Supplementary material for TFSAP book Section 13.1: "Time-Frequency Interference Mitigation in Spread Spectrum Communication Systems"[1]

The additional material[2] in this file is provided by Prof Boashash to assist the reader to better understand Section 13.1 of the TFSAP book.

A. Supplementary Codes:

The MATLAB functions and scripts listed below can be used to reproduce supporting figures for Section 13.1.

MATLAB Functions:

- *mySTFT*: It computes the short-time Fourier transform (STFT) of an input signal.
- *myISTFT*: It computes the inverse short-time Fourier transform (ISTFT) of an input STFT. Note that this function is provided as a protected MATLAB file (.p). Thus, it cannot be edited, but can only be used by the reader.

MATLAB Scripts:

SM_Sec_13_1

- Description: This script produces a similar example to the one depicted in Fig. 13.1.3, on page 752 of the book.
- Process: It creates binary sequence data and performs BPSK and CDMA modulations. Then, it adds a jamming signal and white Gaussian noise to the modulated signal simulating a realistic jammed signal. After that, it computes the STFT of the received signal, using *mySTFT*, computes the filter response, and applies it on the received signal. Finally, it computes the temporal representation, using *myISTFT*, performs CDMA and BPSK demodulations, and plots the output SINR *vs.* input SINR.
- Note: This script is only an example to understand the principles presented in this section. In addition, this script produces plots of BER *vs.* SNR and output SINR *vs.* SNR.

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: 11.3, 11.5, 11.6, 17.4.3, 1.3.1, 10.7, 10.3, 10.6, 17.3.4, 17.4.1.2 and 17.3.5, as detailed below.

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[1] B. Boashash, Ed., "Time-Frequency Interference Mitigation in Spread Spectrum Communication Systems", Supplementary material for Chapter 13.1; in B. Boashash (ed.), *Time-Frequency Signal Analysis and Processing*, 2nd Edition (London: Elsevier/Academic Press, pages 748-753, December 2015); ISBN 978-0-12-398499-9.

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

1. Related Supplementary Material in Chapters 11.3, 11.5 and 11.6:

Different time-frequency *(t, f)* filtering methods are discussed in Chapters 11.3, 11.5, and 11.6. In Chapter 11.3, a time-varying filter is designed for an application involving hands-free telephone speech signals. Figs. 11.3.1 and 11.3.2, on page 661 of the book, illustrate the *(t, f)* representation of noisy and denoised signals after the filtering operation. Run the MATLAB script *speech_time_varying_filtering.m*, provided in the SM of Chapter 11.3, to produce the results.

In addition, Subspace noise filtering using *(t, f)* distributions (TFDs) is discussed in Chapter 11.5. Run the MATLAB script *Sec_11_5_Figures1_to_5.m*, provided in the SM of Chapter 11.5, to produce results that are close to the ones depicted in Figs. 11.5.1-11.5.5, on pages 671 and 673-675 of the book.

Moreover, two *(t, f)* denoising algorithms for speech enhancement are discussed in Chapter 11.6. Run the MATLAB script *Test_algorithms.m* to generate results that are similar to those, depicted in Figs. 11.6.2 and 11.6.3, on pages 686-687 of the book.

2. Related Supplementary Material in Chapter 17.4.3:

Time-frequency filtering techniques, using the TFSAP toolbox[3], are discussed in Chapter 17.4.3. Noise suppression using the Wigner-Ville Distribution (WVD) and STFT are explained in Chapters 17.4.3.1 and 17.4.3.2 respectively (see the SM of Chapter 17).

3. Related Supplementary Material in Chapters 1.3.1 and 10.7:

The instantaneous frequency (IF) is initially introduced and defined in Chapter 1.3.1. Run the MATLAB script *gaussch.m*, provided in the SM of Chapter 1, to produce Fig. 1.3.2 on page 54 of the book, which shows the IF estimation of a linear frequency modulated (LFM) signal.

Furthermore, an IF estimation technique using linear *(t, f)* representations is discussed in Chapter 10.7. Run the MATLAB script *Fig2_making.m* to produce Fig. 10.7.2 on page 626 of the book, which illustrates the results of estimating the IF for a Non-polynomial phase signal.

4. Related Supplementary Material in Chapters 10.3 and 10.6:

Estimating the IF of multicomponent signals using peaks of the TFDs, is discussed in Chapter 10.3. Run the MATLAB script *freq_est_multicomponent.m* to produce results that are similar to those depicted in Figs. 10.3.3 and 10.3.4 on pages 595-596 of the book. The script produces an IF estimate for a two-component signal by adaptively changing the window length of the computed modified B-distribution (MBD).

Furthermore, multicomponent IF estimation using component extraction techniques is discussed in Chapter 10.6. Run the MATLAB scripts *Fig_10_6_4.m*, *Fig_10_6_7.m* and *TFSAP_SUP_MAT_CHAP_10_6_components_separation.m* to reproduce the results depicted in Figs. 10.6.2, 10.6.4, 10.6.6 and 10.6.7 on pages 614 and 617-619 of the book.

5. Related Supplementary Material in Chapters 17.3.4 and 17.4.1.2:

The IF of a time-domain signal can be estimated by accessing the functions of the TFSAP Toolbox either by using the GUI model or by using the MATLAB command window.

6. Related Supplementary Material in Chapter 17.3.5:

[3] TFSAP Toolbox can be found here.

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 SM of Chapter 17).

Acknowledgments:

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

Last version Date: 01-Jun-2017.

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