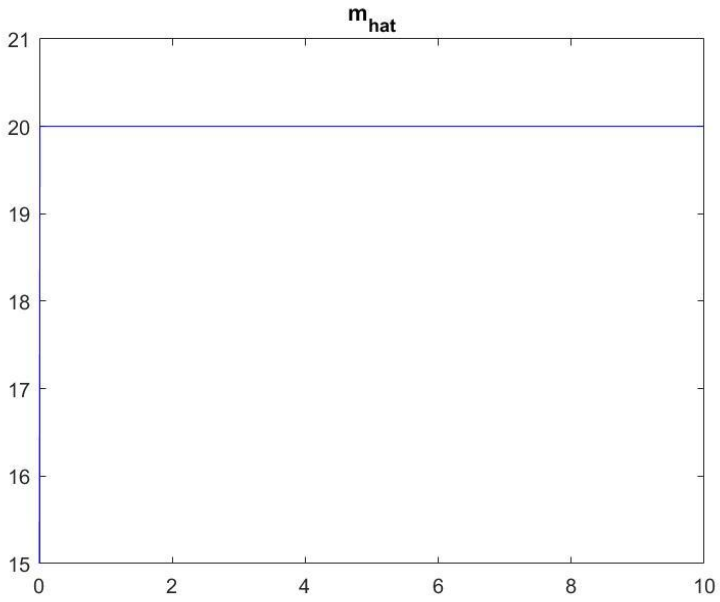
noise(i)=0.001*sin(25*i)+0.005*cos(100*i+pi);



測試2：

disturbance(i)=10*(-1+rand);

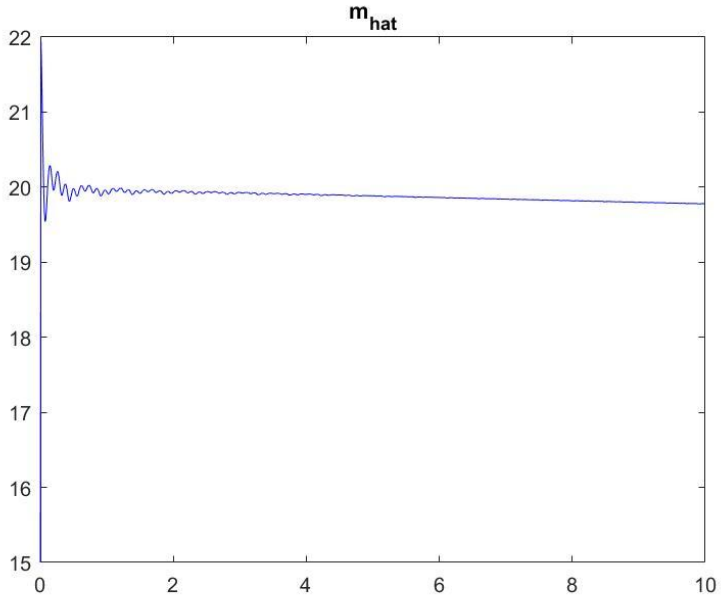
noise(i)=0



測試3：

disturbance(i)=0

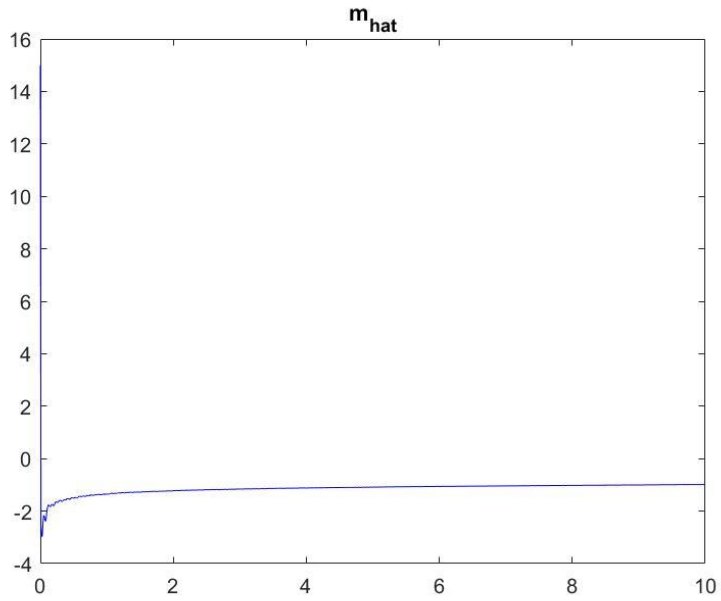
noise(i)=0.001*sin(25*i)+0.005*cos(100*i+pi);



測試4(noise很大則m_{hat}無法收斂到m=20)：

disturbance(i)=10*(-1+rand);

noise(i)=0.001*sin(25*i)+0.005*cos(100*i+pi);



經多次測試結論：

1.m_{hat}收斂情形受到disturbanse影響很小，但是對noise非常敏感。

2.兩條線重疊，用m和m_dot做出來的結果一模一樣@@???????????

