Report

Project Part 2

Spectrum Analyzer

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Contents

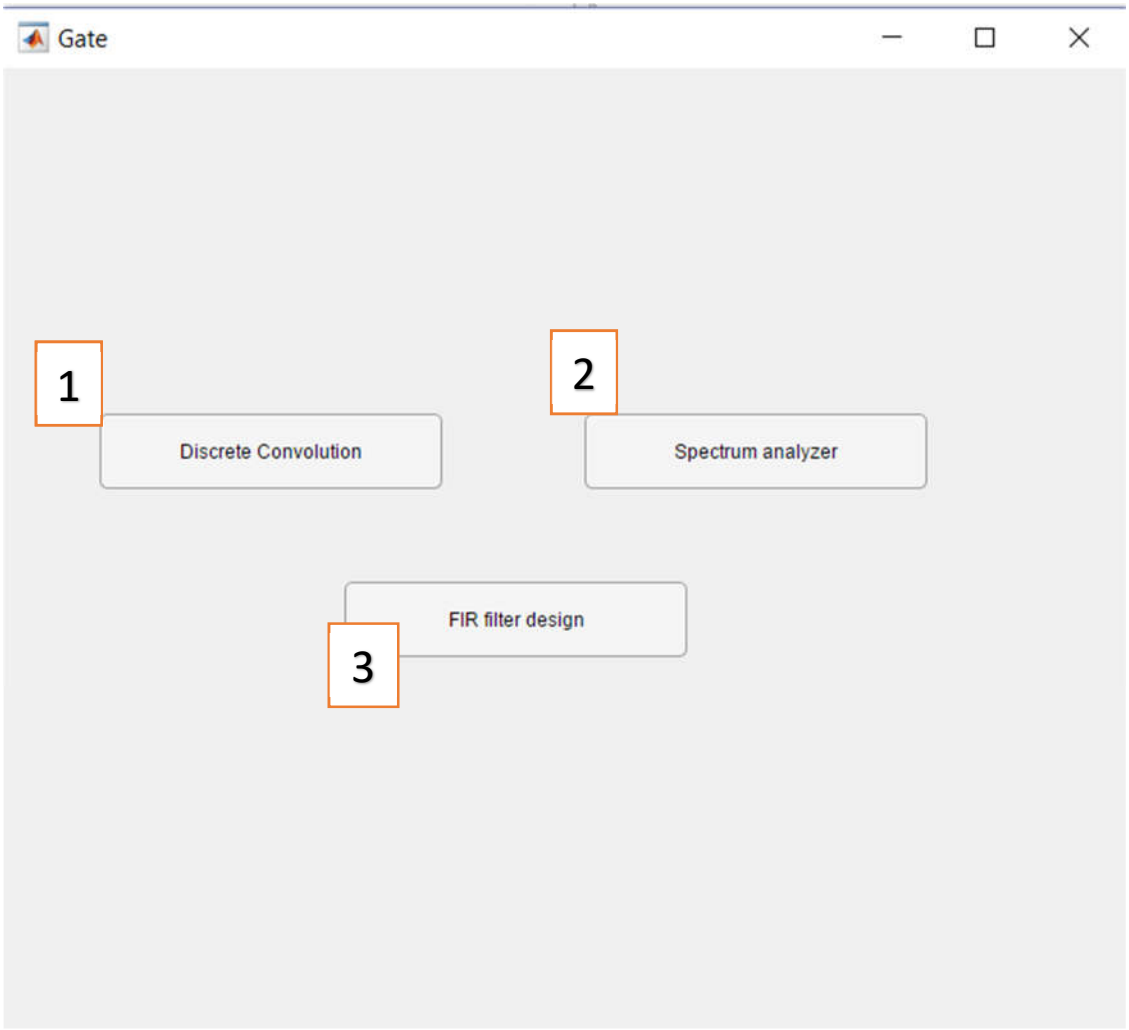
Introduction

Spectrum Analyzer v0.1 is signal processing software based on MATLAB. It does support very necessary features for signal processing

Supported Features:

- Time and Frequency domain analysis.
- Discrete time convolution.
- Windowing effect.
- Comparison mode.
- Calculation mode. (Part 2)
- RMS averaging. (Part 2)
- Peak finding. (Part 2)
- Bias finding. (Part 2)
- Different display options. (Part 2)
- Markers. (Part 2)
- Frequency band choices. (Part 2)
- Different input options. (Part 2)
- FIR filter design using least square method. (Part 2)

