EECS 363: Digital Filtering
Mathlab Code for Parks-McClellan Method
2/19/2017
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Code:

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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
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% 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;
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```
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