

## Lab 8: Development of tracking filter of moving object when measurements and motion model are in different coordinate systems

Team1: Dmitry Shadrin, Eugeni Israelit, Sergey Golovanov @Skoltech

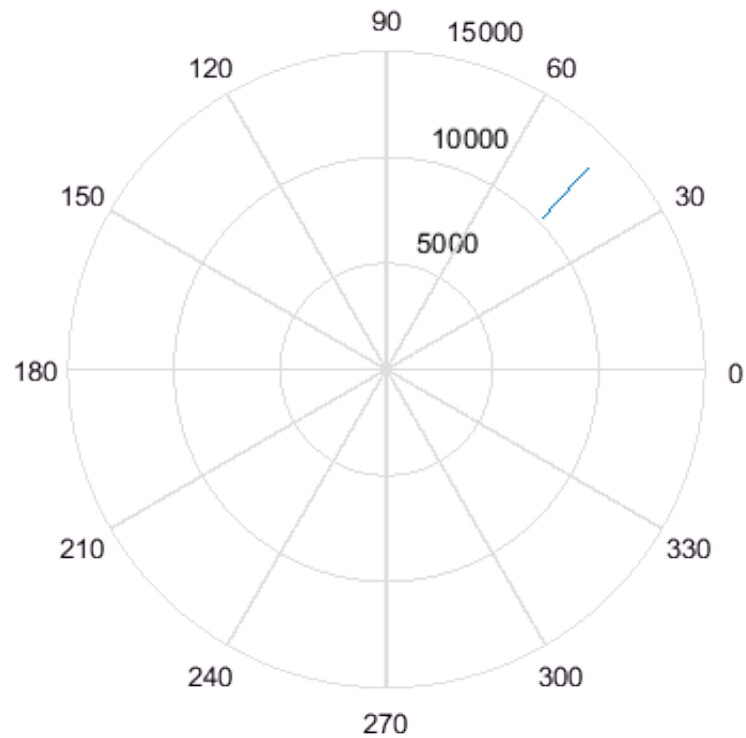
```
clc; clear all; close all

n=26;
t=2;
sigmaD=30;
sigmaB=0.09;
%for part №3
% sigmaD=50;
% sigmaB=0.0015;
X(2,n)=zeros();
V(2,n)=zeros();
x0=13500/sqrt(2);
y0=13500/sqrt(2);
%for part №2, №3
% x0=3500/sqrt(2);
% y0=3500/sqrt(2);
X(:,1)=[x0;y0];
V(:,1)=[-50;-45];
ErrSumextrD=0;
ErrSumfiltrD=0;
ErrSumextrB=0;
ErrSumfiltrB=0;

for i=2:n
    X(:,i)=X(:,i-1)+V(:,i-1)*t;
    V(:,i)=V(:,i-1);
end

for i=1:n
