

Exercise Lecture 1

Introduction to Joint Time Frequency Analysis

Part 1: Basic exercises

1- Construct a time series consisting of two sequential sinusoids of 10 and 40 Hz, each active for 0.5 sec (see Figure 6.2). The sinusoids should be preceded and followed by 0.5 sec of no signal (i.e., zeros). Determine the magnitude of the STFT and plot as both a three-dimensional grid plot and as a contour plot. Do not use the Signal Processing Toolbox routine, but develop code for the STFT. Use a Hanning window to isolate data segments.

2- Generate a linearly increasing sine wave that varies between 10 and 200 Hz over a 1sec period. Analyze this chirp signal using the STFT program used in Example 6.1. Plot the resulting spectrogram as both a 3-D grid and as a contour plot. Assume a sample frequency of 500 Hz.

3- Using the code developed in the previous exercises, plot the spectrogram of common biomedical signals (e.g. ECG, EMG, EEG) under different physiological conditions. Try different windows (including the Gabor Transform). Analyse the advantages over classical spectral methods and discuss the results.

Part 2: Complementary exercises

1- Download the Time-Frequency Toolbox (TFTB) from <http://tftb.nongnu.org/>. The Time-Frequency Toolbox is a collection of Matlab files developed for the analysis of non-stationary signals using time-frequency distributions. In the same webpage (on the Documentation section), there is a tutorial with several examples (and insightful explanations) of Joint Time-Frequency Analysis. These examples will provide a deeper understanding on the topics reviewed in the lecture.

2- For Lecture 1, the recommended examples are:

- Chapter 1: Sections 1.3.1, 1.3.2 and 1.3.3
- Chapter 2: Sections 2.2.1, 2.2.2, 2.6 and 2.7
- Chapter 3: Sections 3.1.2, 3.1.4, 3.3.1, 3.3.2, 3.4.1