EXP 11 ***APPLICATION OF FIR FILTERS***

21/8/14

AIM:

To filter a signal with the help of a FIR filter and examine its power spectral density.

PROGRAM:

*FIR LOW PASS FILTER*

clc;

clear all;

close all;

fprintf('\nFIR LOW PASS FILTER\n');

N=input('ENTER THE ORDER ');

Wc=input('ENTER THE CUT-OFF FREQUENCY ');

m=(N-1)/2;

h=zeros(1,N);

hd=zeros(1,N);

blackwin=zeros(1,N);

for n=0:N-1

hd(n+1)=sin(pi/2\*(n-m))/(pi\*(n-m));

blackwin(n+1)=0.42-0.5\*cos((2\*pi\*(n))/(N-1))+0.08\*cos((4\*pi\*(n))/(N-1));

if n==m

hd(n+1)=Wc/pi;

end

h(n+1)=hd(n+1)\*blackwin(n+1);

end

fprintf('\nTHE FILTER COEFFICIENTS ARE');

disp(h);

[FRF,WF]=freqz(h,1);

figure

set(gca, 'FontSize', 16)

plot(WF/pi,((abs(FRF))));

title('FREQUENCY RESPONSE');

xlabel('NORMALISED FREQUENCY');

ylabel('MAGNITUDE');

figure

set(gca, 'FontSize', 16)

plot(WF/pi,angle(FRF));

xlabel('NORMALISED FREQUENCY');

ylabel('PHASE');

%APPLICATION

Fs = 1000;

T = 1/Fs;

L = 1000;

t = (0:L-1)\*T; % Time vector

inputsig= 1.2\*cos(2\*pi\*400\*t)+ cos(2\*pi\*175\*t)+1.2\*cos(2\*pi\*150\*t)+cos(2\*pi\*t\*450);

figure

set(gca, 'FontSize', 16)

plot(Fs\*t(1:50),inputsig(1:50));

title('Input Signal');

xlabel('time (milliseconds)');

NFFT = 2^nextpow2(L); % Next power of 2 from length of y

Y = fft(inputsig,NFFT)/L;

Y=Y.\*conj(Y);

f = Fs/2\*linspace(0,1,NFFT/2+1);

% Plot single-sided amplitude spectrum.

figure

set(gca, 'FontSize', 16)

plot(f,2\*abs(Y(1:NFFT/2+1)))

title('Amplitude Spectrum of input signal');

xlabel('Frequency (Hz)');

ylabel('|X(f)|');

%PSD OF FILTERED SIGNAL

y=filter(h,1,inputsig);

figure

set(gca, 'FontSize', 16)

plot(Fs\*t(1:50),y(1:50));

title('Filtered Signal y(t)');

xlabel('time (milliseconds)');

NFFT = 2^nextpow2(L); % Next power of 2 from length of y

Y = fft(y,NFFT)/L;

Y=Y.\*conj(Y);

f = Fs/2\*linspace(0,1,NFFT/2+1);

% Plot single-sided amplitude spectrum.

figure

set(gca, 'FontSize', 16)

plot(f,2\*abs(Y(1:NFFT/2+1)))

title('Amplitude Spectrum of y(t)')

xlabel('Frequency (Hz)')

ylabel('|Y(f)|')

OUTPUT:

FIR LOW PASS FILTER

ENTER THE ORDER 11

ENTER THE CUT-OFF FREQUENCY 3\*pi/4

THE FILTER COEFFICIENTS ARE -0.0000 -0.0000 -0.0213 0.0000 0.2703 0.7500 0.2703 0.0000 -0.0213 -0.0000 -0.0000









*FIR HIGH PASS FILTER*

clc;

clear all;

close all;

fprintf('\nFIR HIGH PASS FILTER\n');

N=input('ENTER THE ORDER ');

Wc=input('ENTER THE CUT-OFF FREQUENCY ');

m=(N-1)/2;

h=zeros(1,N);

hd=zeros(1,N);

whm=zeros(1,N);

for n=0:N-1

hd(n+1)=(sin((n-m)\*pi)-sin((n-m)\*Wc))./((n-m)\*pi);

whm(n+1)=0.54-.46\*cos(2\*pi\*(n)./(N-1));

if n==m

hd(n+1)=(pi-Wc)/pi;

end

h(n+1)=hd(n+1)\*whm(n+1);

end

fprintf('\nTHE FILTER COEFFICIENTS ARE');

disp(h);

