clc;

clear all;

load("AE584\_Final\_P1\_meas\_Ts\_0\_01.mat");

load("AE584\_Final\_P1\_pos\_Ts\_0\_01.mat");

k\_all = 0:1:10000;

len = length(k\_all);

T = 0.01;

x0 = [2.5, 0, 1, 0, 0.5, -0.1]';

miu = 0.4;

D1 = [zeros(3,3); 0.01\*eye(3)];

D2 = diag([0.01, 0.01 0.01]);

R =1\*eye(3);

Q = 100\*eye(6);

A\_k\_all = zeros(6,6,len);

P\_all = zeros(6,6,len);

P\_all(:,:,1) = 10\*eye(6);

x\_k\_all = zeros(6,len);

x\_k\_all(:,1) = x0;

C\_k\_all = zeros(6,len);

Tmocap = 1;

for k = 1:1:(len-1)

w1\_k = D1\*normrnd(0,1,[3,1]);

x\_k\_k = x\_k\_all(:,k);

Ak = X\_to\_Ak(x\_k\_k,miu,T);

x\_k1\_k = Ak\*x\_k\_k+w1\_k;

if(mod((k)\*T,Tmocap)==0)

Ck1=X\_to\_C(x\_k1\_k);

y\_k1 =[Range(k+1);Azimuth(k+1);Elevation(k+1)]+D2\*normrnd(0,1,[3,1]);

else

Ck1 = zeros(3,6);

y\_k1 = zeros(3,1);

end

Pkk = P\_all(:,:,k);

P\_k1\_k = Ak\*Pkk\*Ak'+Q;

Kk = P\_k1\_k\*Ck1'\*inv(Ck1\*P\_k1\_k\*Ck1'+R);

P\_k1\_k1 = P\_k1\_k-Kk\*Ck1\*P\_k1\_k;

x\_k1\_k1 = x\_k1\_k+Kk\*(y\_k1-X\_to\_g(x\_k1\_k));

x\_k\_all(:,k+1)=x\_k1\_k1;

end

x\_t\_1 = x\_k\_all;

save("data.mat","x\_t\_1");

clear all;

load("AE584\_Final\_P1\_meas\_Ts\_0\_01.mat");

load("AE584\_Final\_P1\_pos\_Ts\_0\_01.mat");

load("data.mat");

k\_all\_2 = 0:1:10000;

len2 = length(k\_all\_2);

T2 = 0.01;

x0\_2 = [2.5, 0, 1, 0, 0.5, -0.1]';

miu = 0.4;

D1\_2 = [zeros(3,3); 0.01\*eye(3)];

D2\_2 = diag([0.01, 0.01 0.01]);

R2 =1\*eye(3);

Q2 = 100\*eye(6);

A\_k\_all\_2 = zeros(6,6,len2);

P\_all\_2 = zeros(6,6,len2);

P\_all\_2(:,:,1) = 10\*eye(6);

x\_k\_all\_2 = zeros(6,len2);

x\_k\_all\_2(:,1) = x0\_2;

C\_k\_all\_2 = zeros(6,len2);

Tmocap2 = 0.1;

for k1 = 1:1:(len2-1)

w1\_k\_2 = D1\_2\*normrnd(0,1,[3,1]);

x\_k\_k\_2 = x\_k\_all\_2(:,k1);

Ak\_2 = X\_to\_Ak(x\_k\_k\_2,miu,T2);

x\_k1\_k\_2 = Ak\_2\*x\_k\_k\_2+w1\_k\_2;

if(mod((k1)\*T2,Tmocap2)==0)

Ck1\_2=X\_to\_C(x\_k1\_k\_2);

y\_k1\_2 =[Range(k1+1);Azimuth(k1+1);Elevation(k1+1)]+D2\_2\*normrnd(0,1,[3,1]);

else

Ck1\_2 = zeros(3,6);

y\_k1\_2 = zeros(3,1);

end

Pkk\_2= P\_all\_2(:,:,k1);

P\_k1\_k\_2 = Ak\_2\*Pkk\_2\*Ak\_2'+Q2;

