

Hilbert Transform Manual (Ver. 1.0)

2023.7 AO Quest

Introduction

This software can calculate an instantaneous amplitude and an instantaneous phase by Hilbert transform for 1 dimensional signal waveform. The signal waveform's input is CSV format file. The result of Hilbert transform can be saved by CSV format file. In addition, this software can also display the lower side envelope.

Hilbert Transform

Hilbert transform comes true by processing a spectrum.

- * Set the negative frequencies to 0(zero)
- * Double the positive frequencies.

By the way, the swapped positive and negative relation as above will reach the same results for the instantaneous amplitude and the instantaneous frequency.

The source signal as $f(t)$, and the returned signal to the time domain as $\hat{f}(t)$, the instantaneous amplitude and the instantaneous phase can be calculated.

$$u = \text{Re}(\hat{f}): \text{Real part of } \hat{f}$$

$$v = \text{Im}(\hat{f}): \text{Imaginary part of } \hat{f}$$

$$\text{Instantaneous amplitude: } A = \sqrt{u^2 + v^2}$$

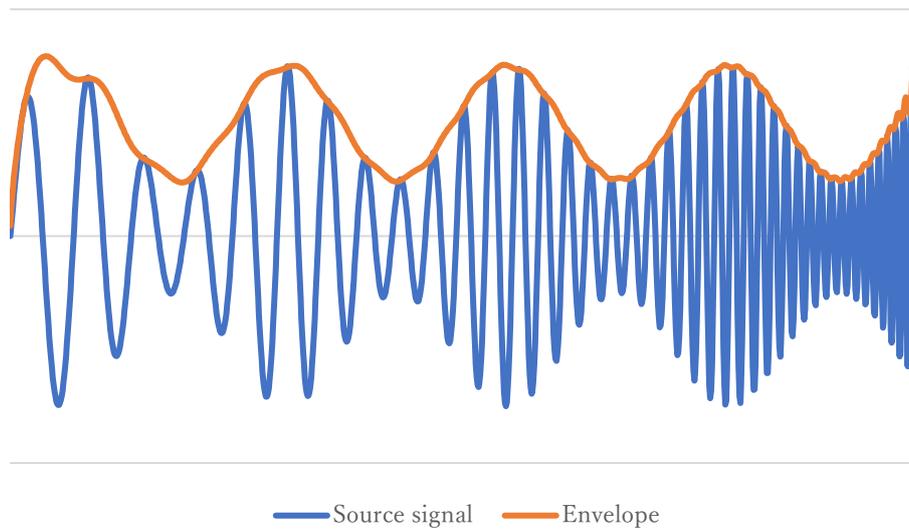
$$\text{Instantaneous phase: } \varphi = \tan^{-1} \frac{v}{u}$$

Now, the instantaneous frequency can be calculated by differentiating the instantaneous phase.

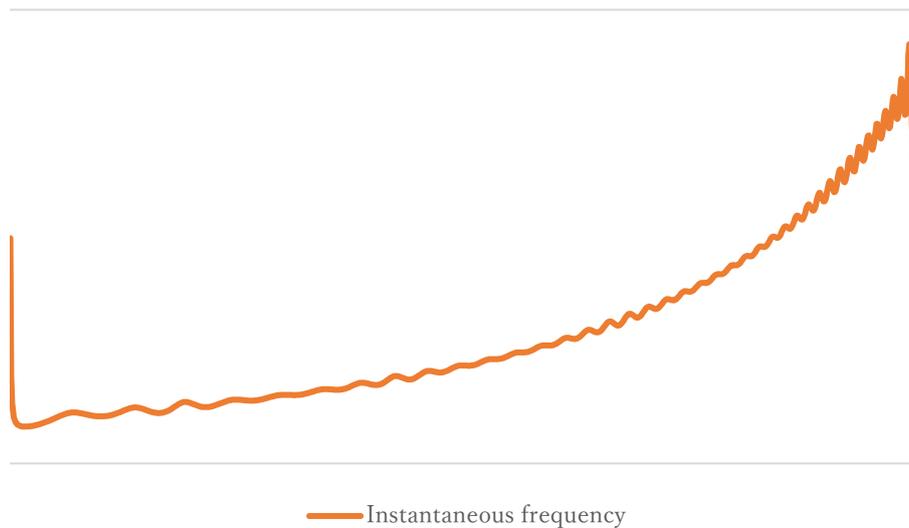
$$\text{Instantaneous frequency: } F = \frac{1}{2\pi} \frac{d}{dt} \varphi = \frac{1}{2\pi} \frac{\Delta\varphi}{\Delta t}$$

Δt : Sampling interval[s]

Take the time difference of the instantaneous phase φ in the discrete system, then divide by the sampling interval Δt . The source signal f 's instantaneous amplitude becomes an **envelope**, this is a general application.



The frequency change can be monitored by the instantaneous frequency.



