

Instructions for Running the MATLAB Wav Analysis Program

1.) Login to any one of four “fast” Windows XP computers (the 4 black ones in the classroom in 6105 ESB) with:

Username = **Your_UIUC_NETID_USERNAME**,
PassWord = **Your_UIUC_NETID_PassWord**,
Domain = **UIUC**

2.) Use the mouse to double-click on the **MATLAB R2006a** shortcut on the desktop. If this shortcut is not there, then go to the "Start" menu on the computer, go to "All Programs", then to “Matlab” then to “R2006a” and click on “R2006a” – be patient – it takes some time to load this program...

4.) The MATLAB program will load. When ready, in the MATLAB *command window* (i.e. the RHS window) type in:

```
>> cd wav_analysis <enter>
```

{i.e. change directory from the

C:\Program Files\MATLAB\R2006a\work folder to the

C:\Program Files\MATLAB\R2006a\work\wav_analysis sub-folder}

(Note: where you are on the C: drive is also shown in the upper left-hand window of the main panel of the MATLAB application window)

then type in:

```
>> ls <enter> {this will show all of the files present in the wav_analysis sub-folder}
```

(Note: these files will also be listed in the upper left-hand window of the MATLAB main panel)

5.) You will see a MATLAB file in this folder called **wav_analysis.m** - to run this program, type in {in the MATLAB *command window* (i.e. RHS window)}:

```
>> wav_analysis <enter>
```

6.) A small pop-up menu-type window titled "**wav_analysis**" {for Waveform Analysis} window will appear on the screen. Use the mouse to click on the "File" pull-down menu. Currently, there are two file options: a.) "**Open WAV**" and b.) "**Open Test Waveform**".

a.) "**Open WAV**" opens a *.wav format file - which is user specified. Currently, there exist many *.wav files located in the **C:\Program Files\MATLAB\R2006a\work\sounds** sub-folder, that you can analyze. Please note that any new *.wav files that you create during the semester should also be put in a new or existing sub-folder in this area on the C: drive!!!

If you click on the "Open WAV" option, a new pop-up window titled "Wav file to edit" will appear, the file location of which is defaulted to the **\wav_analysis** subfolder. Thus, you want to go up one folder - to the **\sounds** sub-folder, then down into the **\sounds** sub-folder, and then down again into any one of the sub-sub-folders containing *.wav files. Choose any *.wav file there by using the mouse - click on it once to select it in the "Wav file to edit:" window, then click on the "Open" button in the "Wav file to edit:" window.

The selected *.wav file will then be read in by the **wav_analysis** program. A pop-up window titled "**Figure No. 1**" will appear, showing the sound waveforms (amplitude vs. time) on both left and right (i.e. stereo) audio information channels.

A small pop-up window, titled "**Which channel**" will appear, asking you to select either the Left or the Right audio channel for analysis. Look at the waveform data shown on "**Figure No. 1**", look *carefully* at the *vertical scales* of *both* left and right channels of the sound data and then decide/choose which channel (left or right) you want to analyze. Then click on either the "**Left**" or "**Right**" button in the small "Which channel?" window. Usually the *left* channel is the one that has sound data recorded on it.

b.) "**Open Test Waveform**" - there are currently two test waveform choices, available in a sub-pulldown menu of this option - triangle or square wave. Choose one of these, if you are interested in seeing the analysis of either one of these "standard" test waveforms.

7.) Next, in the "**wav_analysis**" window, click on the "**Clip Waveform**" button. **Figure No. 1** window will re-appear, this time with the previously selected left or right audio channel information (amplitude vs. time) displayed on the plot. A graphics cursor will also appear. Use the graphics cursor to click (*once only!*) on the **start** and **stop** times on the displayed waveform in order to tell the **wav_analysis** program which segment of the sound data file it is to analyze. Note also that you can double-click on the blue task-bar to expand this window (or any other window) to full screen if you so desire, in order to do a more accurate/precise job on defining the start & stop times. Note further that since the **wav_analysis** program is designed to analyze only steady sounds (accurate tracking of dynamically-changing complex sounds with a computer program is a very difficult problem!!!), it is best to cut out the transient sounds associated with the beginning and the ending of the sound recording, and analyze only a few seconds of the central, "steady" portion of the sound recording.

Immediately after you have used the graphics cursor to click on the start & stop times, the program then re-draws **Figure No. 1** amplitude vs. time, but for just the user-selected region in time.

