Supplementary materials for TFSAP book Section 12.2: "Time-Frequency Signal Analysis and Classification Using Matching Pursuits"[1]

The additional material[2] in this file is provided by Prof Boashash to assist the reader to better understand and use Section 12.2 of the TFSAP book.

A. Supplementary Codes:

The MATLAB functions and scripts listed below are used to reproduce supporting figures for Section 12.5.

MATLAB Functions:

- *MatPur*: It decomposes the signal into a basis of atoms by using matching pursuit algorithm.
- *gabor_atom*: It creates a Gabor atom for given parameters (shift, frequency, scale, phase)

MATLAB Scripts:

main_MP_illustration

- Description: This script demonstrates the principle of matching pursuit as presented in Section 12.2.2.
- Process: It loads a real heart rate variability (HRV) signal from the TFSAP list of demo signals, and a dictionary, from the MATLAB data file *dictionary.mat*, to be used in computing the signal atoms. After that, it computes the time-frequency representations of the HRV using the standard Wigner-Ville distribution (WVD) and the sum of WVDs of each atom as described in Eq. (12.2.8).
- Note: TFSAP Toolbox[3] (or later version) should be installed.

B. Additional Related Supplementary Materials from Other Chapters:

The reader may also benefit from accessing the code and/or other supplementary materials (SM) from the following related Chapters of the book: 4.11.5, 7.6, 16.3, 2.3.1, 2.1.3, 2.1.4, 17.3.3 and 17.3.5 as detailed below.

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[1] B. Boashash, Ed., "Time-Frequency Signal Analysis and Classification Using Matching Pursuits", Supplementary material for Chapter 12.2; in B. Boashash (ed.), *Time-Frequency Signal Analysis and Processing*, 2nd Edition (London: Elsevier / Academic Press, pages 701-708, December 2015); ISBN 978-0-12-398499-9.

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

[3] TFSAP Toolbox can be found here.

1. **Related Supplementary Material in Chapters 4.11.5 and 7.6:**

Matching Pursuit (MP) is utilized to adaptively improve the spectrogram resolution, as detailed in Chapter 4.11.5, and to reduce the computational burdens associated with Compressive Sensing (CS) techniques, as discussed in Chapter 7.6. Fig. 4.11.5, on page 223 of the book, illustrates the results obtained when using the adaptive spectrogram on a Linear Frequency Modulated (LFM) signal. To reproduce the results, run the MATLAB script *TFSAP_SUP_MAT_CHAP_4_11_ASpec_and_GabSepc.m*, provided in the SM of Chapter 4.11.

Furthermore, Figs. 7.6.2 and 7.6.3, on pages 429 and 430 of the book, illustrate the compressed samples of the spectrogram for different test signals. Run the MATLAB scripts *TFSAP_SUP_MAT_CHAP_7_6_figure_2.m* and *TFSAP_SUP_MAT_CHAP_7_6_figure_3.m*, provided in the SM of Chapter 7.6, to produce the results.

2. **Related Supplementary Material in Chapter 16.3:**

Nonstationary signal classification with an illustration on detecting newborn EEG burst-suppression patterns, using time-frequency features, is discussed in Chapter 16.3.

Run the MATLAB script *Call_functions_script.m* to see the performance analysis of the utilized features, extracted from different TFDs, using the ROC method, as illustrated in Table 16.3.1 on page 935 of the book.

3. **Related Supplementary Material in Chapter 2.3.1:**

For more information on the short time Fourier transform (STFT) and the spectrogram (squared magnitude of the STFT), 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 a linear frequency modulated (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 either by using the Toolbox GUI model or by using the MATLAB command window (see Section 17.4.5 of the guide for the Chapter 17 SM). 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.

4. **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.

5. **Related Supplementary Material in Chapter 17.3.3:**

Simulated and real time-domain signals can be generated by accessing the TFSAP Toolbox functions either by using the GUI model or by using the MATLAB command window (see section 17.3.3 of the guide for the SM of Chapter 17).

6. 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 guide for the SM of Chapter 17).

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