HW#6 Quantization Effects: Low Pass FIR Filters

Previously, a low pass FIR decimation filter was designed. The filter was constrained to have an analog cutoff frequency of 50 Hz and stopband frequency defined by $\frac{f_s'}{2}$ = 62.5 Hz. Due to the narrow transition width (12.5 Hz) for this 64-tap filter, the resulting equiripple frequency response characteristics were fairly poor.

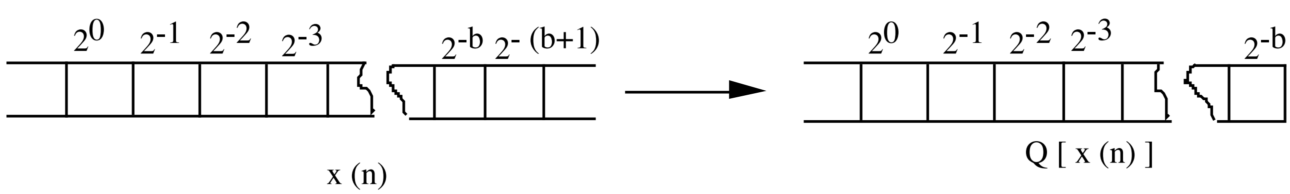
A factor of two increase in transition width can be achieved by the following simple observation. Since the spectral components lying within the passband ($|f| \le 50$ Hz) and not those within the transition region (50 Hz < $|f| \le 62.5$ Hz) are of interest, aliasing into the transition region upon desampling is of no concern. Thus, although $\frac{f_s'}{2}$ = 62.5 Hz, a stopband frequency of 75 Hz would be permissible.

A. Using an equiripple FIR filter design algorithm, redesign the decimation filter with the new stopband frequency and a passband/stopband weighting ratio = 1. Plot h(n) (amplitude) and |H(f)| (dB). Use NFFT = 256. Compare the sidelobe attenuation and passband ripple (dB) of this new filter with the previous filter design.

B. Next, normalize the impulse response so that max |h(n)| =1. Plot h(n) (amplitude) and |H(f)| (dB). Use NFFT = 256. Also, plot the zero locations of H(z).

C. Create the software which will read a data file containing a sequence x(n), amplitude quantize that sequence to a specified number (b) of fractional bits via rounding, and output the resulting sequence Q[x(n)] to an output data file.

Note:



Assume sign and magnitude representation.

D. Amplitude quantize the normalized h(n) to b=11, 7, and 3 fractional bits. (Note that these values of b correspond to 12, 8, and 4 bit representations of the FIR filter multiplier coefficients when a sign bit is included). Plot h'(n) = Q[h(n)] (amplitude) and |H' (f)| (dB) for each of the three values of b. Use NFFT = 256. Also plot the zero locations of H´(z).