[FRF,WF]=freqz(h,1);

figure

set(gca, 'FontSize', 16)

plot(WF/pi,(abs(FRF)));

title('FREQUENCY RESPONSE');

xlabel('NORMALISED FREQUENCY');

ylabel('MAGNITUDE');

figure

set(gca, 'FontSize', 16)

plot(WF/pi,angle(FRF));

xlabel('NORMALISED FREQUENCY');

ylabel('PHASE');

%APPLICATION

Fs = 1000;

T = 1/Fs;

L = 1000;

t = (0:L-1)\*T; % Time vector

inputsig=1.32\*cos(2\*pi\*480\*t)+ cos(2\*pi\*175\*t)+1.2\*cos(2\*pi\*150\*t)+cos(2\*pi\*t\*450);

figure

set(gca, 'FontSize', 16);

plot(Fs\*t(1:50),inputsig(1:50));

title('Input Signal');

xlabel('time (milliseconds)');

NFFT = 2^nextpow2(L); % Next power of 2 from length of y

Y = fft(inputsig,NFFT)/L;

Y=Y.\*conj(Y);

f = Fs/2\*linspace(0,1,NFFT/2+1);

% Plot single-sided amplitude spectrum.

figure

set(gca, 'FontSize', 16)

plot(f,2\*abs(Y(1:NFFT/2+1)))

title('Amplitude Spectrum of input signal');

xlabel('Frequency (Hz)');

ylabel('|X(f)|');

%PSD OF FILTERED SIGNAL

y=filter(h,1,inputsig);

figure

set(gca, 'FontSize', 16)

plot(Fs\*t(1:50),y(1:50));

title('Filtered Signal y(t)');

xlabel('time (milliseconds)');

NFFT = 2^nextpow2(L); % Next power of 2 from length of y

Y = fft(y,NFFT)/L;

Y=Y.\*conj(Y);

f = Fs/2\*linspace(0,1,NFFT/2+1);

% Plot single-sided amplitude spectrum.

figure

set(gca, 'FontSize', 16)

plot(f,2\*abs(Y(1:NFFT/2+1)))

title('Amplitude Spectrum of y(t)')

xlabel('Frequency (Hz)')

ylabel('|Y(f)|')

**OUTPUT:**

**FIR HIGH PASS FILTER**

**ENTER THE ORDER 25**

**ENTER THE CUT-OFF FREQUENCY 3\*pi/4**

****

****

****

****

*FIR BAND PASS FILTER*

clc;

clear all;

close all;

fprintf('\nFIR BAND PASS FILTER\n');

N=input('ENTER THE ORDER ');

WL=input('ENTER THE LOWER CUT-OFF FREQUENCY ');

WU=input('ENTER THE UPPER CUT-OFF FREQUENCY ');

m=(N-1)/2;

h=zeros(1,N);

hd=zeros(1,N);

for n=0:N-1

hd(n+1)=(sin((n-m)\*WU)-sin((n-m)\*WL))./((n-m)\*pi);

if n==m

hd(n+1)=(2\*WU-2\*WL)/(2\*pi);

end

h(n+1)=hd(n+1);

end

fprintf('\nTHE FILTER COEFFICIENTS ARE');

disp(h);

[FRF,WF]=freqz(h,1);

figure

set(gca, 'FontSize', 16)

plot(WF/pi,(abs(FRF)));

title('FREQUENCY RESPONSE');

xlabel('NORMALISED FREQUENCY');

ylabel('MAGNITUDE');

figure

set(gca, 'FontSize', 16)

plot(WF/pi,angle(FRF));

xlabel('NORMALISED FREQUENCY');

ylabel('PHASE');

%APPLICATION

Fs = 1000;

T = 1/Fs;

L = 1000;

t = (0:L-1)\*T; % Time vector

inputsig= cos(2\*pi\*300\*t)+ cos(2\*pi\*75\*t)+cos(2\*pi\*50\*t)+1.22\*cos(2\*pi\*t\*400);

figure

set(gca, 'FontSize', 16)

plot(Fs\*t(1:50),inputsig(1:50));

title('Input Signal');

xlabel('time (milliseconds)');

NFFT = 2^nextpow2(L); % Next power of 2 from length of y

Y = fft(inputsig,NFFT)/L;

Y=Y.\*conj(Y);

f = Fs/2\*linspace(0,1,NFFT/2+1);

% Plot single-sided amplitude spectrum.

figure

set(gca, 'FontSize', 16)

plot(f,2\*abs(Y(1:NFFT/2+1)))

title('Amplitude Spectrum of input signal');

xlabel('Frequency (Hz)');

ylabel('|X(f)|');

