

# EC516 Lab 1 (Fall 2016)

Due Thursday Sept 22, 2016

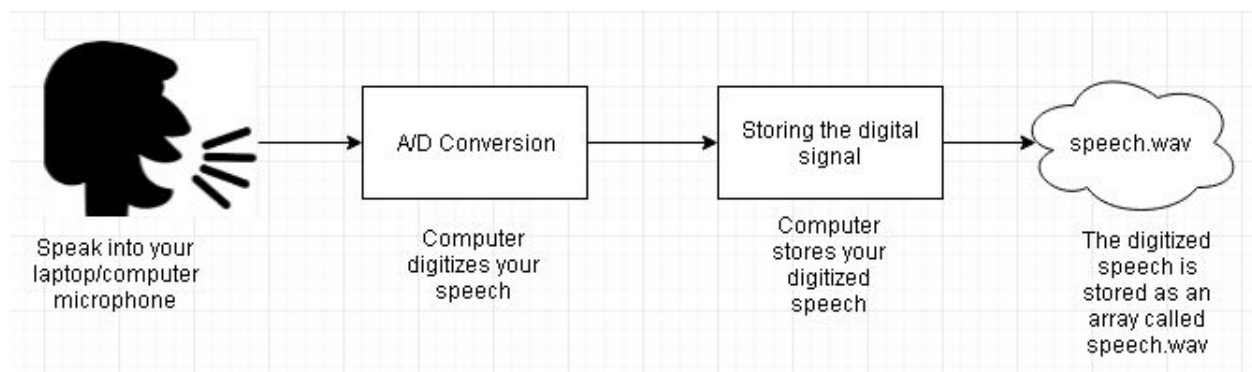
## Lab 1.1

This lab is the first in a series of MATLAB assignments designed to explore Digital Signal Processing from an **alternative patternization** perspective and its importance in computational tasks such as **Learning, Enhancement, Authentication, Detection, Encoding, Recognition or Separation (LEADERS)**. In this particular lab assignment, you will get a sense of the patternization represented by an original speech signal and how that compares to an alternative patternization of the same speech signal. Moreover, you will see how the alternative patternization of the speech signal helps in performing the subsequent task of pitch detection, which is one of the components of LEADERS.

Pitch refers to the frequency at which the vocal chords vibrate in order to produce speech. When we speak, a train of pulses are generated by the vibration of our vocal chords. These pulses then pass through our vocal cavity (mouth) in order to produce speech, as a filtered form of the pulses.

This lab is divided into 6 sections as described below:

### a) Recording your voice(ROV):



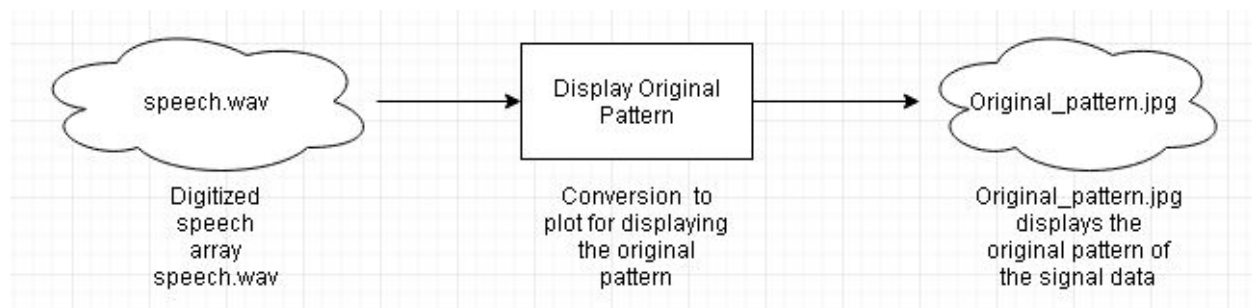
The first step is to record your voice into MATLAB using your laptop/computer microphone. Since our computer can only work on digital data, it digitizes your voice into a digital speech signal and stores it into a file named `speech.wav`, which is an array of real values, that form a pattern as a function of time.