Starting Window



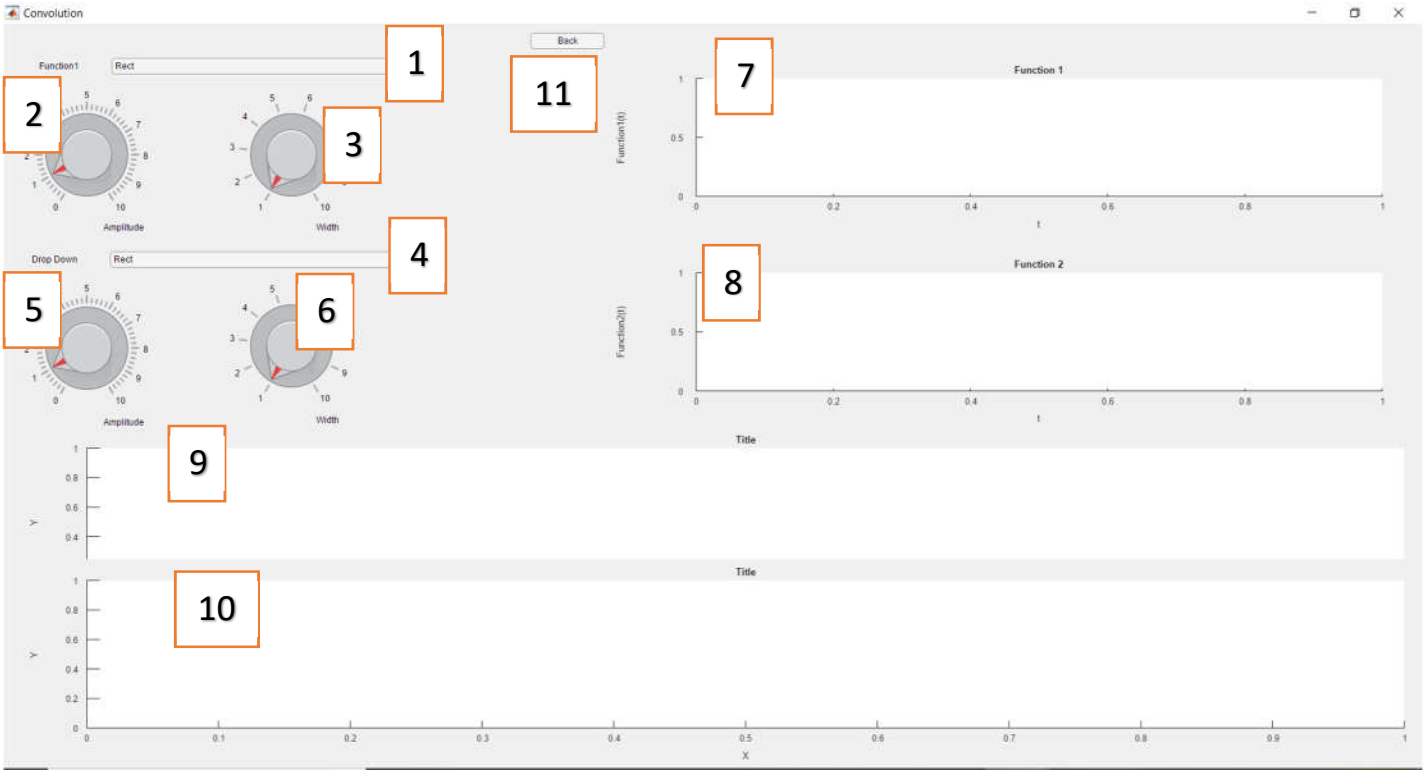
This Window allows the user to navigate through the two main windows of the Software

1- this button leads to Discrete Convolution window

2- this button leads to Spectrum analyzer window

3- this button leads to Filter Design window

Discrete Convolution Window



1- First function selection drop menu
2- First function amplitude control knop
3- First function Width control knop
4- Second function selection drop menu
5- Second function amplitude control knop
6- Second function Width control knop
7- First function graph representation
8- Second function graph representation
9- Convolution graph representation
10- Animated Convolution graph representation
11- Back button: takes you back to the opening window

