

Take-Home Exam (Due 3/2/12)

Introduction

Audio signal processing, sometimes referred to as audio processing, is the intentional alteration of auditory signals, or sound. As audio signals may be electronically represented in either digital or analog format, signal processing may occur in either domain. Analog processors operate directly on the electrical signal, while digital processors operate mathematically on the digital representation of that signal.

In this exam you are required to implement a digital filter in MATLAB to be able to remove (or attenuate) random noise in a sound file, a process called “filtering”. Random noise has been added to a wav file, the same way as the process described in Example 3.5 of the textbook. Figure 1(a) shows a plot of the original sound sequence, and Figure 1(b) shows a plot of the noisy sound sequence. Notice that the original signal is “buried” in noise.

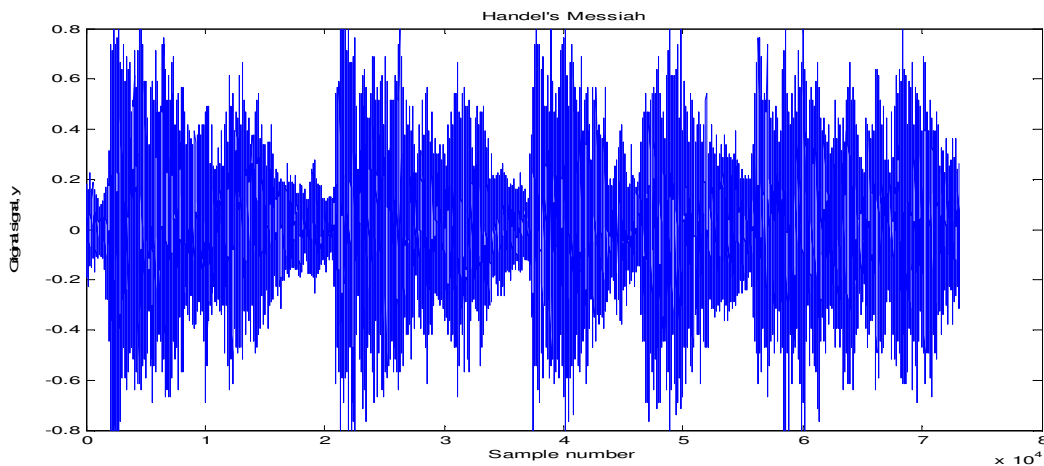


Figure 1(a). Original sound sequence

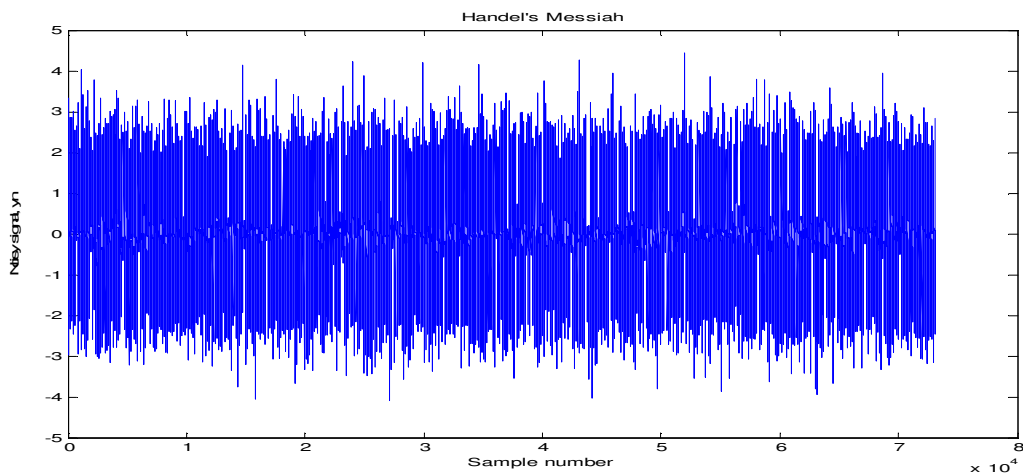


Figure 1(b). Noisy sound sequence

Simple and efficient time domain filters use statistical methods such as the *median* and the *mean* (described in section 3.5.2 of the textbook) on digital sequences, as shown in Figure 2.



Figure 2. Filtering process of a sound file

The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal. The mean filter is implemented the same way (see Wikipedia for more details). Different window sizes and type of filters (median or mean) produce different results, i.e. attenuate the noise differently. You are to implement and experiment with different window sizes and filters, to find the combination that produces the best results. **DO NOT USE ANY BUILT IN MATLAB FILTERS.**

Procedure

Download the noisy file from the website http://www.ee.nmt.edu/~erives/289_12/EE289.html, under the link "Noisyfile.mat". Load the "Noisyfile.mat" file into MATLAB workspace using the *load* command. You may use the function *sound* (*yc*, *Fs*) from MATLAB (described in Example 3.5 of the textbook) to listen to the sound sequence. The variables provided in the "Noisyfile.mat" are: 1) *yn* the noisy sequence, 2) *Fs* the sampling frequency, and 3) *n* the length of the sequence. You are now ready to start processing the noisy sequence.

Items to hand in

- (30 %) A detailed description of the five-step engineering approach followed to solve the problem.
- (20 %) A flow chart of the program.
- (20 %) A discussion of why you think a specific set of parameters produce the best results. Support your answer with well documented plots and/or tables of your results. Include a flow diagram of the filtering process.
- (30 %) A well documented MATLAB program which was used to filter the sequence. Use MATLAB functions to implement the mean and median filters. This improves the readability of the program.

Academic honesty

All students are expected to demonstrate personal integrity. Interaction among students regarding homework assignments are strongly encouraged, however each student *must show individual effort*. Exchange of information during in-class or take-home examinations, as well as copying homework solutions from each other is strictly prohibited. Students exhibiting any form of academic dishonesty will be subject to penalties in accordance with NMT policies.