### *GUI Usage for ROV:*

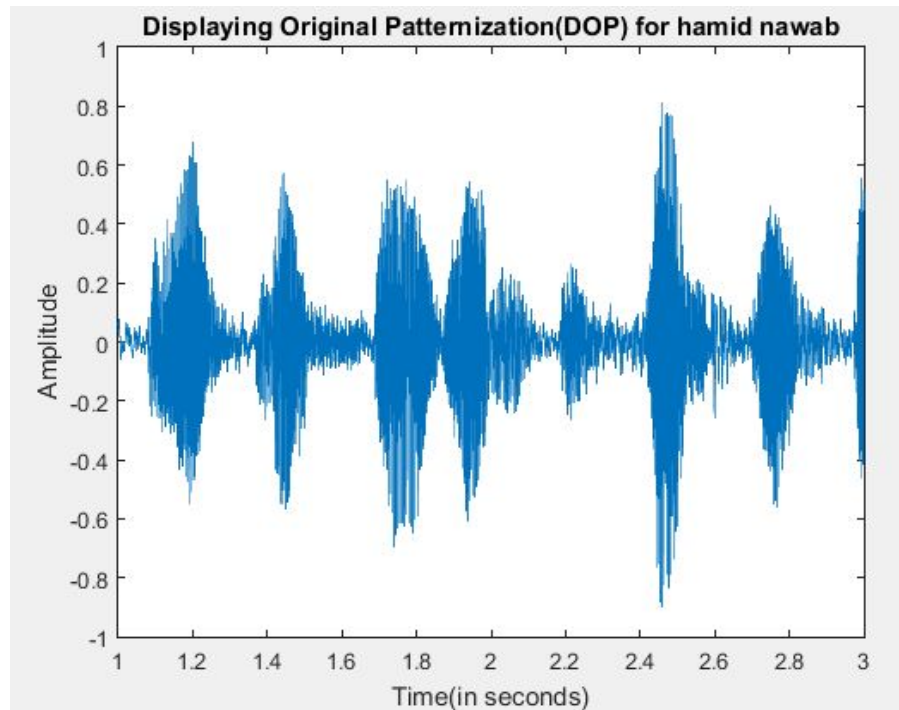


- Download and unzip EC516Lab1.zip provided to you into your current directory in MATLAB.
- Open and run EC516Lab1gui.m provided to you. This will open a GUI named 'EC516Lab1gui'.
- Enter your full name on the top right corner of the GUI. If you do not enter your name, the GUI will not work.
- Click on "Start Recording" when you are ready. Speak the sentence "Two Plus Seven is Less Than Ten " into your laptop's microphone and click on "End Recording". Please make sure you do this in a quiet room. Also ensure that your laptop has a microphone and an audio outlet.
- You can now play the file by clicking on the "Play" button.
- You will see that an audio file 'speech.wav' has been created and saved in your current directory.

### **b) Display Original Pattern (DOP)**



Now that we have stored the original pattern, we would like to display the original pattern(DOP) of our digitized speech signal(speech.wav). An example of 'original\_pattern.jpg' is shown below:



*GUI Usage for DOP:*

Displaying original pattern

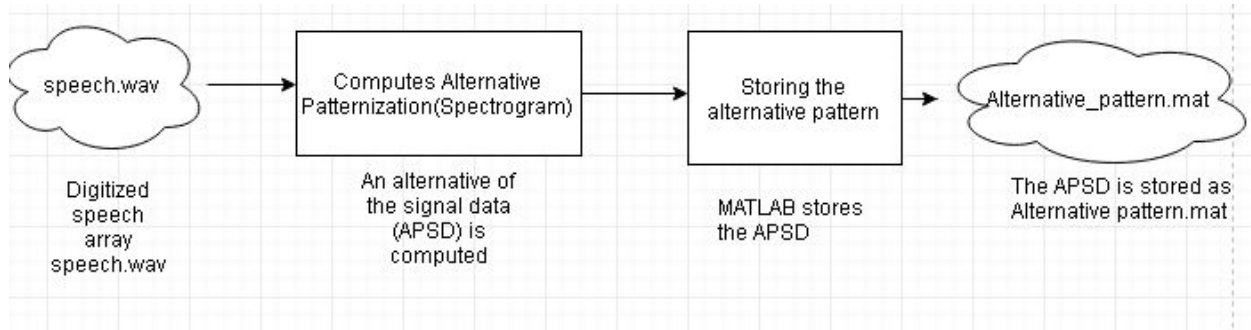
Enter segment start time(in seconds)

