Indian Institute of Technology, Tirupati

EE3701:Digital Signal Processing Lab

Labsheet 6: FIR Filter Design

Prelab:

1. What are the different types of FIR filters.
2. Explain advantages and disadvantages of the FIR filters.
3. Explain the difference between FIR and IIR filters.

Lab Exercises:

1. Design a low-pass FIR filter whose cut-off frequency is 1,000 Hz using the Hamming window function for the following specified filter lengths. Assume that the sampling frequency is 8,000 Hz.
   (a) 21 filter coefficients
   (b) 31 filter coefficients
   (c) 41 filter coefficients.

   List FIR filter coefficients for each design and compare the magnitude frequency responses.
2. Design a 31-tap high-pass FIR filter whose cut-off frequency is 2,500 Hz using the following window functions. Assume that the sampling frequency is 8,000 Hz.
   (a) Hanning window function
   (b) Hamming window function
   (c) Blackman window function.

   List the FIR filter coefficients and plot the frequency responses for each design.
3. Design a 41-tap bandpass FIR filter with the lower and upper cut-off frequencies being 2,500 Hz and 3,000 Hz, respectively, using the following window functions. Assume a sampling frequency of 8,000 Hz.
   (a) Hanning window function
   (b) Blackman window function.

   List the FIR filter coefficients and plot the frequency responses for each design.
4. In a speech recording system with a sampling rate of 10,000 Hz, the speech is corrupted by broadband random noise. To remove the random noise while preserving speech information, the following specifications are given:

   Speech frequency range = 0 - 3000 kHz

   Stop-band range = 4000 - 5000 Hz

   Passband ripple = 0.1 dB

   Stop-band attenuation = 45 dB

Determine the FIR filter length (number of taps) and the cut-off frequency; use MATLAB to design the filter; and plot the frequency response.

5. Given a speech equalizer shown in Figure 1. to compensate midrange frequency loss of hearing:

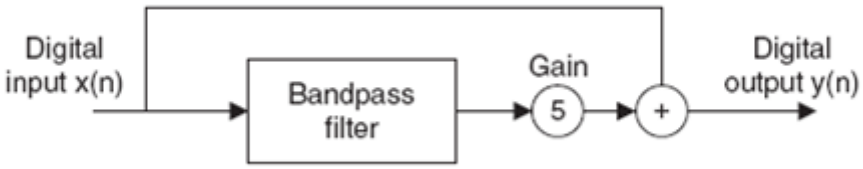

Figure 1:

Sampling rate = 8,000 Hz

Bandpass FIR filter with Hamming window

Frequency range to be emphasized = 1,500-2,000 Hz

Lower stop-band = 0-1,000 Hz

Upper stop-band = 2,500-4,000 Hz

Passband ripple = 0.1 dB

Stop-band attenuation = 45 dB,

Determine the filter length and the lower and upper cut-off frequencies

Experimental Excersize:
1) Record your speech that is suitable for each of these applications, and get the (specified) sampled version from matlab and apply each of these developed filters on it and infer what are the conseqences.
2) Add the appropriate noise atleast in 2 cases and then apply the appropriate FIR filter (that you might have developed in one of these problems say problem 4) check if you could enhance the speech quality by playing the noisy and enhanced or filtered speech !!