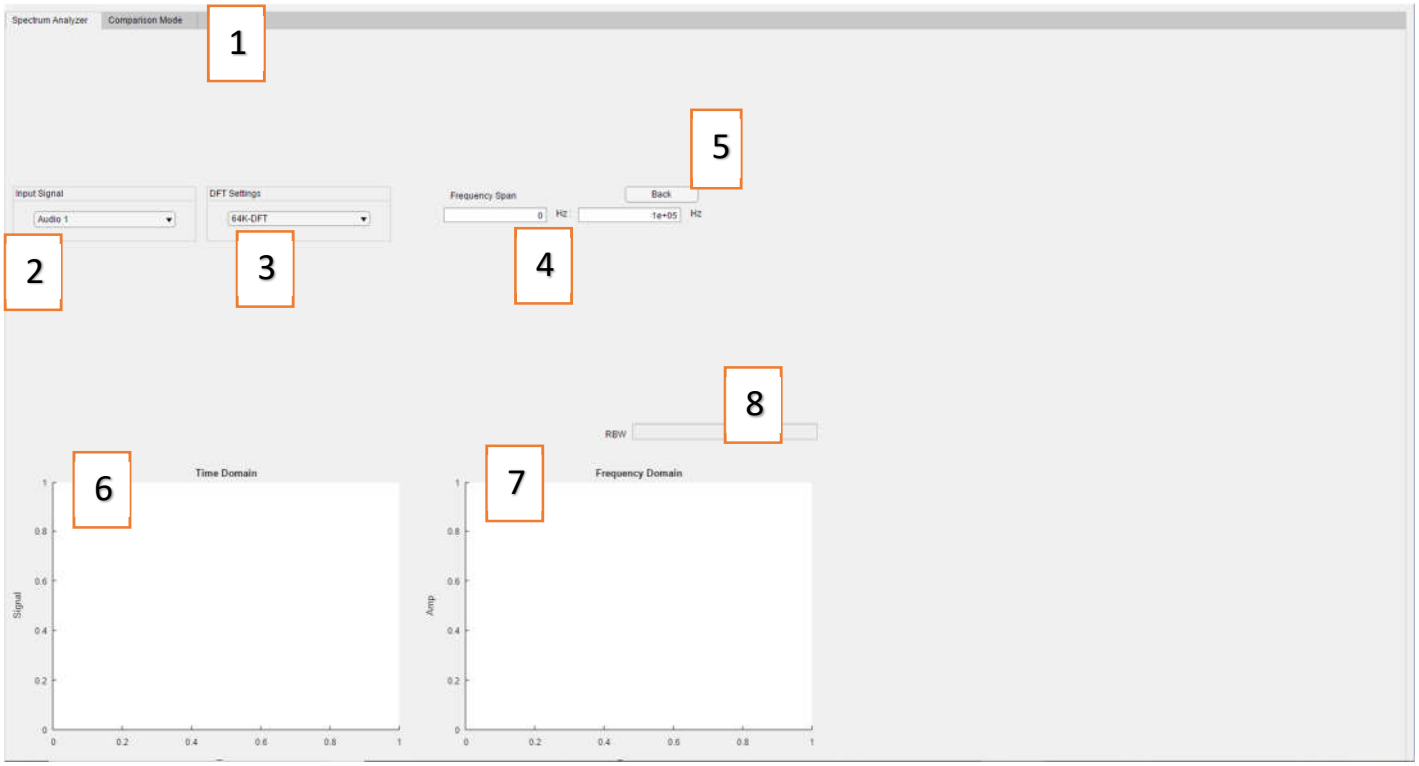
Scale selection was implemented

$$(f * g)[n] = \sum_{m=-\infty}^{\infty} f[m]g[n-m]$$
$$= \sum_{m=-\infty}^{\infty} f[n-m]g[m].$$