Enter segment end time(in seconds)

Display Status: Awaiting user recording

- Click on the “Display Original Pattern” button on the GUI. A plot of the original pattern pops up and this plot will be saved as “original\_pattern.jpg” in your current directory.
- You may also view a segment of your original pattern by specifying the start and end time in the text box provided and clicking on “Display Segment of Original Pattern”.

c) **Compute Alternative Patternization(CAP) :**



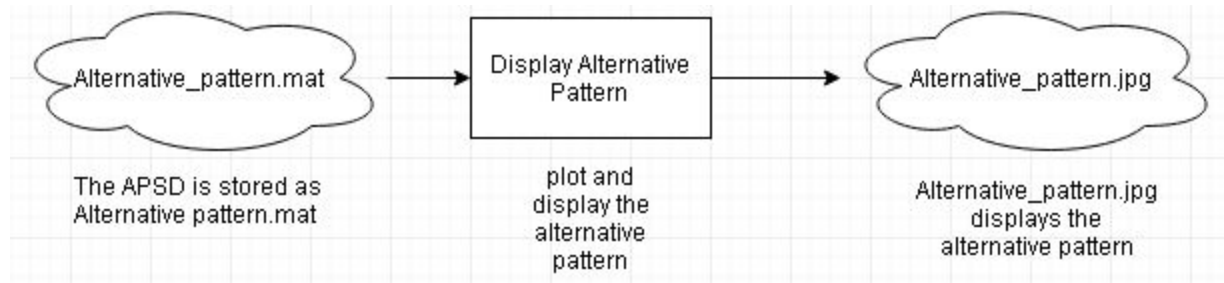
In this step we convert the Original pattern of our speech signal data into an alternative pattern. This process is known as the Alternative Patternization of Signal Data (APSD). The APSD is a matrix of complex values that represent original speech signal data in an alternative pattern.

*GUI Usage for CAP:*

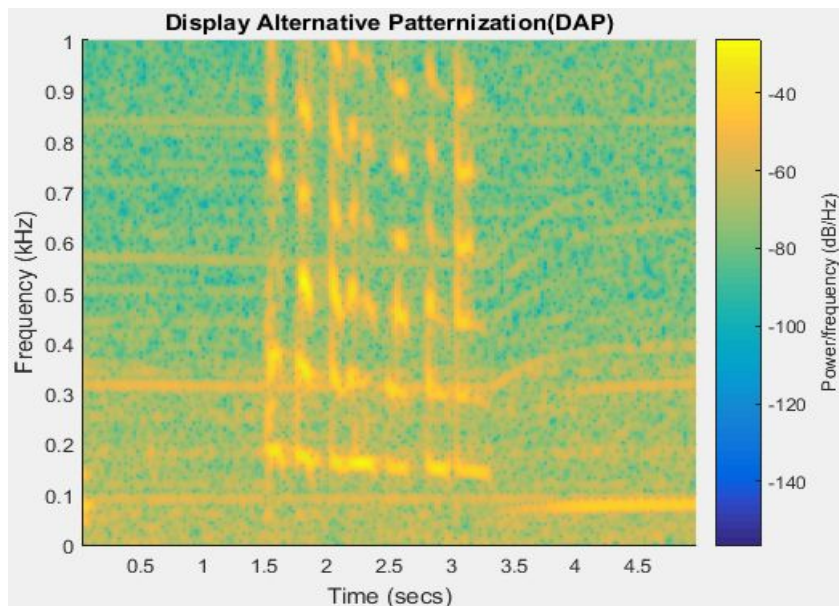


- Click on “Compute Alternative Patternization” on the GUI.You will find a new file ‘Alternative\_pattern.mat’ created and stored in your current directory.

