

# Supplementary Material for Chapter 10: “Instantaneous Frequency Estimation and Localization”<sup>1</sup>

Prof. Boualem Boashash, Editor.

The zip files contained in this directory contain the supplementary materials<sup>2</sup> (SM) for each Section of the Chapter separately. The user is advised to read the Read-me file for each Section to get a good overview of the contents of its SM. Below is a brief overview of the Chapter in the book. Part 2, next page is the actual inventory of the SM provided for this chapter.

## 1. Book Chapter SM Overview:

In many applications, a critical feature of a non-stationary signal is provided by its instantaneous frequency (IF), which accounts for the signal spectral variations as a function of time. This chapter presents methods and algorithms for the localization and estimation of the signal IF using time-frequency  $(t, f)$  based methods. The topics for which SM is available are described below.

In addition to filter-banks and zero-crossings, one approach uses an adaptive algorithm for IF estimation using the peak of suitable Time-Frequency Distributions (TFDs) with adaptive window length. To account for its major limitations related to accuracy, resolution, window dependence, and sensitivity, improvements were made by introducing iterative methodologies on the estimate provided by the first moment of the spectrogram (10.1: see page 2). Another approach uses an adaptive algorithm for IF estimation using the peak of suitable TFDs with adaptive window length (10.2: see page 2). This method was extended to the case of multicomponent signals using high-resolution TFDs such as the modified B-distribution (10.3: see page 2). When the signals considered have polynomial FM characteristics, both the peak of the polynomial WVD and higher-order ambiguity functions can be used as IF estimators (10.4: see page 2). Then, a comparison of multicomponent IF estimation algorithms is provided (10.6: see page 2), and methods for IF and polynomial phase parameters estimation using linear  $(t, f)$  representations are presented (10.7: see page 2).

---

<sup>1</sup> B. Boashash (ed.), Time-Frequency Signal Analysis and Processing, 2nd Edition (London: Elsevier / Academic Press, December 2015); ISBN 978-0-12-398499-9.

<sup>2</sup> All of the book supplementary materials can be found [here](#).

## 2. Book Chapter SM Main Script Inventory:

Supplementary material	Brief Description
<i>Section 10.1: Iterative Instantaneous Frequency Estimation for Random Signals</i>	
<i>full_analysis.m</i>	This script provides results of full error analysis for three IF estimators, to be used in <i>main.m</i> .
<i>main.m</i>	This script estimates the IF of different signals, using different techniques, and presents full error analysis with respect to different noise levels
<i>Section 10.2: Adaptive Instantaneous Frequency Estimation Using TFDs</i>	
<i>Fig_10_2_1.m</i>	This script reproduces the results that are depicted in Fig. 10.2.1 on page 585 of the book.
<i>Fig_10_2_2.m</i>	This script reproduces the results that are depicted in Fig. 10.2.2 on page 587 of the book.
<i>Section 10.3: IF Estimation for Multicomponent Signals</i>	
<i>Fig_10_3_1.m</i>	This script reproduces the results which are depicted in Fig. 10.3.1 on page 589 of the book.
<i>Fig_10_3_2.m</i>	This script produces results that are similar to those depicted in Fig. 10.3.2 on page 590 of the book.
<i>freq_est_general_multicomponent.m</i>	This script produces results that are similar to those depicted in Figs. 10.3.3 and 10.3.4 on pages 595 and 596 of the book.
<i>freq_est_multicomponent.m</i>	This script produces results that are similar to those depicted in Figs. 10.3.3 and 10.3.4 on pages 595 and 596 of the book.
<i>Section 10.4: Parameter Estimation for Polynomial FM Signals in Additive Gaussian Noise</i>	
<i>Fig_10_4_1.m</i>	This script is the implementation of Fig.10.4.1 on page 598 of the book.
<i>Section 10.6: Component Extraction from TFDs for Multicomponent Signal IF Estimation</i>	
<i>Fig_10_6_4.m</i>	This script reproduces the results that are depicted in Fig. 10.6.4 on page 617 of the book.
<i>Fig_10_6_7.m</i>	This script reproduces the results that are depicted in Fig. 10.6.7 on page 619 of the book.
<i>TFSAP_SUP_MAT_CHAP_10_6_components_separation.m</i>	This script produces the results that are depicted in Figs. 10.6.2, 10.6.5 and 10.6.6, on pages 614 and 618 of the book.
<i>Section 10.7: Instantaneous Frequency and Polynomial Phase Parameter Estimation Using Linear Time-Frequency Representations</i>	
<i>Slika_5_6_red.m</i>	This script reproduces the results that are depicted in Fig.10.7.1 on page 625 of the book.
<i>Fig2_making.m</i>	This script produces the results that are depicted in Fig.10.7.2 on page 626 of the book.

**Copyright: Boualem Boashash.**