    D(i)=sqrt(X(1,i)^2+X(2,i)^2);
    B(i)=atan(X(1,i)/X(2,i));
end

polar(B,D); %point 2
```



```

%for M=500 times
M=500;
for i=1:M
    etaB = normrnd(0,sigmaB,1,n);
    etaD = normrnd(0,sigmaD,1,n);
    Dm=D+etaD;
    Bm=B+etaB;
    for i=1:26;
        Xm(i)=Dm(i)*sin(Bm(i));
        Ym(i)=Dm(i)*cos(Bm(i));
    end

    for i=1:26
        Zc(1,i)=Xm(i);
        Zc(2,i)=Ym(i);
    end
    %polar(Bm,Dm);
    %F, G, H, P
    sigmaA=0;
    F=[1 t 0 0;
        0 1 0 0;
        0 0 1 t;
        0 0 0 1];
    H=[1 0 0 0;
        0 0 1 0];
    G=0;
    P=(10^10)*eye(4);

    bias=0;

```

```

[ Xk,Dmextr,Dmfiltr,Bmextr,Bmfiltr, R, CondNum, FilterGainK] = calcKalman4(Zc, sigmaA, sig

Dk=(Xk(1,:).^2+Xk(3,:).^2).^0.5;
Bk=atan(Xk(1,:)./Xk(3,:));

ErrCurextrD = ( Dmextr - D).^2;
ErrCurfiltrD = (Dmfiltr - D).^2;
ErrCurextrB = ( Bmextr - B).^2;
ErrCurfiltrB = (Bmfiltr - B).^2;

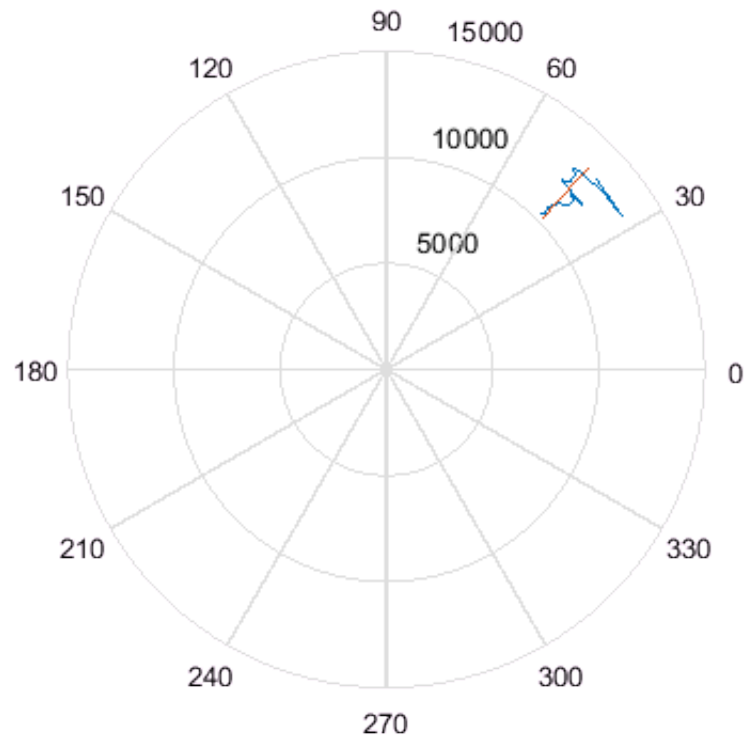
ErrSumextrD = ErrSumextrD + ErrCurextrD;
ErrSumfiltrD = ErrSumfiltrD + ErrCurfiltrD;
ErrSumextrB = ErrSumextrB + ErrCurextrB;
ErrSumfiltrB = ErrSumfiltrB + ErrCurfiltrB;

% polar(Bk(2:end),Dk(2:end));
% hold on
% polar(B,D)
% figure
% hold on
% plot(D)
% plot(Dk)
% figure
% hold on
% plot(B)
% plot(Bk)

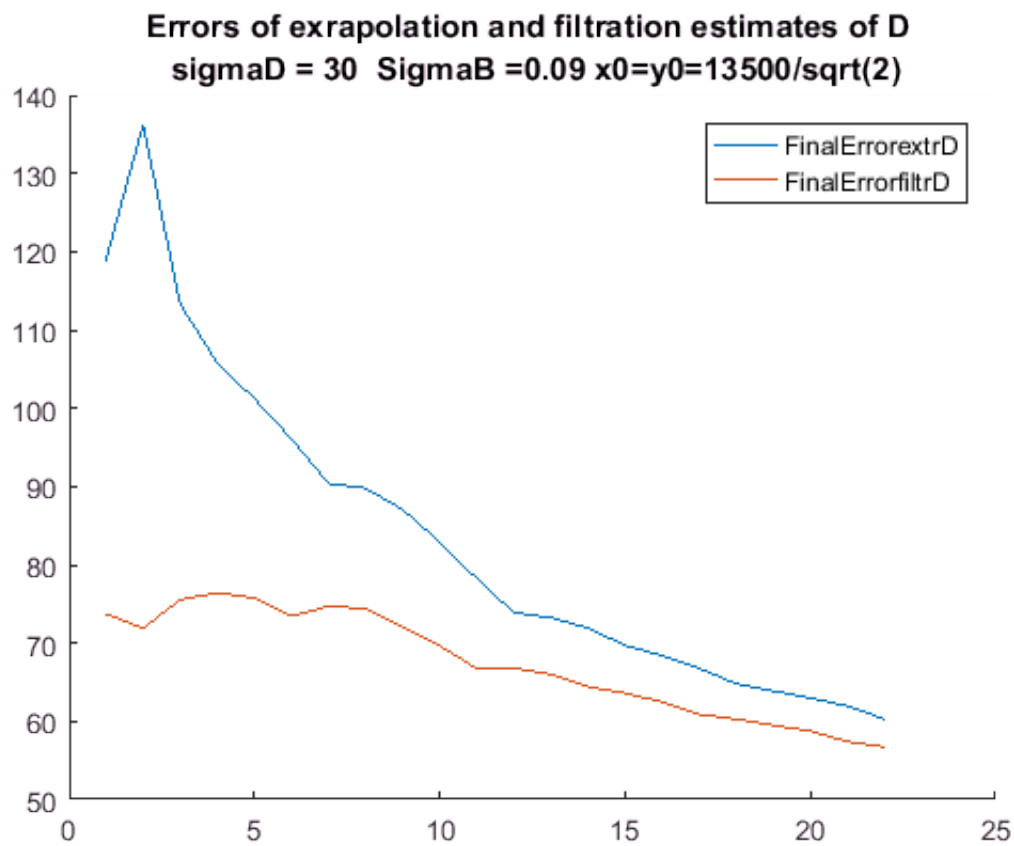
end
FinalErrorextrD = ( ErrSumextrD(3:end)./(M-1) ).^0.5;
