**EECS 363: Digital Filtering**

**Mathlab Code for Parks-McClellan Method**

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**Code:**

clc;

close all;

clear all;

%fequenices for the band stop filter

f1\_pass1 = 0; %Pass band frequenices

f2\_pass1 = 0.06;

f1\_stop = 0.11; %Stop band frequencies

f2\_stop = 0.14;

f1\_pass2 = 0.19; %Pass band frequencies

f2\_pass2 = 0.5;

w1\_pass1 = 0;

w2\_pass1 = 0.12;

w1\_stop = 0.22;

w2\_stop = 0.28;

w1\_pass2 = 0.38;

w2\_pass2 = 1;

ripple\_passband = 0.1; %db

att\_stopband = 40; %db

delta1 = ripple\_passband/8.696; %passband 1

delta2 = 10^(-att\_stopband/20); %stopband

delta3 = ripple\_passband/8.696; %passband 2

w2 = 1; %assuming the weight for the stop band is 1

w1 = (delta2\*w2)/delta1;

w3 = (delta2\*w2)/delta3;

freqs = [w1\_pass1 w2\_pass1 w1\_stop w2\_stop w1\_pass2 w2\_pass2];

mags = [1 1 0 0 1 1];

weights = [w1 w2 w3];

delta = [delta1 delta2 delta3];

disp('Delta: ')

disp(delta)

disp('Weights: ')

disp(weights)

N\_approx = (-10\*log10(delta1\*delta2)-13)/(14.6\*0.05);

disp('N approximate: ')

disp(N\_approx)

% From the approximation formula we get N = 36.

% After trial and error, N = 38 was not selected as the required

% specifications were not met.

%For N = 40, the passband ripple has a maximum amplitude inside the

%required specification.

N = 40;

disp('Order of Filter: ')

disp(N)

i = 1;

h = firpm(N,freqs,mags,weights);

intervals = [f1\_pass1, f2\_pass2; f1\_pass1, f2\_pass1; f1\_stop, f2\_stop; f1\_pass2, f2\_pass2];

figure(i)

for j = 1:size(intervals, 1)

subplot(2,2,j)

%Compute frequency response in db

[fi,Hi] = freqzdB(h,1,301,intervals(j, 1),intervals(j, 2));

%for proper ripple

% if(j ~= 1 || j ~= 3)

% for k=1:length(Hi)

% if(Hi(k)<0)

% Hi(k) = Hi(k) - 0.01538;

% else

% Hi(k) = Hi(k) + 0.01538;

% end

%

% end

% end

if(j == 3)

Stopband\_attenuation = max(Hi(1:226));

disp(strcat('Frequency response from f = ', num2str(intervals(j, 1)), ' to f = ', num2str(intervals(j, 2))))

disp('Attenuation in Stopband: ')

disp(Stopband\_attenuation)

elseif(j == 2 || j == 4)

Ripple = max(max(Hi),-min(Hi));

disp(strcat('Frequency response from f = ', num2str(intervals(j, 1)), ' to f = ', num2str(intervals(j, 2))))

disp('Ripple in Passband: ')

disp(Ripple)

end

%Plot

plot(fi,Hi)

hold on;

grid on;

title(strcat('Frequency response from f = ', num2str(intervals(j, 1)), ' to f = ', num2str(intervals(j, 2))))

end

%Plot zeros of h

i = i+1;

figure(i)

zplane(h)

title('Pole-zero plot')

grid on;

hold on;

%converting h to q15 format

won = 2^15;

hvalsq15 = round(won\*h);

disp('Length of Filter: ');

disp(N+1)

disp('Coefficients (h) in Q15 format: ')

fprintf('%d\n',hvalsq15)

The order of the filter is taken as N = 40. This is done because order as N = 38, the specifications are not met, as the ripple in the passband is around 0.15dB. When N = 40, the ripple specification is 0.85dB. The weight of the stopband is assumed to be 1.

**Output:**

Delta:

0.0115 0.0100 0.0115

Weights:

0.8696 1.0000 0.8696

N approximate:

36.1551

Order of Filter:

40

Frequency response from f =0 to f =0.06

Ripple in Passband:

0.0857

Frequency response from f =0.11 to f =0.14

Attenuation in Stopband:

-41.3925

Frequency response from f =0.19 to f =0.5

Ripple in Passband:

0.0856

Length of Filter:

41

Coefficients (h) in Q15 format:

-293

-215

2

328

494

340

20

-115

90

320

27

-944

-1930

-1812

-29

2621

4272

3358

21

-3721

27423

-3721

21

3358

4272

2621

-29

-1812

-1930

-944

27

320

90

-115

20

340

494

328

2

-215

-293