EEL 6586: HW#1

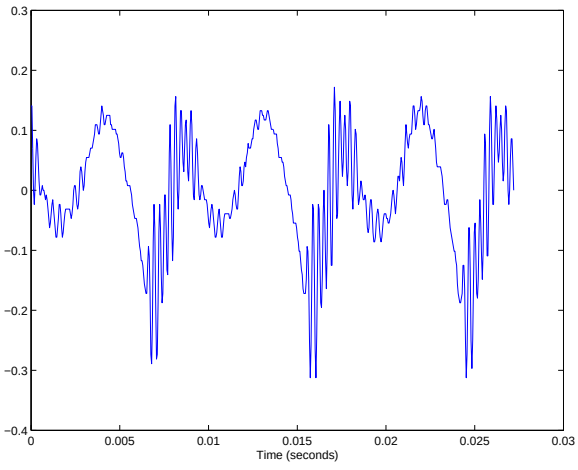
Assignment is due Friday, January 18, 2008 in class. Late homework loses $e^{\#\ of\ days\ late} - 1$ percentage points.

You must hand in your homework AND email your two audio files as attachments to Jeremy Anderson (osobailo@ufl.edu) by the due date/time. Name your files with your first initial and lastname with -b for part b and -c for part c. For example, your professor's files would be called jharris-b.wav and jharris-c.wav Use a subject line of "EEL6586 HW#2 *your full name*", so for example the professor's subject line would be "EEL6586 HW#2 John Harris" Your writeup should contain an appendix that includes all of the matlab code that you wrote for this assignment. You do not need to include any of the code within Parts B or C but you should describe your solution technique in these parts.

PART A: Short Answer Answer each of the following questions with no more than a few sentences.

A1 Suppose that you are an astronaut in outer space and speaking at a normal level. Describe how your voice will sound to a fellow astronaut who is floating about 10 feet away. Assume that neither one of you is wearing any special space suits which may muffle your voice.

A2 A speech clip was recorded and plotted below. Is the speaker a man or a woman? Explain.



A3 Someone recorded themselves speaking a single word shown below in a time domain plot. Identify the word in the list of the following:

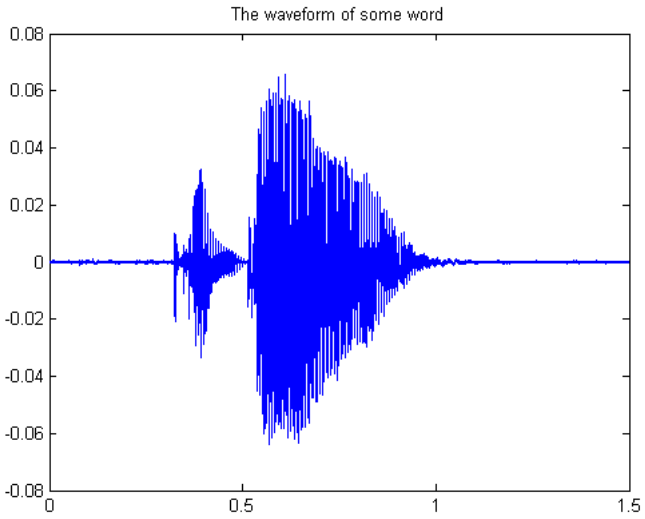
a) fail

b) test

c) obey

d) encyclopedia

e) none of the above



A4 Explain how a tonal language, such as Chinese, is different than English.

A5 A student has designed the following simple vocal tract model $H(z)$ to filter a train of impulses:

$$H(z) = \frac{1}{1 - 2z^{-1} - 2z^{-2}}$$

The student has now come to you for help in explaining their unusual Matlab simulation results. What is the problem?

PART B: Recording a voiced phoneme

B1 Record yourself on a computer saying the phoneme /aa/ for about one second. Remember /aa/ is the first vowel sound in "father". Make sure to hold the microphone to the side of your mouth to reduce noise from the airflow. Email the sound file as described above as a 16-bit 16KHz .wav file. If you have no capability to record sound on a PC, find a classmate who can help. The recording must be your voice.

B2 Hand in a portion of the time domain plots of the phoneme showing a few pitch periods. The axes of this plot (and all plots) should be fully labelled. Clearly indicate the pitch period and note its numerical value. Also, list the pitch frequency. Is your pitch within its expected range?

B3 Plot the magnitude spectrum of the phoneme. Clearly indicate the values of F_1, F_2 and F_3 on the graphs. Also show a log magnitude version of the plot.

B4 Estimate the bandwidth and amplitude of each formant using whichever definition you like. However, be sure to explain your calculation.

B5 Plot the spectrogram of the vowel. Show results from using both short and long windowing functions. Explain what features you can see in one version of the spectrogram that you cannot see in the other.

PART C: Formant Synthesis of a Voiced Vowel

In this part you will try to match your recorded phoneme using simple formant synthesis. Make sure that you properly answer all of the questions and describe your solution technique for each part. You may talk to other students, in fact you are strongly encouraged to do so. However, the final work and matlab code you turn in MUST be your own. Note: some components of this part are open-ended where there are many possible solution methods.

C1 Write a matlab program that can filter a signal using the sum of the output of three bandpass filters. Each bandpass filter will be specified by a center frequency, a bandwidth and an amplitude. Draw a block diagram of your computation. This is an open-ended question, use your

best judgment in the filter design but explain your reasoning. Hint: if your formants are too narrow then your phoneme will sound like a musical tone.

C2 To mimic your recorded phoneme from part [B1], use the code in [C1] to filter a uniform train of impulses of appropriate pitch. Note: use the pitch period you determined in part [B2]. In one sentence, describe how the synthetic vowel sounds.

C3 Do whatever you can think of to improve the quality of your synthetic sound. Hand in a one second sound file (16KHz .wav file) of your best synthetic sound. Make sure you describe exactly what you have done to create this sound. How much better does it sound compared to that in [C2]? Bonus points will be given to the highest quality, most realistic synthetic sound(s) submitted.

C4 Plot time and frequency domain representations of the vowel (don't use spectrograms). Compare your synthetic sound results to the recorded sound. In what ways do they differ, if any?

C5 Listen carefully to your real and synthetic sounds. In what ways do they sound different?