



INSTITUTO DE INVESTIGACIÓN
TECNOLÓGICA

Documentation

Short-Time Fourier Transform with the Window Size Fixed in the Frequency Domain (STFT-FD)

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Prepared by IIT

October, 16th 2017

Version: 1.4

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CONTENTS

1.	INTRODUCTION	1
2.	CODE VERSION	1
3.	FUNCTIONS	2
3.1	DIAGRAM	2
3.2	COMPUTING THE TRANSFORM	3
3.3	INTERFACES	4
3.3.1	<i>Function test_all_examples</i>	4
3.3.2	<i>Function synthetic_signal</i>	4
3.3.3	<i>Function chirp2_signal</i>	4
3.3.4	<i>Function ecg_signal</i>	5
3.3.5	<i>Function analyze_stft_fd</i>	5
3.3.6	<i>Function plot_signal</i>	6
3.3.7	<i>Function STFT_FD1</i>	6
3.3.8	<i>Function STFT_FD2</i>	7
3.3.9	<i>Function plot_stft_fd</i>	8
3.3.10	<i>Function get_colormap</i>	8
4.	REFERENCES	9

1. Introduction

The Short-Time Fourier Transform (STFT) can be used to convert signals whose frequency content changes over time into the time-frequency domain.

This document describes a software package to compute a Short Time Fourier Transform with the Window Size Fixed in The Frequency Domain (STFT-FD). The proposed transform is published in [1,2].

2. Code version

Table 1 – Code metadata (mandatory)

Nr	Code metadata description	
C1	Current code version	V1.4
C2	Permanent link to code/repository used of this code version	Code attached. Pending to upload and release upon acceptance.
C3	Legal Code License	GNU General Public License, version 3.0 (GPL-3.0)
C4	Code versioning system used	None
C5	Software code languages, tools, and services used	Matlab R1012a or higher
C6	Compilation requirements, operating environments & dependencies	<p>Communication toolbox is optionally required to add Gaussian noise to the synthetic signal.</p> <p>File ecg.txt containing an electrocardiogram signal has to be downloaded from http://eleceng.dit.ie/dorran/matlab/ecg.txt in order to test that case study.</p> <p>In any case, there are additional self-generating test case studies that can be directly analyzed using this software.</p>
C7	If available Link to developer documentation/manual	Documentation attached. Pending to upload and link upon acceptance.
C8	Support email for questions	cmateo@comillas.edu

3. Functions

3.1 Diagram

The functions included in the software package are presented in Fig. 1, showing the relations among the functions. The main function is *test_all_examples*, which analyzes a synthetic signal (generated in the *synthetic_signal* function), a two linear chirp signal (generated in the *chirp2_signal* function) and an electro-cardiogram signal (loaded in the *ecg_signal* function). The three signals are presented and analyzed in [1,2]. The signals can be analyzed with the proposed STFT-FD transform, using the *analyze_stft_fd* function. The transform is computed using two variant implementations, *STFT_FD1*, which is based on the use of the Fast Fourier Transform, and *STFT_FD2*, which directly computes the equation of the proposed transform, as explained in [1,2]. The signals are represented in the time domain using the *plot_signal* function, and in the time-frequency domain using the *plot_stft_fd* function (which calls to the *get_colormap* function). The computation time required to compute the transform with the two approaches is also displayed.