程式碼：

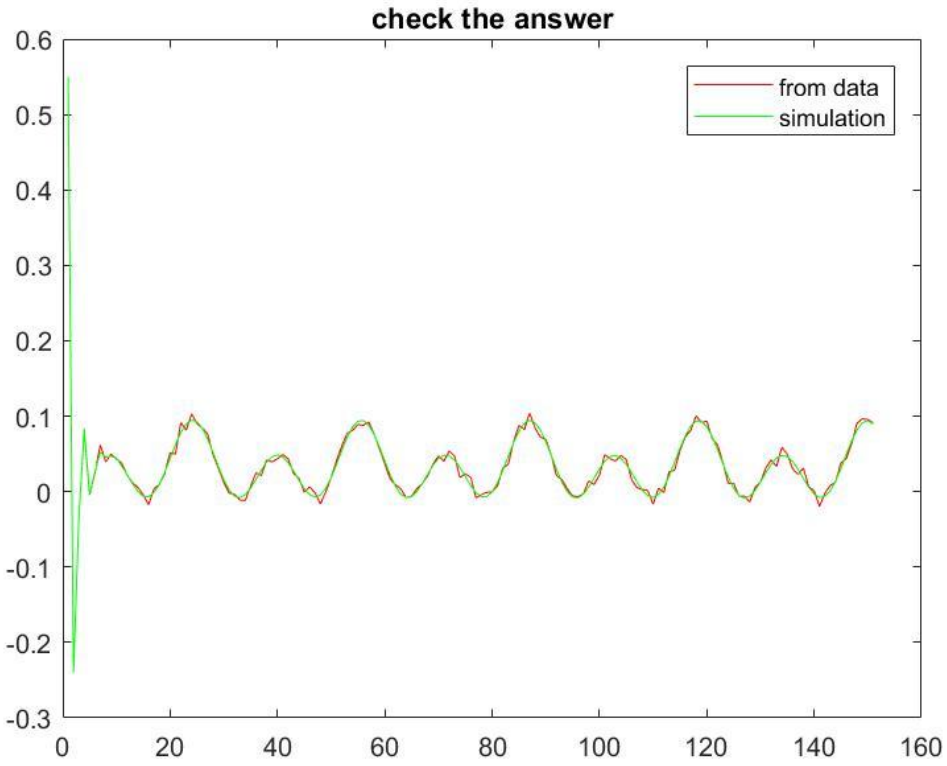
```
clear;clc;
totaltime=10;
delta=0.01;
totalstep=totaltime/delta;

m=20;
m_hat1(1)=15;
u(1)=1;
%make n,d
for i=1:totalstep
    disturbance(i)=10*(-1+rand);
    noise(i)=0.001*sin(25*i)+0.005*cos(100*i+pi);
end

% use m
for i=1:totalstep
    yarray(i)=(u(i)/m)+noise(i);

    num=delta*sum(yarray.*u);
    den=delta*sum(yarray.*yarray);
    m_hat1(i+1)=(num/den);
    u(i+1)=m_hat1(i+1)*(yarray(i))+disturbance(i);
end;

%clear var.
yarray=[0:1:totalstep-1]*0;
u=yarray;
m_hat2(1)=15;
u(1)=1;

%use m_dot
for i=1:totalstep
    yarray(i)=(u(i)/m)+noise(i);

    num=(u(i)-m_hat2(i)*yarray(i))*yarray(i);
    den=delta*sum(yarray.*yarray);
    m_hat_dot(i)=(num/den);
```

```
    m_hat2(i+1)=m_hat2(i)+m_hat_dot(i)*delta;
    u(i+1)=m_hat2(i+1)*(yarray(i))+disturbance(i);
end;

plot([0:1:totalstep]*delta,m_hat1,'r');
hold on;
plot([0:1:totalstep]*delta,m_hat2,'b');
title('m_h_a_t');
```

3.

算出答案：a1=0.453557 a2=0.250984 b1=-0.356244 b2=0.168191。

使用算出的答案和同樣u做模擬，並和所給的y做比較：



Matlab程式碼：

```
clear;clc;
%read data%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Data=textread('hw6Data.txt','%f');
y=zeros(1,length(Data)/2);u=zeros(1,length(Data)/2);k=1;
for i=1:length(Data)
    if mod(i,2)==0
        y(k)=Data(i);
        k=k+1;
    else
        u(k)=Data(i);
    end
end
%find matrix phi%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
for k=3:length(y)+1
    phi(k-1,1)=y(k-1);
```

```
    phi(k-1,2)=y(k-2);
    phi(k-1,3)=u(k-1);
    phi(k-1,4)=u(k-2);
end
%find matrix theta%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
tmpA=[0 0 0 0;0 0 0 0;0 0 0 0;0 0 0 0];
tmpB=[0 0 0 0];
for k=3:151
    for i=1:4
        for j=1:4
            tmpA(i,j)=tmpA(i,j)+phi(k-1,j)*phi(k-1,i);
        end
        tmpB(i)=tmpB(i)+y(k)*phi(k-1,i);
    end
end
theta=inv(tmpA)*tmpB';
a1=-theta(1);
a2=-theta(2);
b1=theta(3);
b2=theta(4);
fprintf('a1=%f a2=%f b1=%f b2=%f \n',a1,a2,b1,b2);
%check the answer%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
yy(1)=y(1);yy(2)=y(2);
for k=3:151
    yy(k)=-a1*yy(k-1)-a2*yy(k-2)+b1*u(k-1)+b2*u(k-2);
end
plot(y,'r');
hold on;
plot(yy,'g');
legend('from data','simulation');
title('check the answer');
```