Spectrogram

Description

A spectrogram is a visual representation of the spectrum of a signal which shows the frequency components as they vary with time. MatDeck contains a function called spectrogram() which shows the results in a 3D graph.

Calculation

MatDeck's function, spectrogram() has the following arguments: input the signal as a vector for which the power spectral density is estimated, window function is determined by the string name of the window used, and number of samples used to generate the result which is also number of samples to perform fft() within each block in time. The last two arguments are: the block length in samples, and number of overlapping samples between consecutive blocks. These two arguments define the overall number of points within time to calculate the spectrum.

Example I

In the following, we illustrate how to use spectrogram() on several illustrative test signals. The first test signal is obtained by combining two cosine signals given by a normalized frequency. The frequency is abruptly changed from one value to another. The test signal is displayed in the following graph.

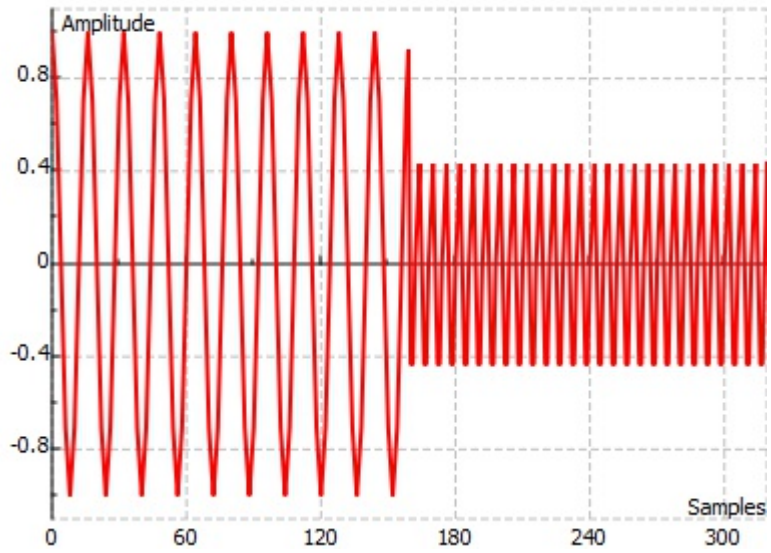
$n := \text{ynodes}(x1 , 0 , 319 , 320)$ Sample index vector

$x1 := \cos((\pi/8) \cdot n)$ Cosine signal

$x2 := 0.5 \sin((\pi/3) \cdot n)$ Noisy signal with two cosine/sine waves

$xs := \text{join mat rows}(\text{subset}(x1 , 0 , 0 , 159 , 0) , \text{subset}(x2 , 160 , 0 , 319 , 0))$

$g1 := \text{join mat cols}(n , xs)$ Graph of signal with noise



We prepare other arguments and we calculate the spectrogram of the test signal defined above. We plot the obtained spectrogram versus a normalized frequency, and time which means that the results are displayed using a 3D graph.