**d) Display Alternative Patternization(DAP):**



Now that we have computed an alternative pattern, we would like to display the alternative patternization of our signal. data. An example of 'alternative\_patternization.jpg' is shown below:



*GUI Usage for DAP:*

Display Alternative Patternization

Display Status: Awaiting user recording

Displaying Alternative Patternization

Enter segment start time(in seconds)

0

Enter segment end time(in seconds)

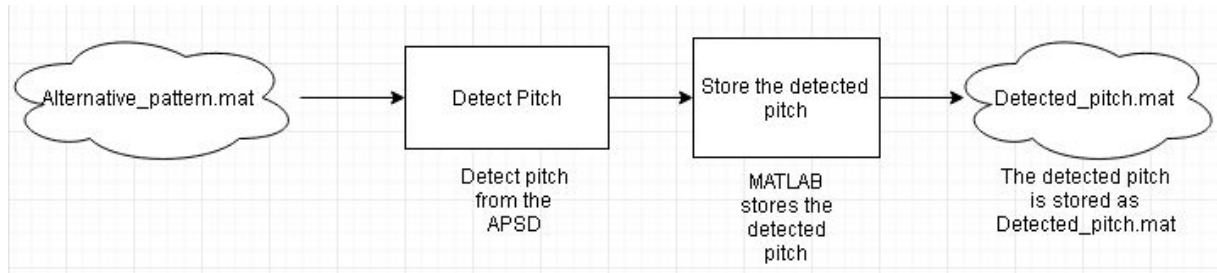
5

Display Segment of Alternative Pattern

Play Segment

- Click on “Display Alternative Patternization” on the EC516Lab1gui. An image of the alternative patternization will be displayed and saved as ‘alternative\_patternization.jpg’ in your current directory.
- You may also view a segment of your alternative pattern by specifying the start and end time in the text box provided and clicking on “Display Segment of Alternative Pattern”.

**e) Pitch Detection(PD):**



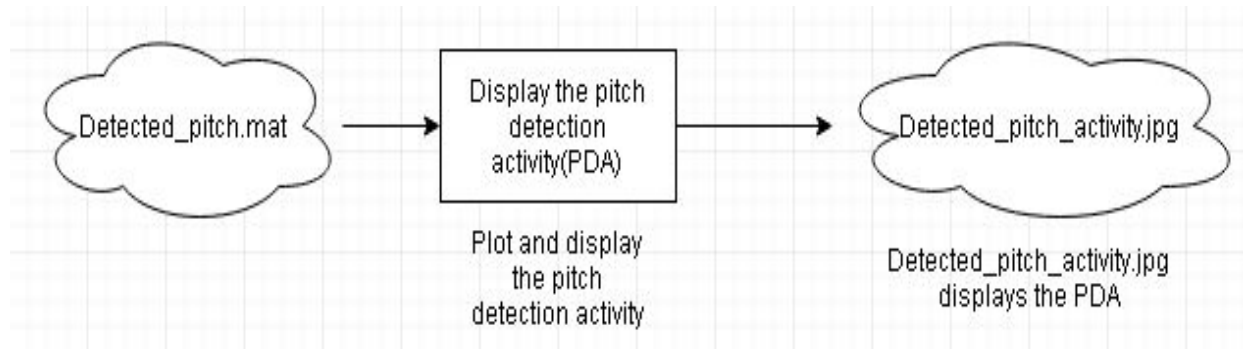
In this step we use the APSD to perform pitch detection. The Alternative Patternization gives us more helpful information about the pitch than the original pattern. Thus, the task of pitch detection can be done more efficiently.

