UCLA
Dept. of Electrical and Computer Engineering
ECE 114, Fall 2019
Computer Assignment 3: Temporal Analysis of Speech

Introduction: This assignment focuses on the temporal analysis of speech.

Short-time energy analysis:

Run one (it is the same function you ran for CA1). Now you have in your workspace the files for the entire sentence, data, the vowel /a/ of "wash," a, and the fricative /S/, sh.

Given a sampling rate of 8000Hz, compute the length in samples of a window used for narrowband analysis, i.e., a window of duration 25ms, and call that length N_{wn}. Compute the length in samples of a window used in wideband analysis, i.e., a window of duration 3ms, and call that N_{ww}. The function time analysis implements the formula

$$Q(n) = \sum_m \mathrm{T}\left[s(m)\right] w(n-m),$$

and returns a vector Q. The function has the following inputs: the input vector, the window type (i.e., 'rectwin', 'hamming', 'hann', 'bartlett', etc.), the window length, and the type of analysis (1 for short-time energy, $\mathrm{T}[s(n)] = (s(n))^2$; 2 for amplitude, $\mathrm{T}[s(n)] = |s(n)|$; 3 for ZCR, $\mathrm{T}[s(n)] = |\mathrm{sgn}(s(n)) - \mathrm{sgn}(s(n-1))|$).

The function amdf implements the average magnitude difference function:

$$AMDF(k) = \frac{1}{N}\sum_n |s(n) - s(n+k)|$$

Run the following

```
Q1 = time analysis(data,'rectwin',Nwn,1);
Q2 = time analysis(data,'rectwin',Nwn,2);
Q3 = time analysis(data,'rectwin',Nwn,3);
Qa = time analysis(a,'rectwin',Nwn,3); Qsh = time analysis(sh,'rectwin',Nwn,3);
```

Question:

1. Try to determine from your plots how you can use Q1 and Q2 to segment the sentence into silence, vowels and consonants. Compare with the plot of data.

2. Compare the plots of Q3 and data and see if you can set a threshold on Q3 that can be used to discriminate vowels from noise/silence/fricatives. Use the plots of Qa and Qsh to set those thresholds.

3. Feel free to use different window types and window lengths and see what effect they have on your results.

4. Run

```
Ra = xcorr(a,a);
Rsh = xcorr(sh,sh);
AMDFa = amdf(a);
AMDFsh = amdf(sh);
```

Note that Ra is the autocorrelation of a, and Rsh is the autocorrelation of sh. Compare Ra with AMDFa and Rsh with AMDFsh.

The Effect of Window Size:
In this section we will study the effect of window size on resulting spectral representations. Load the necessary data into your workspace by typing:

load in; at the prompt. Next, you can display the spectra of the male and female sounds by

typing:

```
zpfft(male_a,8000,8);
zpfft(female_a,8000,8);
```

Each time domain signal, which is sampled at F_s = 8000 Hz, has a length of 320 samples, or 40 ms. Reduce the length of the analysis window by typing the following:

```
zpfft(female a(1:Nw),8000,8);
```

This command windows the first N_w samples of the signal "female a" during spectral analysis. Note that as window length is decreased, spectral resolution is decreases, and harmonics become less resolved.

Question:

1. For each signal ("female a" and "male a"), at approximately what window size, N_w, are harmonics no longer resolved? What is the spectral resolution (DFT-bin spacing) in Hz corresponding to these window lengths?