

## Exercise Lecture 2

### The Wigner-Ville Distribution (WVD)

#### Part 1: Basic exercises

1- Construct a time series consisting of two sequential sinusoids of 10 and 40 Hz, each active for 0.5 s. The sinusoids should be preceded and followed by 0.5 s of no signal (i.e., zeros). Apply the WVD to analyse this signal.

2- Generate a linearly increasing sine wave that varies between 10 and 200 Hz over a 1 s period (you can use the Matlab `chirp` routine). Analyze this chirp signal using WVD. 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, compare the spectrogram and the WVD of common biomedical signals (e.g. ECG, EMG, EEG) under different physiological conditions. Try different windows (including the Gabor Transform). Analyse the advantages and disadvantages of the WVD in comparison to the spectrogram. What happens to the interference terms in the spectrogram in comparison to the WVD?

#### 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 2, the recommended examples are:

- Chapter 1: Review sections 1.3.1, 1.3.2 and 1.3.3 in the light of new knowledge about WVD.
- Chapter 2: Sections 2.3, and 2.4
- Chapter 4: Sections 4.1.1. Pay special attention to sampling issues of the WVD and the analytic signal in pp. 65-67.