Spectrum Analyzer Window

This window has 2 tabs

Spectrum Analyzer tab



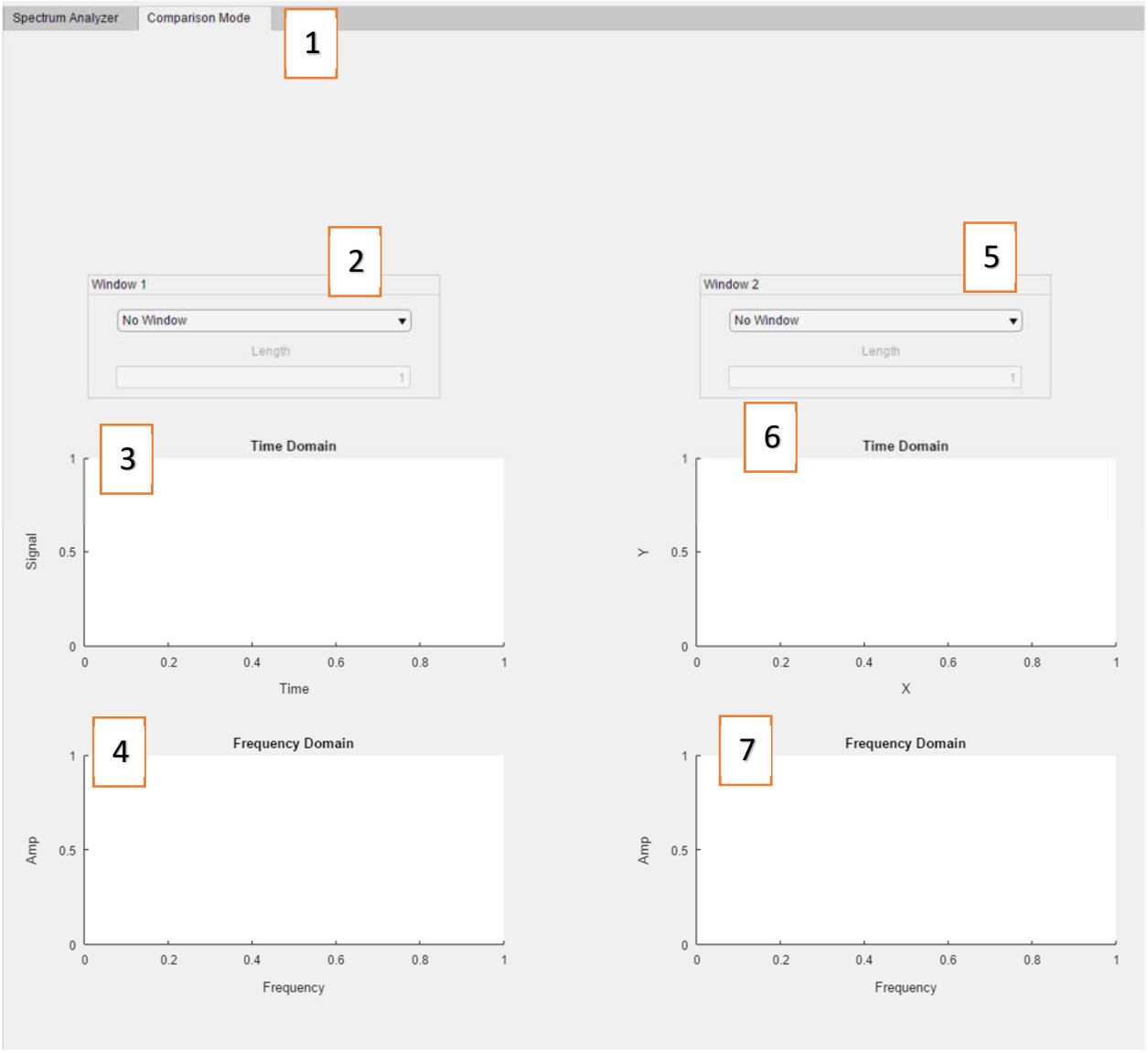
Scale selection was implemented

Calculation mode was implemented

1- Tab switch
2- Choosing the input signal
3- Choosing the desired DFT settings
4- Choosing the frequency span
5- Back button: takes you back to the opening window
6- Time domain graph representation of the input signal
7- Frequency domain graph representation of the input signal
8- RBW calculation (Resolution Bandwidth)