nfft := 512 Number of samples for periodogram

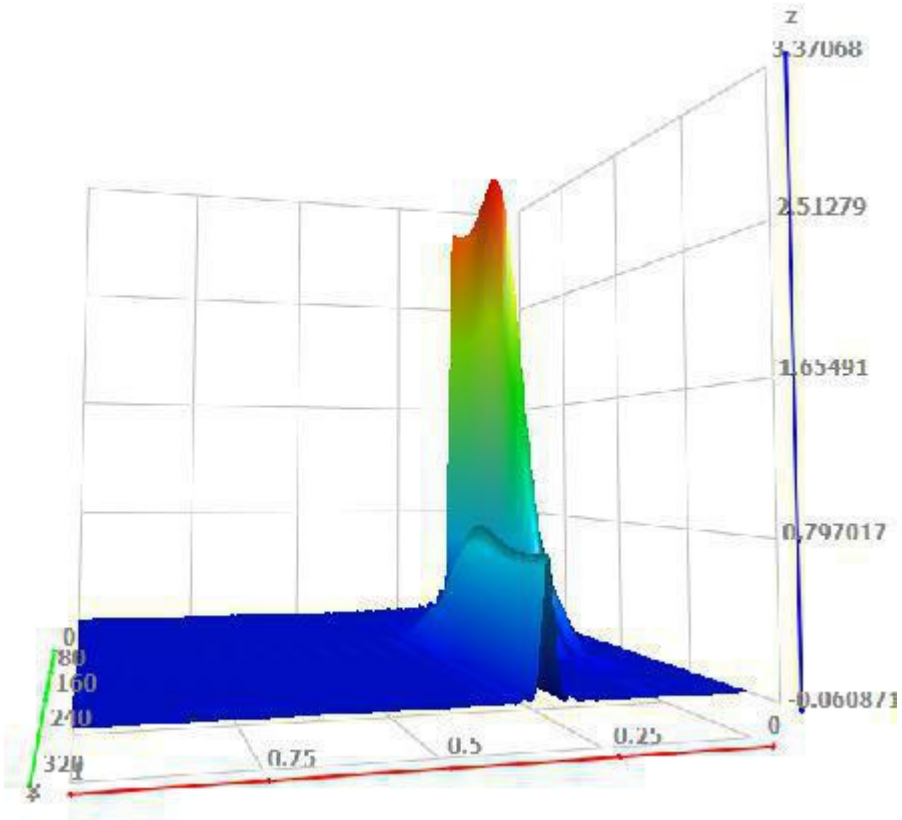
block := 80 Length of the block

nover := 40 Samples overlapping between consecutive blocks

Pxx := spectrogram(xs , "rectangular" , nfft , block , nover) Spectrogram, rectangular window is used

Sp := data3d(Pxx , xx , 0 , 1 , y , 0 , 320) Prepare data for 3D graph

Spgr := graph3d(0 , Sp) 3D graph widget created



Example II

In the following example we calculate the spectrogram of a signal which consists of a sinusoidal function whose frequency is gradually changing. We generate the test signal using a chirp signal. The spectrogram is displayed in the following graph.

fr := ynodes(ff , 0 , π/2 , size(n)) Variable frequency

y := sin(mul(fr , n)) Chirp signal with frequency variable changing

g2 := join mat cols(n , y)

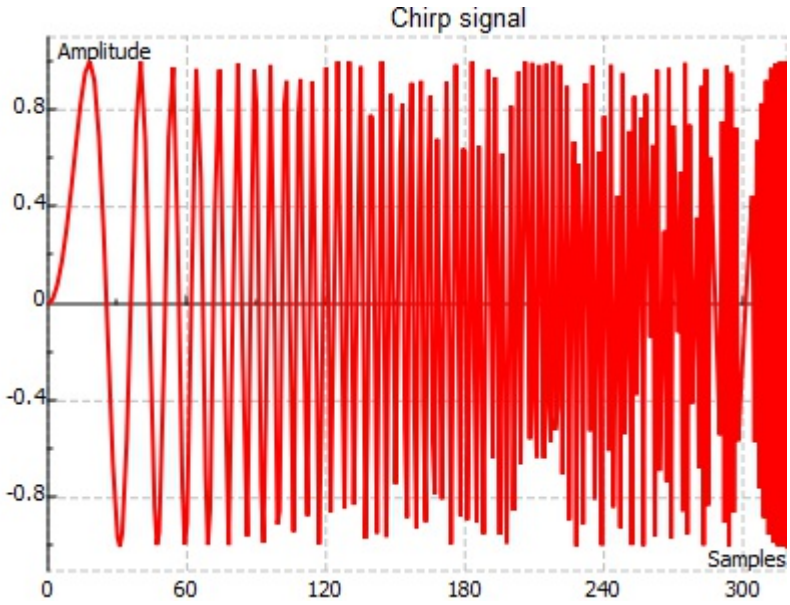
Next, we plot a spectrogram of the chirp signal evaluated from the above test signal.

nfft1 := 512 Number of samples for periodogram

block1 := 80 Length of the block

nover1 := 40 Samples overlapping between consecutive blocks

Pxg := spectrogram(y , "hamming" , nfft1 , block1 , nover1) Spectrogram, Hamming window



Sp1 := data3d(Pxg , xx , 0 , 1 , yy , 0 , 320) Prepare data for 3D graph

Spgr1 := graph3d(0 , Sp1) 3D graph widget created