Kk\_2 = P\_k1\_k\_2\*Ck1\_2'\*inv(Ck1\_2\*P\_k1\_k\_2\*Ck1\_2'+R2);

P\_k1\_k1\_2 = P\_k1\_k\_2-Kk\_2\*Ck1\_2\*P\_k1\_k\_2;

x\_k1\_k1\_2 = x\_k1\_k\_2+Kk\_2\*(y\_k1\_2-X\_to\_g(x\_k1\_k\_2));

x\_k\_all\_2(:,k1+1)=x\_k1\_k1\_2;

end

x\_t\_2 = x\_k\_all\_2;

figure(1)

hold on

plot3(Xref,Yref,Zref,'b','LineWidth',2);

plot3(x\_t\_1(1,:),x\_t\_1(2,:),x\_t\_1(3,:),'g');

plot3(x\_t\_2(1,:),x\_t\_2(2,:),x\_t\_2(3,:),'r');

hold off

axis equal;

xlabel("x");

ylabel("y");

zlabel("z");

legend("reference trajectory","T\_{mocap}=1 estimated trajectory","T\_{mocap}=0.1 estimated trajectory");

figure(2)

rcwA\_Ts\_0\_01 = [Xref;Yref;Zref];

for i=1:1:3

subplot(3,1,i)

hold on

plot(0:0.01:100,rcwA\_Ts\_0\_01(i,:));

plot(0:0.01:100,x\_t\_1(i,:),'g');

plot(0:0.01:100,x\_t\_2(i,:),'r');

hold off

legend("reference","T\_{mocap}=1","T\_{mocap}=0.1");

if(i==1)

st = "trajectory versus time x-axis";

elseif(i==2)

st = "trajectory versus time y-axis";

else

st = "trajectory versus time z-axis";

end

title(st);

xlabel("time(s)");

end

function matrix = vec\_to\_mat(w)

wx = w(1);

wy = w(2);

wz = w(3);

matrix = [0,-wz,wy;wz,0,-wx;-wy,wx,0];

end

function matrix = X\_to\_Ak(X,miu,Ts)

xk = X(1);

yk = X(2);

zk = X(3);

r = sqrt(xk^2+yk^2+zk^2);

Fxyz = zeros(3,3);

Fxyz(1,1) = 3\*miu\*xk^2/r^5-miu/r^3;

Fxyz(1,2) = 3\*miu\*xk\*yk/r^5;

Fxyz(1,3) = 3\*miu\*xk\*zk/r^5;

Fxyz(2,1) = 3\*miu\*xk\*yk/r^5;

Fxyz(2,2) = 3\*miu\*yk^2/r^5-miu/r^3;

Fxyz(2,3) = 3\*miu\*zk\*yk/r^5;

Fxyz(3,1) = 3\*miu\*xk\*zk/r^5;

Fxyz(3,2) = 3\*miu\*zk\*yk/r^5;

Fxyz(3,3) = 3\*miu\*zk^2/r^5-miu/r^3;

F = [zeros(3,3), eye(3);

Fxyz, zeros(3,3)];

matrix = expm(F\*Ts);

end

function gx = X\_to\_g(Xk)

x = Xk(1);

y = Xk(2);

z = Xk(3);

g = [ sqrt(x^2+y^2+z^2);

-atan2(x,y);

atan2(z,sqrt(x^2+y^2))];

gx = g;

gx(2) = AzUnwrap(g(2),0);

end

function C = X\_to\_C(Xk)

x = Xk(1);

y = Xk(2);

z = Xk(3);

pos = [x, y, z];

r = sqrt(x^2+y^2+z^2);

r\_min = sqrt(x^2+y^2);

C = zeros(3,6);

C(1,1:3) = pos/r;

C(2,1) = -y/(r\_min^2);

C(2,2) = x/(r\_min^2);

C(3,1) = -x\*z/(r^2\*r\_min);

C(3,2) = -y\*z/(r^2\*r\_min);

C(3,3) = r\_min/r^2;

end