8.) Next, again in the "**wav_analysis**" menu window, click on the "**Show 3D Surface**" button to display the 3D color plot of the log of the amplitude² vs. frequency vs. time. Another small pop-up window will appear, titled "**Plot3d...**" You can change the lower and upper bounds of the **Frequency Axis Scaling** from its default values (e.g. 0-5500 Hz). You can also change the **Minimum Amplitude** displayed from its default value of 0.01. If any of these values are changed, the 3D plot can then be replotted by clicking on the "**Replot**" button in this small pop-up window.

9) Going back to the main "**wav_analysis**" menu window, you can make the window with the 3-D log(Amplitude²)-frequency-time surface disappear by clicking on the "**Hide 3D Surface**" button.

10.) Next, you can look at the harmonic content of the selected waveform by clicking on the "**Choose Harmonics**" button of the main "**wav_analysis**" menu window. A new (big) window titled "**get_harms**" will pop-up which displays a *semi-log* plot of amplitude² vs. frequency. Use the graphics cursor to select several (e.g. up to 5) of the largest harmonics. To do this correctly for each harmonic, one uses the graphics cursor to click *once* on the low-side of a big harmonic and then click *once* on the high side of a big harmonic. One does this for each harmonic one wishes to analyze. As one uses the graphics cursor to select the low-high frequency analysis window for each harmonic, vertical green bands will appear at these boundaries for each selected harmonic, and the corresponding numerical values of the frequencies of the selected harmonic ranges will appear in a small window on the LHS of this plot.

If a mistake is made in selecting harmonics with the graphics cursor, this entry of low-high frequencies can be deleted by selecting the unwanted entry in the "**Harmonic Ranges**" window of the LHS of the plot. When one does this, two vertical red lines appear on the plot, indicating the low-high frequency pair that will be removed. Click on the "**Remove Selected**" button to remove this low-high frequency pair. When completely satisfied with selection of harmonics, use the graphics cursor to click on the "**Done**" button at the bottom of the big "**get_harms**" window.

If the overall frequency range of interest is desired to be changed from its default values, this can also be accomplished by changing the upper/lower bounds of the "**Frequency Axis Scaling**" window on the LHS of the big "**get harms**" window.

11.) Next, go back to the main "**wav_analysis**" menu and click on the "**Analyze**" button. As soon as this button is clicked on, you will first hear the (selected portion of the) sound file, and then in succession, each of the sounds associated with each harmonic on the computer's speakers. When analysis of the sound has been completed, a small window "**Done Fitting Harmonics**" pops up - click on **OK**.

12.) Next, in the main "**wav_analysis**" menu click on the "**Show Harmonic Fits**" button to see how the frequency and phase of each of the harmonics that were selected, vary with time - Figures 3 & 4. You can hide these harmonic fit plots from the main "**wav_analysis**" menu.

13.) Next, click on "**Show Aggregate Plots**" to view aggregate plots of the fitted frequencies vs. time, absolute and relative phases vs. time for the selected harmonics, a phasor plot of the harmonics, and a bar chart showing the relative strengths of the harmonics, normalized to the fundamental (in dB units).

14.) After you become familiar with using this program, after selecting the input *.wav file for analysis, you can instead just click on the last "**Run/Show All**" button in the main "**wav_analysis**" menu to do all of the above, automatically. You will still have to select/choose left/right channels of the *.wav file and select/choose the start/stop times on the selected channel of data, and select/choose the harmonics. This option of the main "**wav_analysis**" just automatically proceeds from one menu item after another in the main "**wav_analysis**" menu.

15.) You can save plots and analysis results by going to the pull-down file menu and selecting any one of the following options:

- a.) **Save Data to XML** – writes out sound analysis data to a file in XML format
- b.) **Write Shown Figures to EPS** – exports shown figures to a file in EPS format
- c.) **Write Shown Figures to PNG** – exports shown figures to a file in PNG format
- d.) **Write Filtered Sounds** – writes out *.wav files for each selected harmonic
- e.) **Save All** – writes out all data and saves figures in EPS/PNG format

16.) When each sound analysis is completed, exit the MATLAB **wav_analysis** program by clicking on the "X" in the small red box in the upper right-hand corner of the MATLAB **main analysis window**; do similarly for all of the remaining figures and other pop-up windows on the computer screen. Note that it is very important to do this for each analyzed sound, before analyzing another sound file!!!

17.) Backup any sound analysis files that you have created to your own personal sub-folder on the [\\Phyapportal\PHYCS199POM\Common](#) area – double click on the **P199POM Backup** icon on the desktop of the computer to get to this area.

18.) Then, don't forget to logout from the computer!!!