$$X_k = \sum_{n=0}^{N-1} x_n e^{-i 2\pi k n / N} \qquad k = 0, \ldots, N-1.$$

Comparison Mode tab

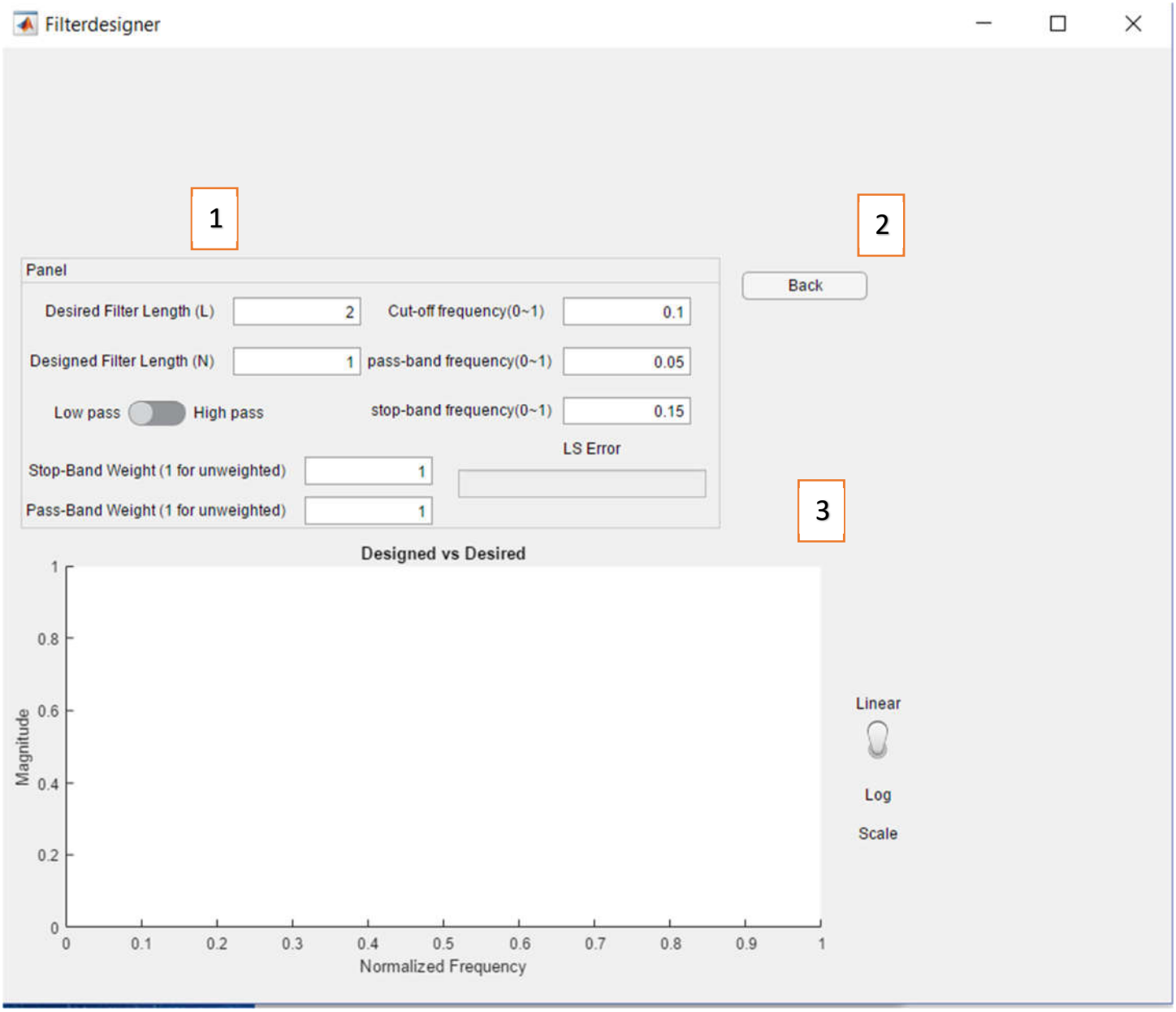


1- Tab switch
2- Window 1 selector: it allows user to select desired window and set its length with maximum value of signal length
3- Windowed Signal time domain graph representation
4- Windowed Signal frequency domain graph representation
5- Window 2 selector: it allows user to select desired window and set its length with maximum value of signal length

6- Windowed Signal time domain graph representation
7- Windowed Signal frequency domain graph representation
Scale selection was implemented
Note: this tab uses the same input signal entered in the spectrum analyzer tab. If the user tried this tab first without setting an input signal the controls will not respond.

