

National Tsing Hua University
EE 6641 Analysis and Synthesis of Audio Signals
Lab #4: FIR filtering using FFT and overlap-add
Lecturer: Prof. Yi-Wen Liu
Due Oct 20, 2015

In this lab, you are asked to use a band-stop filter to remove the vocal part of a piece of music as much as you can. To obtain the impulse response of a band-stop filter, use the function `fir1()`:

```
h = fir1(512, f_cut, 'stop');
```

where `f_cut = [f1 f2]` specifies the edge frequencies.

Then, for each frame of length N , you should multiply it with a Hann window whose cosine period is N ; this can be achieved, somewhat awkwardly, by the following lines:

```
win = hann(N+1); % Hann window  
win = win(1:end-1);
```

After this, every windowed frame needs to be convolved with the filter h . You are required to do it in the frequency domain by completing the following steps:

- Zero-pad both the windowed frame and the filter to a sufficient length N_{zp}
- Multiply the FFT of both the windowed frame and the filter after zero-padding.
- Apply inverse FFT to the product of spectrums.
- Overlap and add the results. I suggest a hopsize of $N/2$, under which the Hann window would satisfy the constant overlap-add (COLA) constraint.

To make sure your codes are working, verify your result against this simple line:

```
y = conv(x, h)
```

directly, for whatever the filter h is. Your output needs to be identical to the y above.

Suggestions for further discussion next week in class

When you are confident that your program is doing the right things, try to determine what edge frequencies `[f1 f2]` can most effectively remove the vocal part without affecting the background music. Does the length of h matter? Finally, check whether the same edge frequencies work well for removing the vocal part of another piece of music of your choice.

What to turn in:

1. The result of your band-stop filtered signal in .wav format.

2. A plot of the frequency response of your filter, possibly using `freqz ()`

**** Useful functions for this homework:**

`freqz, log10, abs, max, fir1`