CS3570 Introduction to Multimedia

Homework #2

Due: 11:59pm, 4/14/2016

Q1. (50%) Create your own FIR filters to filter audio signal:

"**HW2_Mix.wav**" is a mix of 3 songs. Based on the ideal impulse responses given in slide #76 and the windowing functions in slide #79, you need to design and apply different FIR filters in time domain to separate the **three audio signals** from the given audio file. You can refer to the algorithm on slide #80.

1. Implement **3 different FIR filters** to separate the three audio signals with:
   - **Blackman** window function (You have to pick the appropriate window size and cut-off frequency)
2. Implement **1-D convolution on the input signal** of the given audio with your filters
3. **Plot** the result
   - The spectrum of the input signal
   - The spectrums of the output signals
   - The spectrums of the filters
   - The shapes of the filters (time domain)
4. **Store** the filtered audio files and name **"FilterName_[para1]_ [para2].wav"**
5. In the report
   - Discuss how you determine the filters
   - How you implement the filter and convolutions to separate the mixed song
   - Compare spectrum and shape of the filters
   - Anything worth mentioning

Q2. (50%) There are noise and sharp stair-step effect in **"Moonlight_4bit.wav"** after bit reduction from 8-bit to 4-bit. To eliminate the noise, you need to apply **audio dithering**, **noise shaping**, and use **low-pass filter** you finished in Q1 to filter out the high frequency components.

1. **(Dithering)** Add random noise (uniform distribution) into the input signals
2. **(Noise shaping)** Apply the first-order feedback loop for noise shaping. You can choose the coefficient **c** yourself
3. **(Low-pass filter)** Apply low-pass filtering by determining an appropriate cutoff frequency
4. **Plot** the result
   - The shape and spectrum of the input signals
   - The shape and spectrum of the output signals
   - The spectrum of the result of dithering and noise shaping
5. **Store** the filtered audio file and name **"Moonlight _Recover.wav"**
6. In the report
   - How you implement the dithering, noise shaping and low-pass filter
   - Discuss the effect of dithering and noise shaping according to the spectrums and shapes you plotted
   - Anything worth mentioning

Reminder

- Follow the instructions (hints) and spec in the sample codes given by TA
- Matlab built-in function "**conv**" is not allowed to use in this homework
- Plot the spectrum and shape in appropriate range for better visualization
- Please save the report as **"[YourID]_report.pdf"**
- Please compress all the .m files, output audio files and report into the zip file and name it **"HW2_[YourID].zip"**