$$X(n) = x(n)\,.\,w(n)$$
$$X(m) = x(m) * w(m)$$

Filter Design Window-



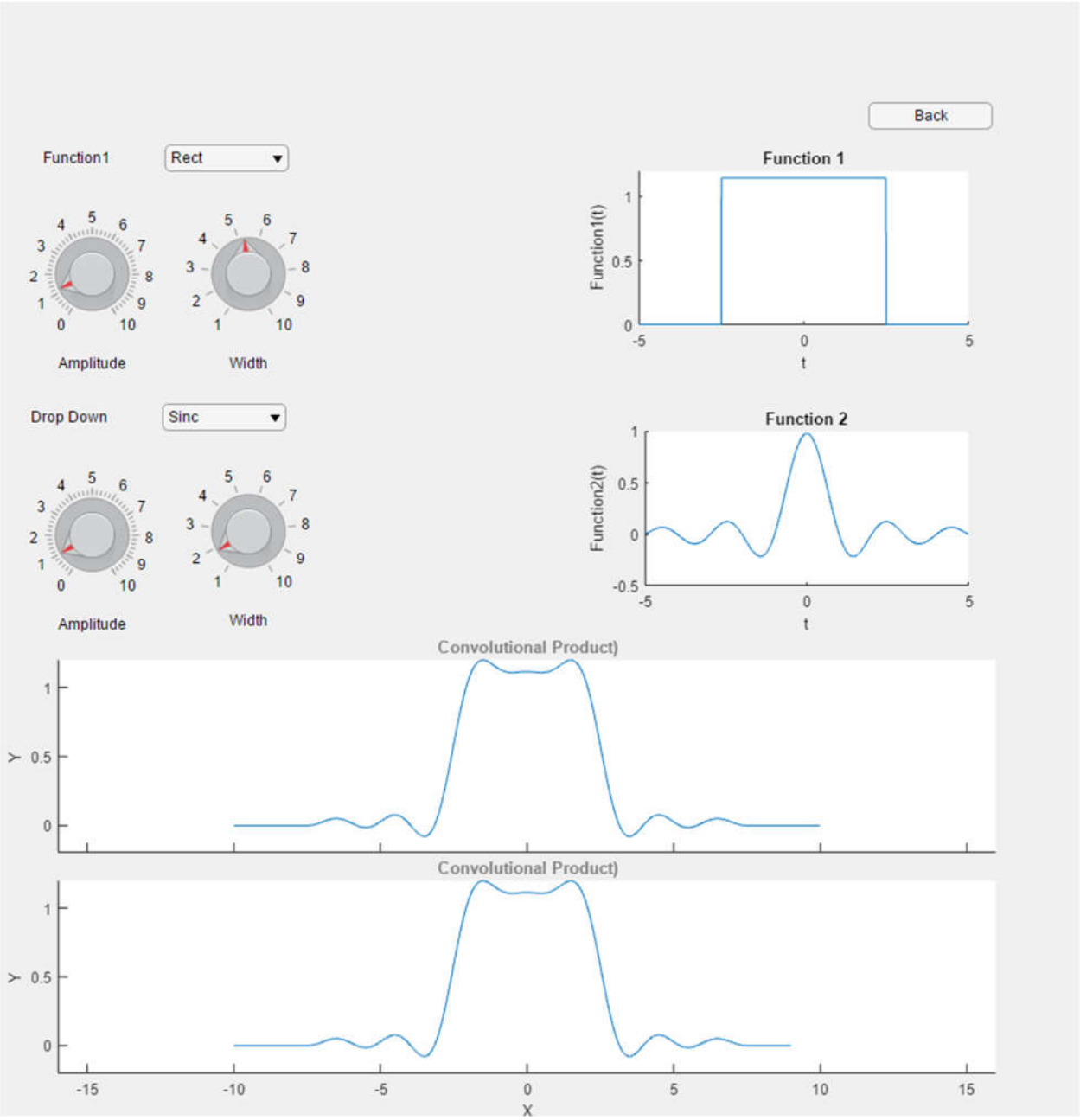
1- filter parameter settings

2- back button: takes you back to gate

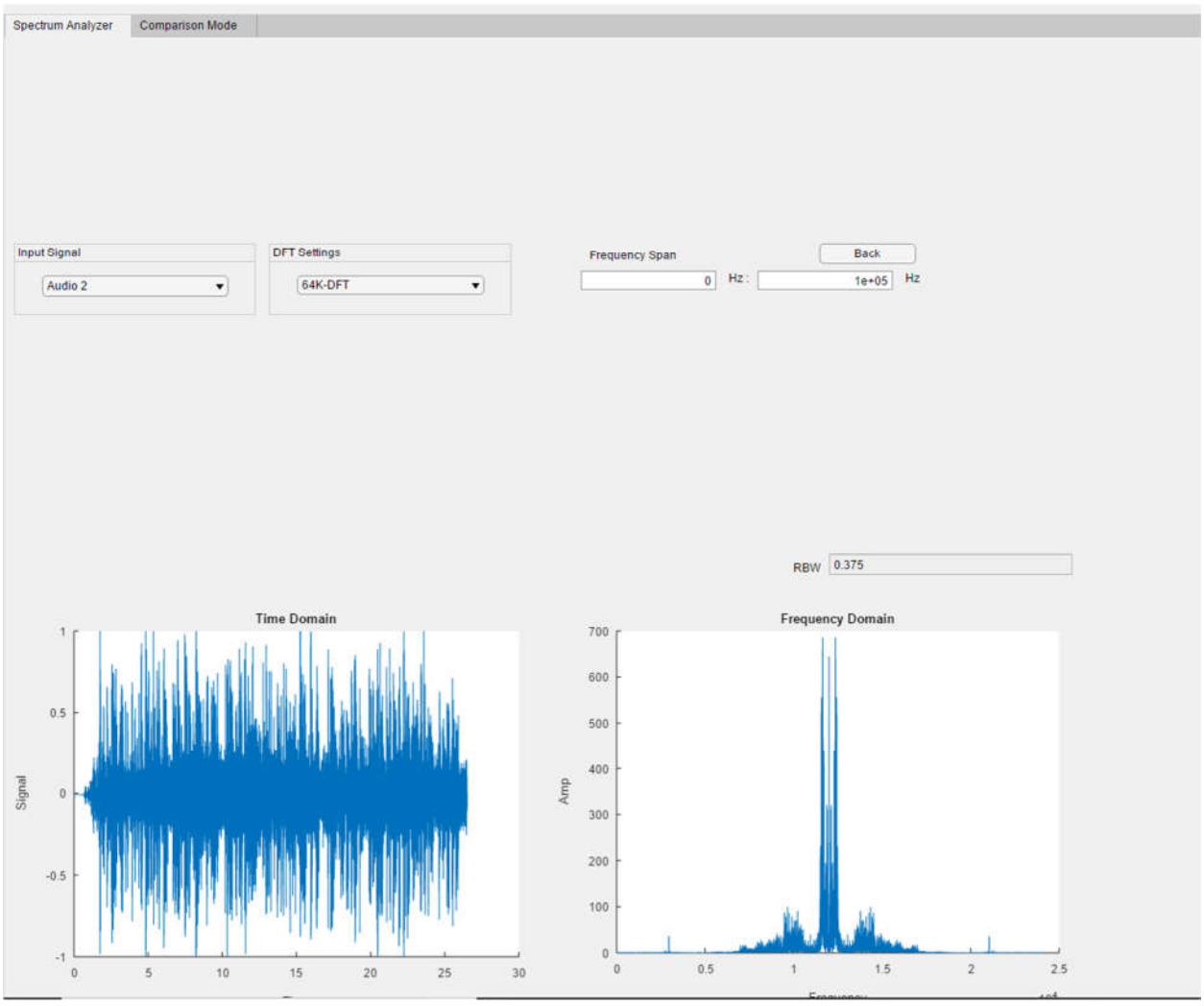
3- Designed filter vs Desired filter graph