FinalErrorfiltrD = ( ErrSumfiltrD(3:end)./(M-1) ).^0.5;
FinalErrorextrB = ( ErrSumextrB(3:end)./(M-1) ).^0.5;
FinalErrorfiltrB = ( ErrSumfiltrB(3:end)./(M-1) ).^0.5;

% plot for last realization (M=500) as an examole
polar(Bk(2:end),Dk(2:end));
hold on
polar(B,D)

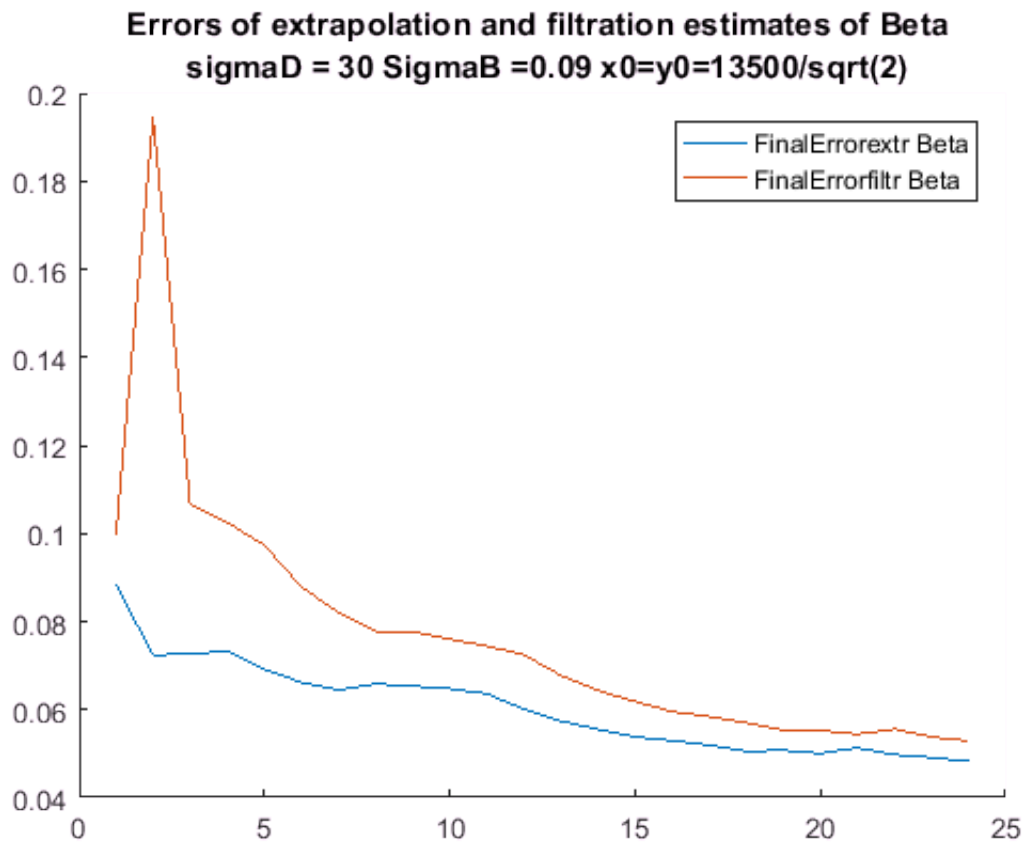
```



```
figure
hold on
plot(FinalErrorextrD(3:end))
plot(FinalErrorfiltrD(3:end))
title( sprintf ('Errors of exrapolation and filtration estimates of D \n sigmaD = 30  SigmaB
legend('FinalErrorextrD', 'FinalErrorfiltrD');
```

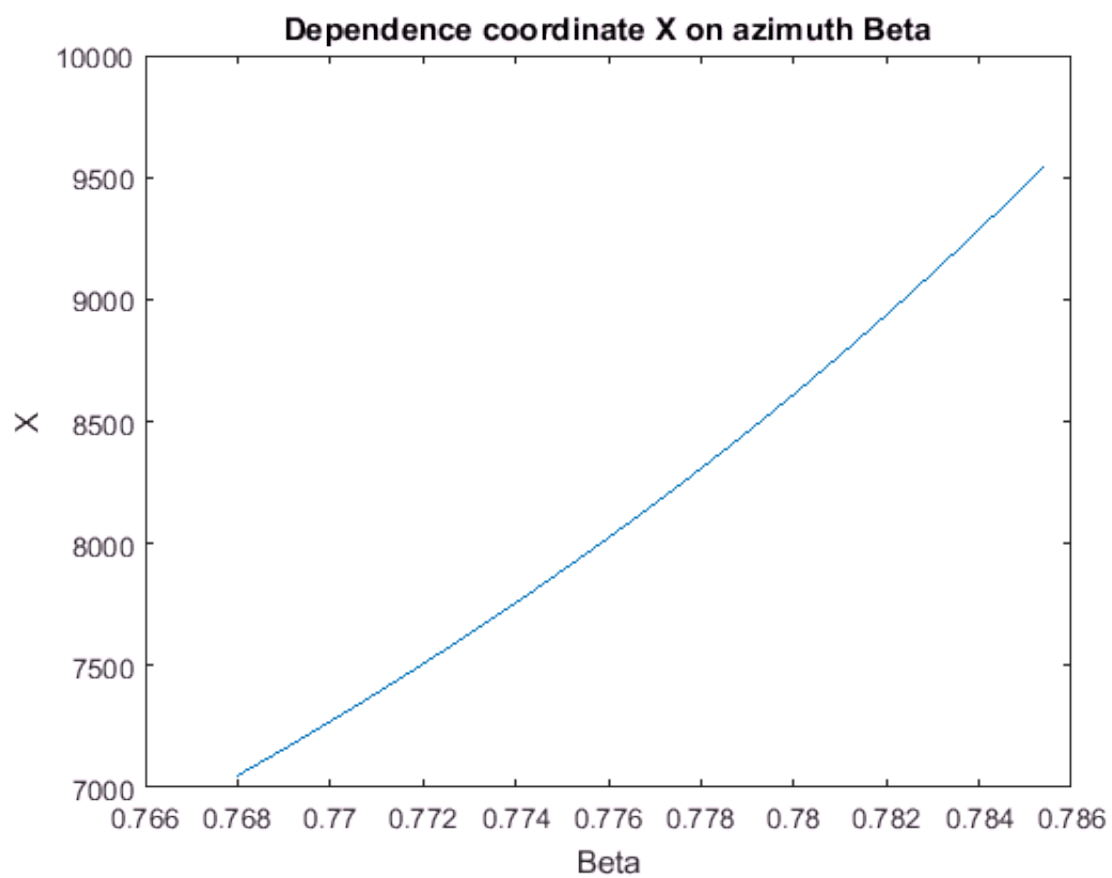


```
figure
hold on
plot(FinalErrorfiltrB)
plot(FinalErrorextrB)
