Lab Assignment #04 The source-filter model and schwa

Due M Sept 12 at 11:15am on Sakai
20 points total

Purpose

The way that the vocal tract produces sounds can be understood in terms of the **source-filter model of speech acoustics**, a model that depends heavily on the concepts of **resonance frequencies** in node/node and node/antinode systems.

This assignment provides an opportunity to:

- Review how to interpret and analyze the **spectrum** of a complex wave
- Review how to calculate **tube length**, given **resonance frequencies**
- Practice working with the key concepts behind the **source-filter model**
- Apply the source-filter model to the production of a **uniform-vocal-tract vowel**, [ə] (schwa)
- Compare the applications of **narrow-band and wide-band spectra**

Task

A. Prepare to complete the lab assignment

- **Download** the following files from the "Lab assignments" page and save them on your computer, and then open them with Praat. You will probably need to right-click on the link and choose "Download as...", "Save as...", "Save link as...", or a similar-sounding command.
  `[lab04_schwa01.wav]`
  `[lab04_schwa02.wav]`
  `[lab04_vs-x.wav]`

B. Answer questions (1)–(10) directly in Sakai

- Go to Tests & Quizzes, "Lab 04 | The source-filter model and schwa" (work in progress may be saved; no time limit)

1. The spectrum of a uniform-tube [ə]

- Open the sound file `[lab04_schwa01.wav]` in a Sound window (`View & Edit`). This is a synthesized [ə] vowel, produced with the characteristics of a uniform-tube vocal tract. Use the `Spectrogram > Spectrogram settings` menu to change the "window length" to 0.05 sec (not 0.5 as in Lab #03). Click once near the (time) midpoint and view the spectrum (spectral slice). Then answer the following questions.

(1) What is the **frequency** of the **first** (lowest-frequency) **component** of this [ə]?

(2) What are the **frequencies** of the **next four components** of this [ə]?

(3) What is the **frequency** of the **first** (lowest-frequency) **formant** of this [ə]?

(4) What is the **frequency** of the **second formant** of this [ə]?

(5) Assuming that the speed of sound in air is 350 m/s, what is the **length of the vocal tract** of a speaker who could produce this [ə]?

- Now open the sound file `[lab04_schwa02.wav]` in a Sound window. This is another synthesized [ə] vowel, likewise produced with the characteristics of a uniform-tube vocal tract.

(6) This [ə] has either the same **source**, or the same **filter**, as the first [ə] you viewed. Which is it? Use the "Rationale" box to explain how we can tell which it is.

2. Narrow-band and wide-band spectra

- Open the file `[lab04_vs_x.wav]` in a Sound window. This is the synthesized [ə] vowel we heard and analyzed in class on Wednesday; see the lecture-outline slides for details.

(7) Click near the (time) midpoint of the sound and view a spectrum (spectral slice). The `Window length` setting in `Spectrogram > Spectrogram settings` should still be at 0.05 sec; a spectrum with a long time window like this is called a **narrow-band spectrum**. Take a **screenshot** of this Spectrum window and **upload it** to the Lab #04 T&Q on Sakai. (Please remember to include your name in the filename of the screenshot.) *PDF is preferred, but image files in .jpg, .png, or .gif formats are also acceptable.*

(8) Go back to the Sound window showing `[lab04_vs_x.wav]` and use the `Spectrogram > Spectrogram settings` menu to change the `Window length` setting to 0.005 sec. Click near the (time) midpoint of the sound and view a spectrum (spectral slice). A spectrum with a short time window like this is called a **wide-band spectrum**. Take a **screenshot** of this Spectrum window and **upload it** to the Lab #04 T&Q on Sakai. (Please remember to include your name in the filename of the screenshot.) *PDF is preferred, but image files in .jpg, .png, or .gif formats are also acceptable.*

(9) Which of the two spectra, the **narrow-band spectrum** from question (7) or the **wide-band spectrum** from question (8), makes it easier to see the **individual components** of the **glottal source wave**? If you like, you may use the "Rationale" box to expand on your answer (optional).

(10) Now consider the spectrum that you did *not* choose for question (9). Is there anything about the [ə] vowel that is **easier to see** on this spectrum than on the one you chose for question (9)?

Criteria for success

This lab assignment is worth a total of 20 points, with each question worth 2 points. Points will be awarded for accuracy, and partial credit will be given where appropriate. Some of the parts will be automatically graded on Sakai, but I will double-check by hand in case of Sakai errors.