%PSD OF FILTERED SIGNAL

y=filter(h,1,inputsig);

figure

set(gca, 'FontSize', 16)

plot(Fs\*t(1:50),y(1:50));

title('Filtered Signal y(t)');

xlabel('time (milliseconds)');

NFFT = 2^nextpow2(L); % Next power of 2 from length of y

Y = fft(y,NFFT)/L;

Y=Y.\*conj(Y);

f = Fs/2\*linspace(0,1,NFFT/2+1);

% Plot single-sided amplitude spectrum.

figure

set(gca, 'FontSize', 16)

plot(f,2\*abs(Y(1:NFFT/2+1)))

title('Amplitude Spectrum of y(t)')

xlabel('Frequency (Hz)')

ylabel('|Y(f)|')

OUTPUT:

FIR BAND PASS FILTER

ENTER THE ORDER 25

ENTER THE LOWER CUT-OFF FREQUENCY pi/3

ENTER THE UPPER CUT-OFF FREQUENCY 2\*pi/3









*FIR BAND STOP FILTER*

clc;

clear all;

close all;

fprintf('\nFIR BAND STOP FILTER\n');

N=input('ENTER THE ORDER ');

WL=input('ENTER THE LOWER CUT-OFF FREQUENCY ');

WU=input('ENTER THE UPPER CUT-OFF FREQUENCY ');

m=(N-1)/2;

h=zeros(1,N);

hd=zeros(1,N);

Wt=zeros(1,N);

for n=0:N-1

hd(n+1)=(sin(pi\*(n-m))+sin((n-m)\*WL)-sin((n-m)\*WU))./((n-m)\*pi);

Wt(n+1)=1-((2\*abs(n-m))/(N-1));

if n==m

hd(n+1)=1+WL/pi-WU/pi;

end

h(n+1)=hd(n+1)\*Wt(n+1);

end

fprintf('\nTHE FILTER COEFFICIENTS ARE');

disp(h);

[FRF,WF]=freqz(h,1);

figure

set(gca, 'FontSize', 16)

plot(WF/pi,(abs(FRF)));

title('FREQUENCY RESPONSE');

xlabel('NORMALISED FREQUENCY');

ylabel('MAGNITUDE');

figure

set(gca, 'FontSize', 16)

plot(WF/pi,angle(FRF));

xlabel('NORMALISED FREQUENCY');

ylabel('PHASE');

%APPLICATION

Fs = 1000;

T = 1/Fs;

L = 1000;

t = (0:L-1)\*T; % Time vector

inputsig= cos(2\*pi\*300\*t)+ cos(2\*pi\*75\*t)+cos(2\*pi\*50\*t)+1.22\*cos(2\*pi\*t\*475);

figure

set(gca, 'FontSize', 16)

plot(Fs\*t(1:50),inputsig(1:50));

title('Input Signal');

xlabel('time (milliseconds)');

NFFT = 2^nextpow2(L); % Next power of 2 from length of y

Y = fft(inputsig,NFFT)/L;

Y=Y.\*conj(Y);

f = Fs/2\*linspace(0,1,NFFT/2+1);

% Plot single-sided amplitude spectrum.

figure

set(gca, 'FontSize', 16)

plot(f,2\*abs(Y(1:NFFT/2+1)))

title('Amplitude Spectrum of input signal');

xlabel('Frequency (Hz)');

ylabel('|X(f)|');

%PSD OF FILTERED SIGNAL

y=filter(h,1,inputsig);

figure

set(gca, 'FontSize', 16)

plot(Fs\*t(1:50),y(1:50));

title('Filtered Signal y(t)');

xlabel('time (milliseconds)');

NFFT = 2^nextpow2(L); % Next power of 2 from length of y

Y = fft(y,NFFT)/L;

Y=Y.\*conj(Y);

f = Fs/2\*linspace(0,1,NFFT/2+1);

% Plot single-sided amplitude spectrum.

figure

set(gca, 'FontSize', 16)

plot(f,2\*abs(Y(1:NFFT/2+1)))

title('Amplitude Spectrum of y(t)')

xlabel('Frequency (Hz)')

ylabel('|Y(f)|')

OUTPUT:

*FIR BAND STOP FILTER*

*ENTER THE ORDER 25*

*ENTER THE LOWER CUT-OFF FREQUENCY pi/3*

*ENTER THE UPPER CUT-OFF FREQUENCY 2\*pi/3*

**

**

**

**

RESULT:

Thus,FIR filters have been used to filter a signal and the power spectral density of the signal has been examined.