*GUI Usage for PD:*

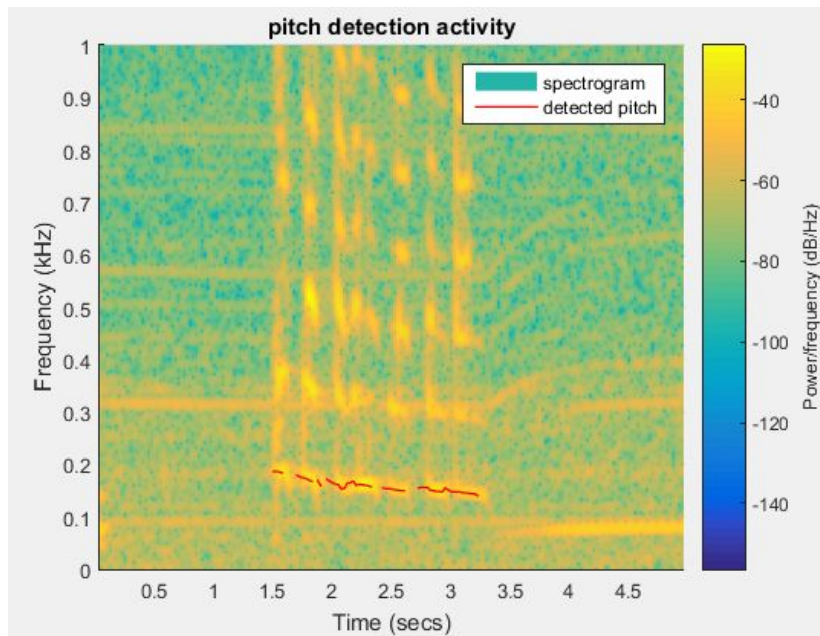


- Click on the “Detect Pitch” button on the GUI. You will find a new file ‘Detected\_pitch.mat’ created and stored in your current directory.

**f) Displaying the pitch detection activity(PDA) :**



Now we would like to display the pitch detection activity of our pitch detector. An example of Figure 'pitch\_detection\_activity.jpg' is shown below:



### *GUI Usage for PDA:*

Displaying Pitch Detection Activity

Display Pitch Detection Activity

Enter segment start time(in seconds) 0

Enter segment end time(in seconds) 5

Display Segment of Pitch Detection

Play Segment

Display Status: Awaiting user recording

- Click on Display Pitch Detection Activity on the EC516Lab1gui. An image of the alternative patternization will be displayed and saved as 'pitch\_detector\_activity.jpg' in your current directory.
- You may also view a segment of your alternative pattern by specifying the start and end time in the text box provided and clicking on "Display Segment of Alternative Pattern".

### **Submission:**

Please submit a printed copy of all the plots generated. Please staple the printed plots together. Do not staple them with HW2.

### Additional Information on MATLAB Function Usage(Optional Reading):

#### MATLAB Script Usage-recording.m:

The MATLAB files recording.m and EC516Lab1.m has been provided to you.

- Make sure these files are in your current directory in MATLAB.
- Enter your full name in name.txt and save it.
- Open EC516Lab1.m and enter and run the following command in section A of this file: recording();.
- You will be prompted to speak the sentence "Two Plus Seven is Less Than Ten " into your laptop's microphone. Please make sure you speak the sentence within 4 seconds after being prompted in a quiet room.
- You will see that an audio file 'speech.wav' has been created and saved in your current directory.

#### MATLAB Script Usage-display\_original\_pattern.m:

- Make sure the file display\_original\_pattern.m is in your current working directory.
- Enter and run the following command in section B of EC516Lab1.m: display\_original\_pattern()



- A plot of original\_pattern pops up and this plot will be saved as original\_pattern.jpg in your current directory.

#### MATLAB Script Usage-alternative\_patternization.m:

- Make sure the file alternative\_patternization.m is in your current working directory.
- Enter and run the following command in section C of EC516Lab1.m: alternative\_patternization();
- You will find a new file Alternative\_pattern.mat created and stored in your current directory.

#### MATLAB Script Usage-display\_alternative\_pattern.m:

- Make sure the file display\_alternative\_pattern.m is in your current working directory.
- Enter and run the following command in section D of EC516Lab1.m: display\_alternative\_pattern().
- An image of the alternative patternization will be displayed and saved as alternative\_patternization.jpg in your current directory.

#### MATLAB Script Usage-pitch\_detect.m:

- Make sure the file pitch\_detect.m is in your current working directory.
- Open EC516Lab1.m and run the following command: pitch\_detect();
- You will find a new file Detected\_pitch.mat created and stored in your current directory.

#### MATLAB Script Usage- display\_detected\_pitch.m:

- Make sure the file display\_detected\_pitch.m is in your current working directory.
- Enter and run the following command in EC516Lab1.m display\_detected\_pitch().
- A plot of pitch detection activity pops up and the same plot is saved as pitch\_detector\_activity.jpg is saved in your current directory.