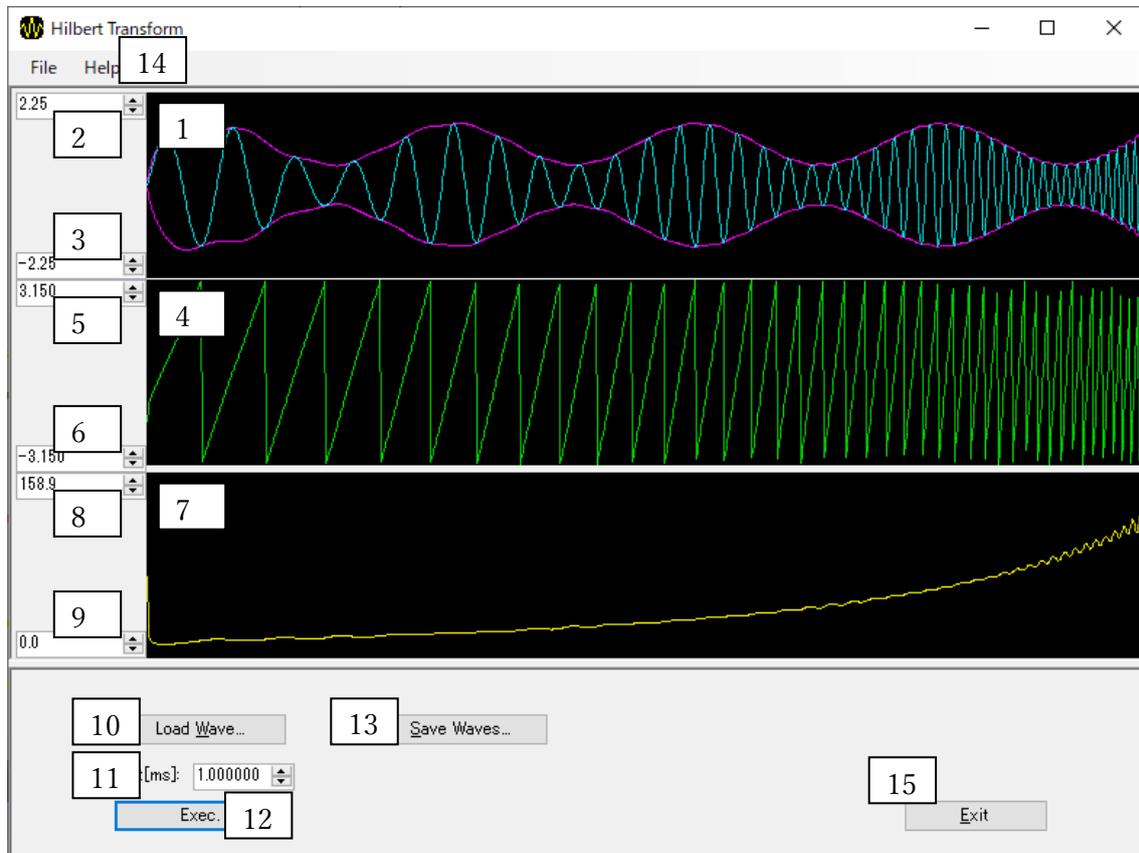
Operation Environment

- * Windows10 64bit, or later
- * . Net Framework4.8

Installation Method

There isn't installer. Copy the software-folder to any local directory, then execute the software(HilbertTransform.exe).

Software Function Description



1. Input Waveform and Envelope Waveform's Display Pane
This pane is for displaying the source signal waveform(cyan) and the envelope waveforms(magenta). Besides, to load the waveform's CSV file can be available by dragging and dropping.
2. Input Waveform and Envelope Waveform's Display Range(Upper Limit Threshold)
This is an upper limit threshold of the input waveform and the envelope waveforms. Adjust the display range.
3. Input Waveform and Envelope Waveform's Display Range(Lower Limit Threshold)
This is an lower limit threshold of the input waveform and the envelope waveforms. Adjust the display range.
4. Instantaneous Phase Waveform's Display Pane

This pane is for displaying the instantaneous phase waveform(green).

5. Instantaneous Phase Waveform's Display Range(Upper Limit Threshold)

This is an upper limit threshold of the instantaneous phase waveform. Adjust the display range.

6. Instantaneous Phase Waveform's Display Range(Lower Limit Threshold)

This is a lower limit threshold of the instantaneous phase waveform. Adjust the display range.

7. Instantaneous Frequency Waveform's Display Pane

This pane is for displaying the instantaneous frequency waveform(yellow).

8. Instantaneous Frequency Waveform's Display Range(Upper Limit Threshold)

This is an upper limit threshold of the instantaneous frequency waveform. Adjust the display range.

9. Instantaneous Frequency Waveform's Display Range(Lower Limit Threshold)

This is a lower limit threshold of the instantaneous frequency waveform. Adjust the display range.

10. Load Wave

Load the input waveform. The input file is CSV format. Besides, dragging and dropping CSV file to (1) can be available. CSV file must be 1 columns format.

f
0
0.084784
0.171179
0.258551
0.346237
0.433553

The data after the second column will be ignored. The data count must be above 16, and the row which have the data except digits will be skipped to read.

11. Δt [ms]

Enter the sampling interval in ms unit.

12. Exec.

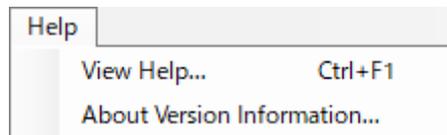
Execute Hilbert transform.

13. Save Waves

Save the input waveform, the envelope waveform, the instantaneous phase waveform, and the instantaneous frequency waveform as CSV format file.

f	envelope	neg-envelope	phase[rad]	frequency[Hz]
0	0.09214088	-0.081764939	-1.6836452	69.57050491
0.08478433	0.23353177	-0.223155828	-1.2465208	27.42283873
0.17117914	0.3375241	-0.327148162	-1.074218	18.69232263
0.25855069	0.4307375	-0.420361564	-0.9567707	16.10099659
0.34623706	0.51216944	-0.501793502	-0.8556052	14.24201366
0.43355309	0.58725153	-0.576875593	-0.76612	13.46808822

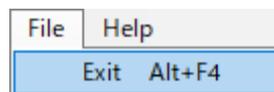
14. Help



View Help	Display Help (this document).
About Version Information	Display Version information.

15. Exit

Exit the software. This can be available from File Menu.



Terms of Service

This software is freeware. AO Quest does not take any responsibility for the damage caused by the software.

Inquiry

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