



# **ELECTRICAL AND ELECTRONICS ENGINEERING INSTITUTE**

## **EE 286: Digital Audio Signal Processing**

### **Exercise 5: Echo and Reverberation**

Reverberation and echo both occur because the listener hears two or more versions of the same sound, where each version arrives at a slightly different time instant.

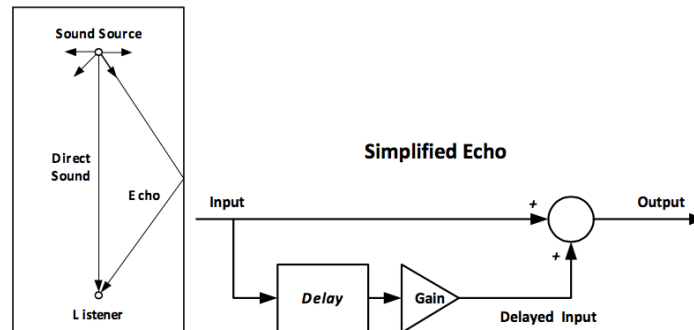


Figure 1. Basic block diagram of echo

Echo is audible because the speed of sound is relatively slow, about 400 meters per second. If we consider only one echo path, then an echo can be modeled using the block diagram in Figure 1.

Reverberation is very similar to echo, except that the additional sound sources are added due to the reflections of the original sound.

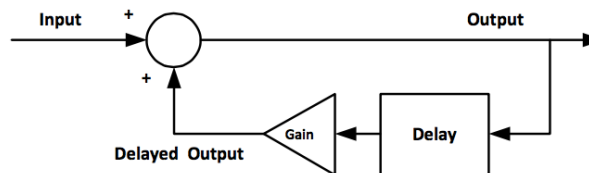


Figure 2. Block diagram of reverberation

A real room will have several echo paths. When sound is reflected off a surface there will be “coloration”. Certain frequencies will be absorbed and there will be phase changes. Therefore, a commercial echo / reverberation unit will contain many different delay paths.

Procedure:

1. Record the phrase “the quick brown fox jumps over the lazy dog.” Use a sampling rate of 8 kHz.
2. Using the recorded speech as input, write a Matlab script to model echo from Figure 1. Use a gain of 0.8, then try to vary the delay in the range of 5 msec to 200 msec. Save some outputs as WAV files.
3. Using the same input, write a Matlab script to model reverberation from Figure 2. Use a gain of 0.8, then try to vary the delay in the range of 5 msec to 200 msec. Save some outputs as WAV files.

Questions:

1. Can you describe the perceptual differences as a function of time delay for the implementation of echo and reverb? Why does reverberation require shorter time delay than echo?
2. What is the effect of the gain setting on the stability of the reverberation system? How can you make the reverb effect sound more natural?
3. Suppose you want to recreate the reverberation of a room or hall. Can you propose a practical approach that can easily be implemented in MATLAB?

You are expected to work independently for this exercise. Together with your answers to the questions, submit the Matlab script `yoursurname_reverb.m`. Compress your files as a zip file then upload in UVLE.