title(sprintf('Errors of extrapolation and filtration estimates of Beta \n sigmaD = 30 SigmaB = 0.09 x0=y0=13500/sqrt(2)'))
legend('FinalErrorextr Beta', 'FinalErrorfiltr Beta');
```



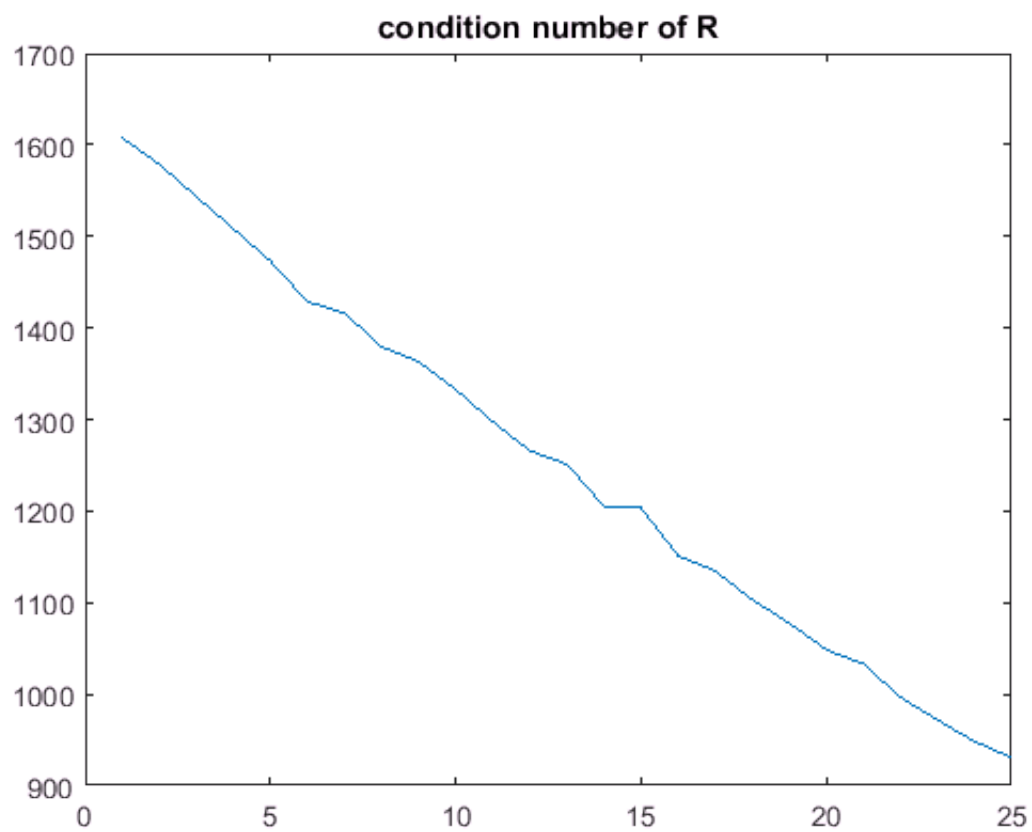
```
% hold on
% polar(B,D);
% polar(Bmextr,Dmextr);
% polar(Bmfiltr,Dmfiltr);

%point 11
for i=1:n
Xx(i)=D(i)*sin(B(i));
end
figure
plot(B,Xx);
ylabel('X');
xlabel('Beta');
title('Dependence coordinate X on azimuth Beta');
```



Dependence coordinare X on azimuth Beta is nonlinear

```
%point 13  
plot(CondNum(2:end));  
title('condition number of R')
```



Condition number decrease in time

```
%point 14  
plot(FilterGainK(2:end));  
title('filter gain K')
```



