Practical Assignment 3 (Digital filters)

Answer in no more than 8 pages total
Minimum 10pt font size
Due Friday, 6 November 2015, 5:00 PM
Submit via learnonline

October 18, 2015

1. (**Butterworth filtering a SNES classic**) The file `classic.wav` available at:

   `http://robbymckilliam.github.io/signalsandsystems/2015/classic.wav`

   contains 13 seconds of audio from a classic Super Nintendo game. The audio is in mono format and sampled at $F = 44\,100$ Hz. Added to the audio is an interfering sinusoid. Read this file using a computer and find the number of samples that this audio file contains. Suppose that the original audio signal is bandlimited with bandwidth less than $22\,050$ Hz. Compute and plot the magnitude of the Fourier transform of the signal on the interval $[0, 8\,\text{kHz}]$. At what frequency is the interfering sinusoid?

   Play this audio recording through the Butterworth filter you designed in Practical 2 and record the response of the filter into a `wav` file. Listen to the recording. What has happened to the interfering sinusoid? Compute and plot the magnitude of the Fourier transform of the signal in the interval $[0, 8\,\text{kHz}]$. By approximately what factor has the amplitude of the interfering sinusoid been decreased?

2. **(FIR filtering a SNES classic)** Design a finite impulse response (FIR) digital filter to remove the interfering sinusoid from the `classic.wav` audio file from Question 1. Plot the magnitude spectrum of the digital filter you have designed. Ensure that the filter attenuates the amplitude of the interfering sinusoid by at least the factor $\frac{1}{1000}$ and that frequencies below 5 kHz are attenuated by at most the factor $\frac{1}{10}$. Apply the filter to the audio from `classic.wav` and record the result into a `wav` file. Listen to the filtered audio. What has happened to the interfering sinusoid? Plot the Fourier transform of the FIR filtered audio on the interval $[0, 8\,\text{kHz}]$.