Lab assignment

Part 1: Plot the *waveform* of each of the 12 vowels in separate subplots.

Part 2: Plot the *amplitude spectra* of the 12 vowels in separate subplots.

Part 3: Plot *spectrograms* of the 12 vowels in separate subplots.

Part 4: Use the TrackDraw program to measure the formant frequencies F1, F2, and F3 at approximately 1/3 of the vowel's duration. Make a table of the formant frequencies.

Part 5: Compare your measurements to the vowel formant means obtained by Assmann & Katz (J. Acoust. Soc. Am. 2000). If there are substantial discrepancies, consider possible reasons why they might arise. (`http://www.utdallas.edu/~assmann/hcs7367/formant_data.html`)

```
(1) Use browse button to change to directory containing your waveform files.

(2) load the waveform file:              [y,rate]=wavread('hawed.wav');

(3) create the first subplot:            subplot(3,4,1);

(4) Create the time axis:                t=(1:length(y))./(rate/1000);

(5) Plot the waveform:                   plot(t,y);

(6) Expand plot to fill plot box:        axis tight;

(7) Put on the title:                    title('hawed');
```

Repeat/modify steps 3-7 to make each of the 11 remaining subplots.

Once you've finished the waveform plots, print it out and start on the plots of the amplitude spectra. Note that some of the information on the class web page last week was outdated. The procedure for the spectral plots is similar to the waveform plots, but you can use the function fp.m to make the plots. Replace steps (4) and (5) with the following:

```
(4) Plot the amplitude spectrum:         fp(y,rate);
(5) Display only the 0-4 kHz region:     set(gca,'XLim',[0 4]);
```

Then replace the amplitude spectrum plot command **`fp(y,rate)`** with the spectrogram plot command **`sp(y,rate);`**

Use a **for-loop** to perform repeated actions:

```
files=str2mat('heed.wav','hid.wav', … );
for i=1:12
      [y,rate]=wavread(files(i,:));
      t=(1:length(y))./(rate/1000);
      subplot(3,4,i);
      plot(t,y);
      axis tight;
      tile(files(i,1:end-4))
end;
```

Load the Hillenbrand vowel database:

(1) Download the Hillenbrand vowel database (.zip files)
`http://homepages.wmich.edu/~hillenbr/voweldata.html`
(2) Extract files to local directory (download Winzip):
`http://www.winzip.com/download.htm`>
(3) Start Matlab and load the acoustic measurements (text files):
Coarse sampling < http://homepages.wmich.edu/~hillenbr/voweldata/vowdata.dat>

```
[files,dur,F0s,F1s,F2s,F3s,F4s,F120,F220,F320,F150,F250,F350,F180,F280,F380] = …
      textread('vowdata_no_header.txt',…
      '%s%4.1f%4.1f%4.1f%4.1f%4.1f%4.1f%4.1f%4.1f%4.1f%4.1f%4.1f%4.1f%4.1f%4.1f%4.1f');
```

(4) Create vowel, talker group, and talker number codes

```
% character 1:     m=man, w=woman, b=boy, g=girl
% characters 2-3:  talker number
% characters 4-5:  vowel (ae="had", ah="hod", aw="hawed", eh="head",
%    er="heard", ei="haid", ih="hid", iy="heed", oa=/o/ as in "boat",
%    oo="hood", uh="hud", uw="who'd")

  vowel = str2mat('ae','ah','aw','eh','er','ei','ih','iy','oa','oo','uh','uw');

  talker_group = str2mat('m','w','b','g');

  filenames=char(filenames); % convert cell array to character matrix

  [nfiles,nchar]=size(filenames);

  for ifile=1:nfiles,

      vowel_code(ifile) = strmatch(filenames(ifile,4:5),vowel);
      talker_group_code(ifile) = strmatch(filenames(ifile,1),talker_group);
      talker_number(ifile) = str2num(filenames(ifile,2:3));

   end;
```

(5) Make histograms of the acoustic measurements, separately for the 4 talker groups.

% For example: plot the **adult male** fundamental frequencies:

```
   x = F0s(find(talker_group_code==1));
   figure(1);
   subplot(221);
   hist(x,20);
% use 20 "bins"
   set(gca,'XLim',[50 500]);  % set x-axis limits between 50 & 500 Hz
   title('adult males');
```

% Next plot the **adult female** fundamental frequencies:

```
   x = F0s(find(talker_group_code==2));
   subplot(222);
   hist(x,20); % use 20 bins
```

```
set(gca,'XLim',[50 500]); % set x-axis limits
title('adult females');
```

% Next, plot the fundamental frequencies for **boys** and **girls** (separately)

(6) Repeat the steps in (5) for each of the remaining variables (dur, F1s, F2s, ... F380) and print out the figures.

(7) Calculate the means for each variable, separately for each of the 4 talker groups. Write a brief descriptive paragraph noting the patterns across the four groups.

```
x = F0s(find(talker_group_code==1));
mx = mean(x);
disp('Mean F0 for males:')
disp(mx);
```

(8) Find and remove all F0 values that are more than 2 standard deviations above or below the mean, remove these and re-calculate the mean F0. Does it change?

```
x = F0s(find(talker_group_code==1));
mx = mean(x);
disp('Mean F0 for males:')
disp(mx);
sd2 = std(x) * 2;
ind_higher = find( x > mx+sd2 );
ind_lower = find( x < mx – sd2 );
ind = intersection ( ind_higher, ind_lower );
x(ind) = [ ];
mx = mean(x);
disp('Mean F0 for males (outliers removed):')
disp(mx);
```