Results, and Example

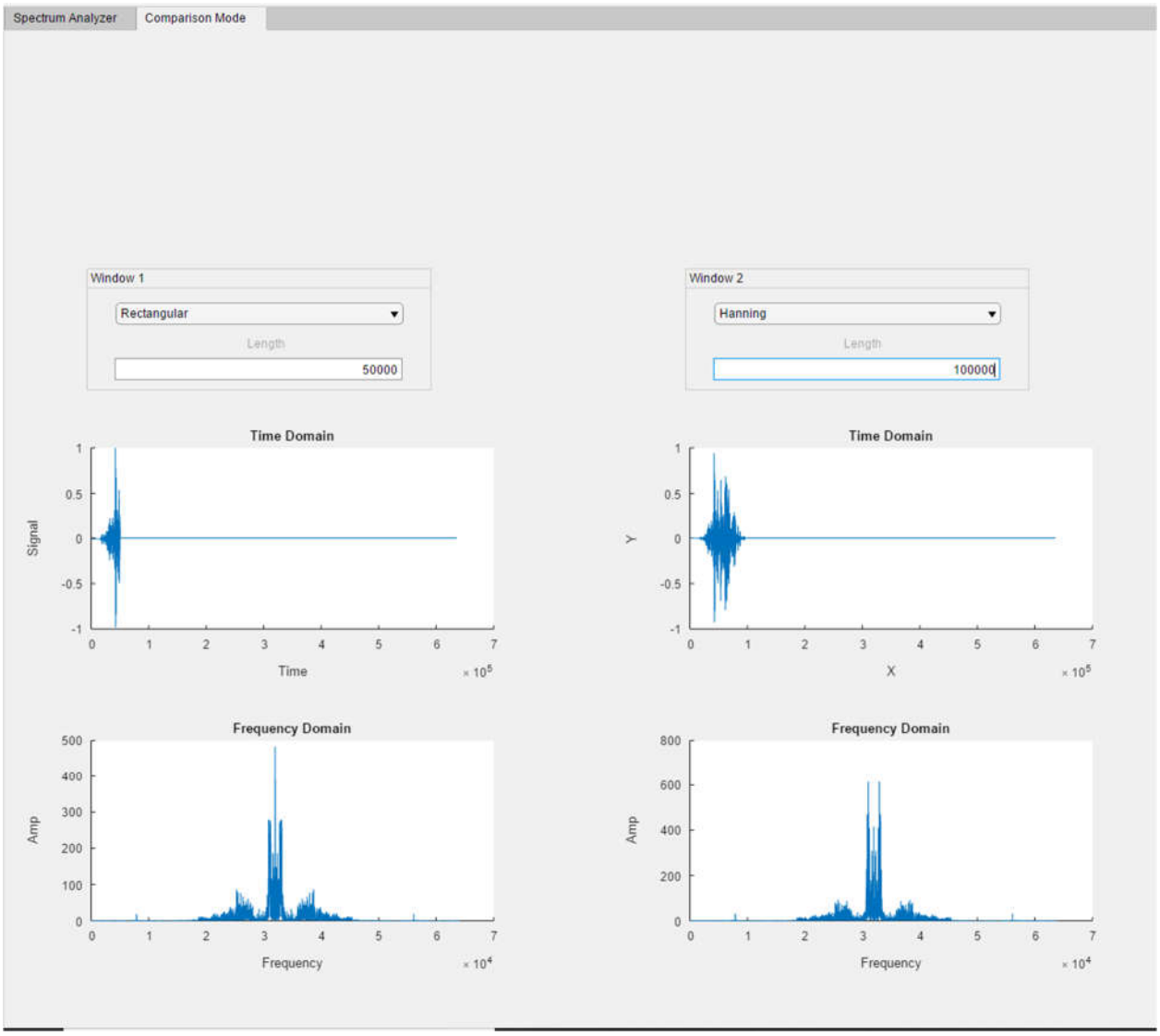
DFT convolution Example



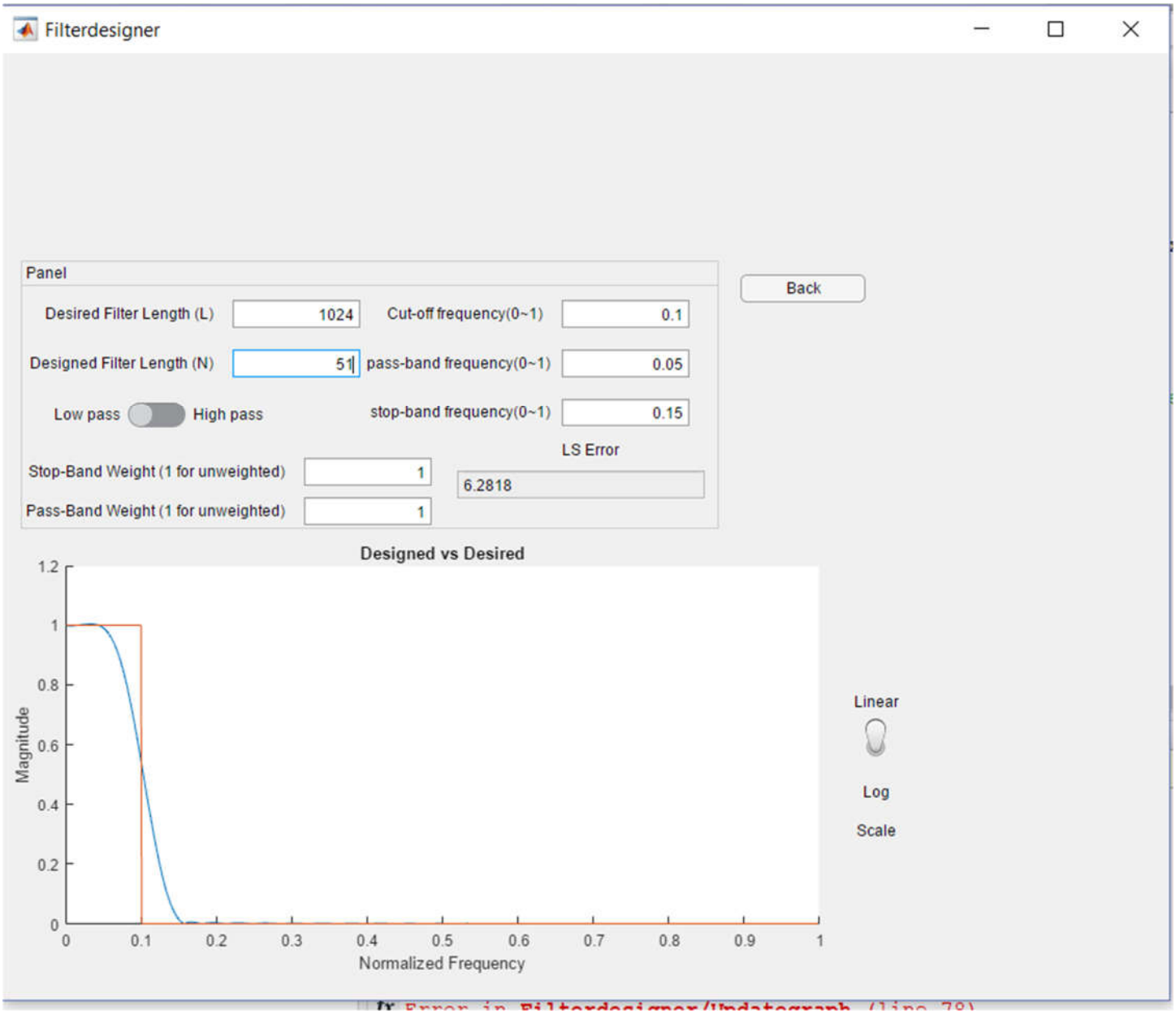
Spectrum Analyzer Example



Comparison Mode Example



Filter Design Example



References

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https://en.wikipedia.org/wiki/Fast_Fourier_transform

https://en.wikipedia.org/wiki/Window_function

https://www.mathworks.com/help/signal/ug/discrete-fourier-transform.html

http://eeweb.poly.edu/iselesni/EL713/firls/firls.pdf