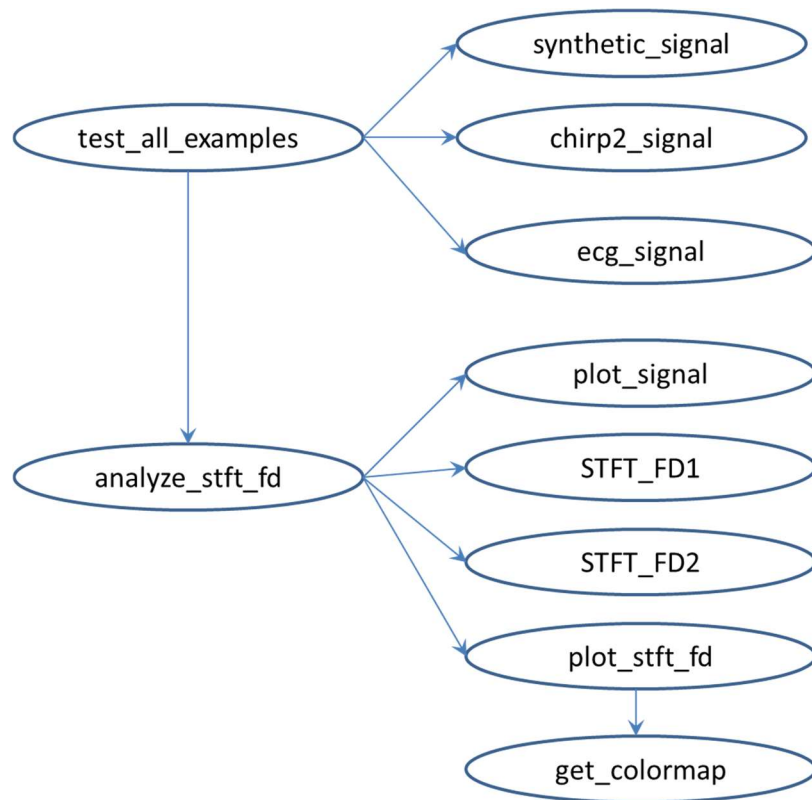


Fig. 1. Functions included in the software package

3.2 Computing the transform

The flow chart of the functions used to compute the transform (*STFT_FD1* & *STFT_FD2*) is shown in Fig. 2.

