Supplementary material for TFSAP book Section 12.1: "Optimal Time-Frequency Detectors"[1]

The additional material in this file is provided by Prof Boashash to assist the reader to better understand Section 12.1 of the TFSAP book. The reader may benefit from accessing the code and/or other supplementary materials (SM)[2] from the following related Chapters of the book: 12.5, 13.4.4, 15.5, 15.6.7, 16.1.3, 16.3, 2.3.1, 2.1.3, 2.1.4 and 17.3.5 as detailed below.

1. Related Supplementary Material in Chapter 12.5:

Optimal detectors in Section 12.1 are further extended in Chapter 12.5. An illustration for detecting newborn EEG seizures is presented using general formulation of time-frequency *(t, f)* matched filters. Run the MATLAB scripts *Call_functions_script.m* and *Fig_1.m* to reproduce the results presented in Table 12.5.2 and Fig. 12.5.1 on pages 730 and 728 of the book respectively.

2. Related Supplementary Material in Chapter 13.4.4:

The detection of chirp signals using a statistic based on the fractional autocorrelation function is explained in Chapter 13.4.4 of the book. Figs. 13.4.1 and 13.4.2, on pages 775 and 776 of the book, illustrate the detector outcomes for a mono-component Linear Frequency Modulated (LFM) signal and a multi-component LFM signal. Run the MATLAB scripts *Figure_13_4_1.m* and *Figure_13_4_2.m* to reproduce the results.

3. Related Supplementary Material in Chapters 15.5 and 15.6.7:

Time-frequency *(t, f)* detection of different biomedical signals is discussed in Chapters 15.5 and 15.6.7.

In Chapter 15.5, changes in phonocardiogram (PCG) signals are detected using *(t, f)* features. Figs. 15.5.3 and 15.5.4, on pages 892 and 893 of the book, illustrate the ambiguity functions and the *(t, f)* representations of normal and abnormal PCG signals respectively. Run the MATLAB script *Sec_15_5_EMBD_code.m*, provided in the SM of Chapter 15.5, to reproduce the results.

Furthermore, Chapter 15.6.7 discusses the detection of EEG abnormalities in newborns using *(t, f)* features. Run the MATLAB script *figure15_6_3.m*, provided in the SM of Chapter 15.6, to compute the extended modified B-distribution of normal and abnormal EEG patterns, as depicted in Fig. 15.6.3 on page 902 of the book.

4. Related Supplementary Material in Chapters 16.1.3 and 16.3:

Automatic detection of seizure and Burst-Suppression (B-S) patterns in newborn EEG, using *(t, f)* information, is discussed in Chapters 16.1.3 and 16.3 respectively. Fig. 16.1.2 (e), on

---

[1] B. Boashash, Ed., "Optimal Time-Frequency Detectors", Supplementary material for Chapter 12.1; in B. Boashash (ed.), *Time-Frequency Signal Analysis and Processing*, 2nd Edition (London: Elsevier / Academic Press, pages 694-701, December 2015); ISBN 978-0-12-398499-9.

[2] All of the book supplementary materials can be found here.

page 921 of the book, illustrates the output of an automated seizure detector using the *(t, f)* matched filter.
Run the MATLAB script *eeg_analysis_example.m*, provided in the SM of Chapter 16.1, to reproduce the results. In addition, Table 16.3.1, on page 935 of the book, shows the relevance of the selected features, extracted from different TFDs, in detecting B-S patterns in newborn EEG.
Run the MATLAB script *Call_functions_script.m*, provided in the SM of Chapter 16.3, to reproduce the results.

5. Related Supplementary Material in Chapter 2.3.1:
The short time Fourier transform (STFT) and the spectrogram (squared magnitude of the STFT) are defined in Chapter 2.3.1. See Figs. 2.3.1 and 2.3.2, on pages 78 and 79 of the book, which illustrate the spectrogram of a sinusoidal frequency modulated signal and n LFM signal.
Run the MATLAB scripts *Spec_SIN_FM.m* and *Spec_LFM.m* to reproduce the results. The STFT of a time-domain signal can be computed by accessing the functionalities of the TFSAP Toolbox[3] either by using the Toolbox GUI model or by using the MATLAB command window (see Section 17.4.5 of the Readme document for the SM of Chapter 17). For more details, see help for the STFT by typing `help stft` in the MATLAB command window after adding the toolbox to the MATLAB path.

6. Related Supplementary Material in Chapters 2.1.3 and 2.1.4:
Formulations of the Wigner and the Wigner-Ville distributions are presented in Chapters 2.1.3 and 2.1.4 and illustrated in Figs. 2.1.1 and 2.1.2 on pages 68 and 69 of the book. Run the MATLAB scripts *WVD_lfm_signal.m* and *WD_and_WVD.m* to reproduce the results.

7. Related Supplementary Material in Chapter 17.3.5:
Quadratic Time-Frequency distributions, e.g. the WVD and the Spectrogram, of a time-domain signal can be computed and plotted by accessing the functionalities of the TFSAP Toolbox either by using the GUI model or by using the MATLAB command window (see Section 17.3.5 of the Readme document for the SM of Chapter 17).

Acknowledgments:

This Supplementary Material was made possible by NPRP grant #6-885-2-364 from QNRF.

Last version Date: 30-May-2017.

Copyright: Boualem Boashash.

[3] TFSAP Toolbox can be found here.