UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Department of Electrical and Computer Engineering

ECE 498MH Signal and Image Analysis

Lab 3

Fall 2014

Assigned: Thursday, October 9, 2014 Due: Thursday, October 16, 2014

Reading: *Fundamentals of Signal Processing* by Minh Do, Sections 1-3 and 1-4

Lab 3.1

Download the sample TIMIT sentence from `https://catalog.ldc.upenn.edu/LDC93S1`. You will use this sentence for parts (b) and (d) of this lab.

(a) Create a function `y=feedforward(x,d,s)` that adds one feedforward echo to a signal. This function should create an output signal $y[n]$ that is as long as the input signal, and whose values are given by

$$y[n] = x[n] + sx[n-d]$$

Create an input signal which is a length-10 unit impulse (thus `x=zeros(10,1); x[1]=1;`). In your `runlab.m` function, run a `for` loop that creates each of six different outputs, for delays $2 \leq d \leq 7$, all with the scale parameter $s = -0.9$. In figure 1, create six subfigures (perhaps use `subfigure(3,2,i)`); in each subfigure, plot the impulse response ($y[n]$ in response to $x[n] = \delta[n]$) of one of your six different feedforward systems. You need not label the axes, but add a title to each figure specifying the feedforward delay.

(b) The TIMIT sentence is sampled at $F_s = 16kHz$. We want to test three very different types of feedforward delays: a delay of $d = 0.001/F_s$ will change the timbre of the sound somewhat (because the frequency response will have a zero, right at 1/0.001=1000 Hertz), a delay of $d = 0.03/F_s$ will sound like a reverberant room, and a delay of $d = 1/F_s$ will sound like two people talking at once. Create three output signals, corresponding to these three different delays, and listen to them.

In figure 2, create four subfigures. Use `subplot(4,1,1); spgrambw(x,fs);` to create a spectrogram of the original audio file in the first subfigure (you will have to download the `spgrambw` program by Mike Brooks). In each of the other subfigures, use `spgrambw(y,fs);` to plot a spectrogram of one of the reverberated signals. You may see some frequency filtering in the first reverberated signal, but no time-domain distortion. You should see significant echo speech added to the third reverberated signal.

(c) Create a function `y=feedback(x,d,s)` that adds one feedback echo to a signal. This function should create the output signal

$$y[n] = x[n] + sy[n-d]$$

Create an input signal which is a length-50 unit impulse. In your `runlab.m` function, run a for loop that creates each of six different outputs, for delays $2 \leq d \leq 7$, all with the scale parameter $s = -0.9$. In figure 1, create six subfigures (perhaps use `subfigure(3,2,i)`); in each subfigure, plot the impulse response ($y[n]$ in response to $x[n] = \delta[n]$) of one of your six different feedback systems. You need not label the axes, but add a title to each figure specifying the feedforward delay.

(d) Repeat part (b), but using `feedback` instead of `feedforward`.