EE4440 HW#6

March 25, 2011

1. Implement differential PCM in MATLAB, write a function that DPCM encodes a data stream, a function that DPCM decodes a data stream, and a script which tests the two.

   (a) Assume that you have some mechanism of letting the decoder know what initial condition is. Is this a realistic assumption? Why or why not?

   (b) Use the following data stream as a test: x=[127 125 123 121 119 120 121 122 123 124 123 122 121 120 123 126].

   (c) Plot your input signal, differentially encoded signal, and decoded signal in one figure using subplot and the plot command "stem."

   (d) Assuming that the given signal is an 8 bit signed signal, how many bits will you need to represent the encoded signal?

2. What is the valid range of digital frequencies expressed as fractions of the sample rate? In radians per second?

3. What are the maximum and minimum sampled frequencies expressed as a fraction of the sample rate? Given the following frequencies and sample rates find the digital frequency of the given frequencies at the given sample rate, and note what legitimate frequency will be interfered with in the case of frequencies that are above the Nyquist rate:

   (a) $f_s = 20,000Hz$ and $f = 39,000Hz$

   (b) $f_s = 40,000Hz$ and $f = 39,000Hz$

   (c) $f_s = 80,000Hz$ and $f = 39,000Hz$

   (d) $f_s = 2000Hz$ and $f = 100Hz$

4. What frequencies will alias to the following digital frequencies for the given sample rates?

   (a) $f_s = 20,000Hz$ and $f_d = f_s/4$

   (b) $f_s = 16,384Hz$ and $f = 3f_s/4$

   (c) $f_s = 20,000Hz$ and$f = 9f_s/16$

   (d) $f_s = 2000Hz$ and $f = -9f_s/16$
   Keep in mind that your answer needs to include ALL the frequencies that would map to these digital frequencies, so it should be in the form of a sequence, not a single number.

5. If you require 100db of SQNR how many bits do you need in your A/D? For 200dB? What is the SQNR for these common A/D bit widths: 8,12,16 and 24?

6. Create a plot like Figure 6.2 in your book for a sine wave w/ frequency 100Hz. Sample the sinewave at the Nyquist rate, sample your sinc shaped pulses at 20 times the Nyquist rate for the sinewave or more. Plot one complete cycle of the sinewave. Use the stem function to plot the sinewave samples, plot the sinc functions with dotted lines, and plot the sum of the sinc functions with a solid line. What is the error between the sum of your sinc functions and the sinewave?