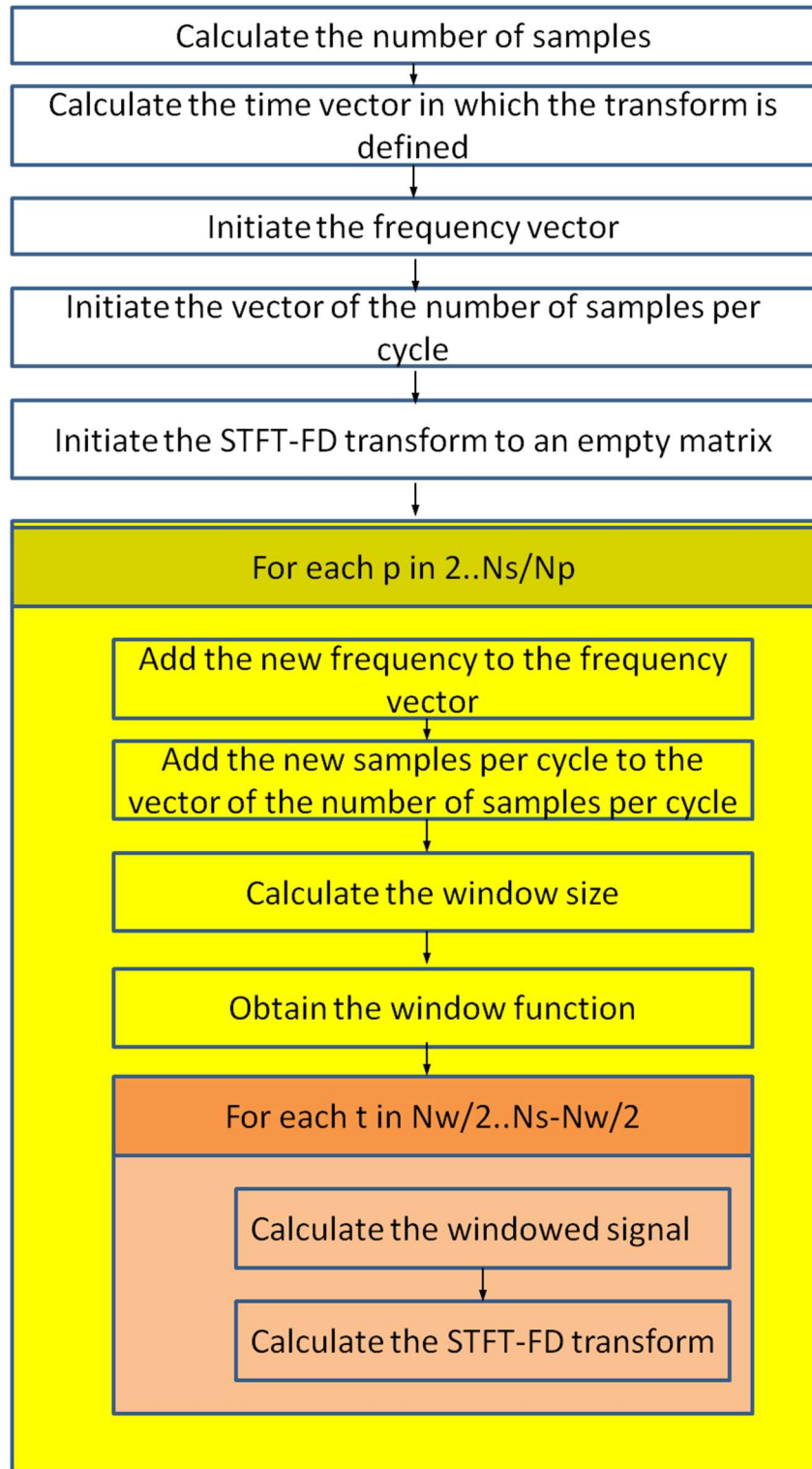


Fig. 1. Flow chart of functions *STFT_FD1* and *STFT_FD2*

3.3 Interfaces

A brief description of all the functions together with a definition of their interfaces (i.e. the input arguments and their outputs) is presented in this section.

3.3.1 Function *test_all_examples*

Description:

It tests all the examples using the STFT-FD transform:

- Synthetic signal.
- Chirp signal.
- ECG signal.

3.3.2 Function *synthetic_signal*

Description:

It builds a synthetic signal, comprised of a long sinusoid, a short-time sinusoid, and an impulse. Gaussian noise is added to the signal if the Communication toolbox is available.

Outputs:

x: Synthetic signal
Ts: Sampling period

3.3.3 Function *chirp2_signal*

Description:

It builds a two linear chirp signal

Outputs:

x: Two linear chirp signal
Ts: Sampling period

3.3.4 Function *ecg_signal*

Description:

It loads an electrocardiogram (ECG) signal. The ECG test signal has to be downloaded from <http://eleceng.dit.ie/dorran/matlab/ecg.txt> and saved in the same folder than this function, so that it can be loaded.

Input arguments:

filename: Name of the ECG signal file

Outputs:

x: ECG signal

Ts: Sampling period

3.3.5 Function *analyze_stft_fd*

It calculates and plots the Short Time Fourier Transform with the Window Size Fixed in the Frequency Domain (STFT-FD)

Input arguments

x: Signal

Ts: Sampling period

signal_label: Signal label indicating the name of the signal

method: 'STFT-FD1' (using FFT) or 'STFT-FD2' (with STFT-FD formula)

NC: Number of cycles within the window function

b_display_signal: Boolean value indicating whether the signal in the time domain has to be plotted

3.3.6 Function *plot_signal*

Description:

It plots the signal in the time domain

Input arguments

t: time vector

x: Signal

signal_label: Signal label indicating the name of the signal

3.3.7 Function *STFT_FD1*

Description:

Short Time Fourier Transform with the Window Size Fixed in the Frequency Domain.
Solution based on the FFT

Input arguments:

v_t: Time vector

x: Signal

Ts: Sampling period

NC: Number of cycles within the window function

Outputs

v_time: Time vector

v_freq: Frequency vector

stft_fd: Short Timer Fourier Transform with the Window Size Fixed in The
Frequency Domain

elapsed_time: Elapsed CPU time

3.3.8 Function *STFT_FD2*

Description:

Short Time Fourier Transform with the Window Size Fixed in the Frequency Domain. Solution based on the STFT-FD formula.

Input arguments:

v_t: Time vector

x: Signal

Ts: Sampling period

NC: Number of cycles within the window function

Outputs

v_time: Time vector

v_freq: Frequency vector

stft_fd: Short Time Fourier Transform with the Window Size Fixed in The Frequency Domain

elapsed_time: Elapsed CPU time

3.3.9 Function *plot_stft_fd*

Description:

It plots the STFT-FD transform in the time-frequency domain

Input arguments

v_time: Time vector

v_freq: Frequency vector

stft_fd: Short Timer Fourier Transform with the Window Size Fixed in The Frequency Domain

NC: Number of cycles within the window function

signal_label: Signal label

method: 'STFT-FD1' (using FFT) or 'STFT-FD2' (with STFT-FD formula)

3.3.10 Function *get_colormap*

Description:

It builds and returns a colormap

Output arguments

cm: Custom colormap based on default copper colormap

4. References

- [1] C. Mateo, J.A. Talavera, Short Time Fourier Transform with the Window Size Fixed in the Frequency Domain (this issue), Digit. Signal Process. (2017).
- [2] C. Mateo, J.A. Talavera, Short Time Fourier Transform with the Window Size Fixed in the Frequency Domain: Implementation (this issue), SoftwareX. (2017).



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