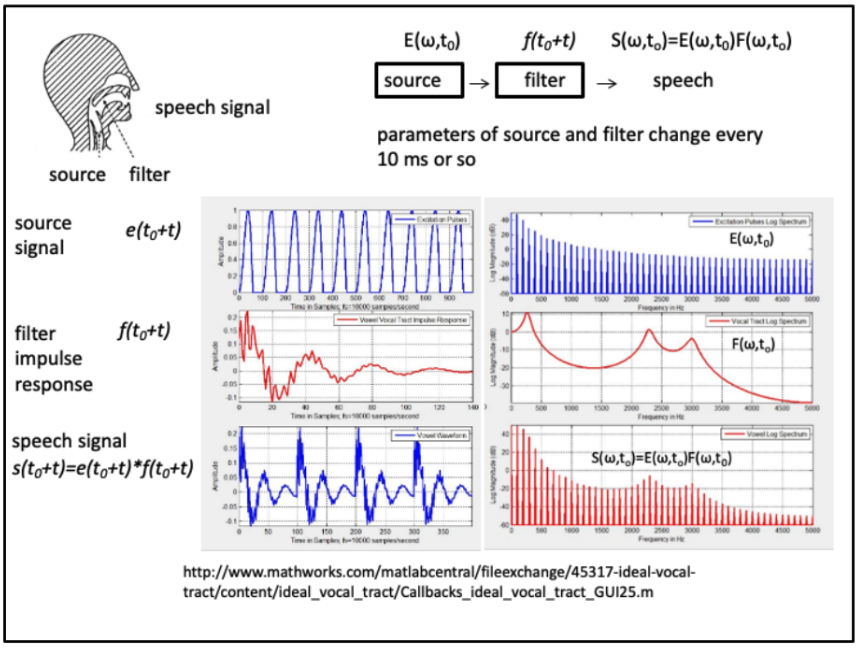
EN.520.680 Speech and Auditory Processing by Humans and Machines
Homework 3

Due: March 3^{rd}



In class we looked at how speech is generated by convolution of a source (generated by your vocal chord) with a filter (created by the shape of your vocal tract).

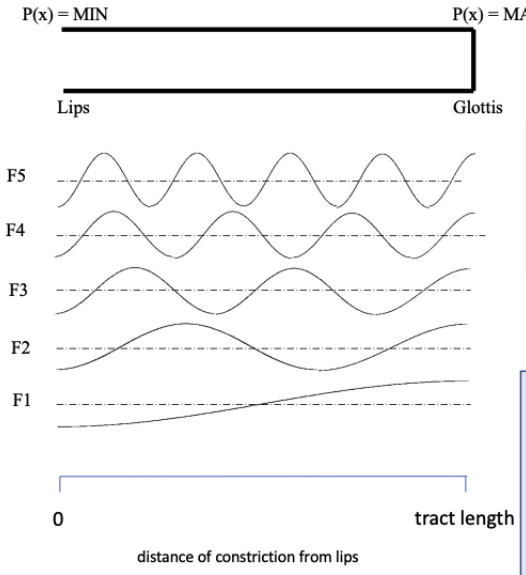
1. Simulate the source-filter model for 3 vowels
    - Phoneme /aa/, which has spectral peaks at 800 Hz and 1100 Hz

- Phoneme /uh/, which has spectral peaks at 300 Hz and 800 Hz
- Phoneme /iy/, which has spectral peaks at 300 Hz and 2300 Hz

Use any filter design tool in Python or MATLAB. Assuming the source to be a train of impulses at 130 Hz, generate the three vowels using your emulated filters. (**Points:25**)

2. Listen to the generated signals and report your observations. (**Points:5**)

Sensitivity to tract constriction



$$sensitivity = -\cos\left(\pi \cdot \frac{distance}{length} \cdot (2i-1)\right)$$

where i – formant number

then

$f_i \simeq -\cos(\pi\pi * d/l\ (2i-1))\ (c/4l)$

f_i - frequency of i-th formant
c – speech of sound,
l – vocal tract length,
d – distance from lips (tube opening)

3. Design three quarter-wave resonators with appropriate constrictions to simulate the vocal tract shapes that resonate at the first two spectral peaks(or formants) necessary for the three vowels from part 1. The vocal tract length l should be constant for the three cases. You can consider speed of sound to be 340m/s.

(**Points:20**)