Periodogram power spectral density estimate

Description

In signal processing, periodograms are used to estimate the power spectral density of a signal. Periodogram is a standard component in more complex methods for spectral estimation, such as Welch's method for spectral estimation. Periodogram is calculated as the Fourier transform of a auto-correlation function that is $FT\{x(t)*x(-t)\}=X(f)*X^{*}(f)=abs(X(f))^{2}$. MatDeck contains a function called periodogram().

Calculation

MatDeck's function periodogram() 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 the number of samples to generate the result which is also number of samples to perform fft() within the periodogram function.

Example I

In the following, we illustrate how to use periodogram() on several illustrative test signals. The first test signal is obtained by combining a cosine signal given by a normalized frequency, and additive white Gaussian noise -AWGN.

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

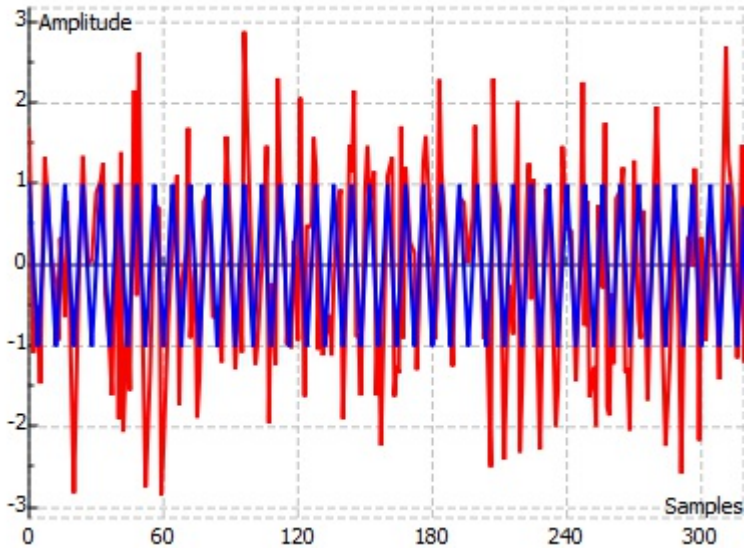
$x := \cos((\pi / 4) \cdot n)$ Cosine signal

$\text{noise} := \text{normrandvec}(0 , 1 , 320)$ Additive white Gaussian noise

$xs := x + \text{noise}$

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

$g2 := \text{join mat cols}(n , x)$ Graph of original cosine signal



We prepare other arguments and we calculate the periodogram of the noisy signal defined above. We

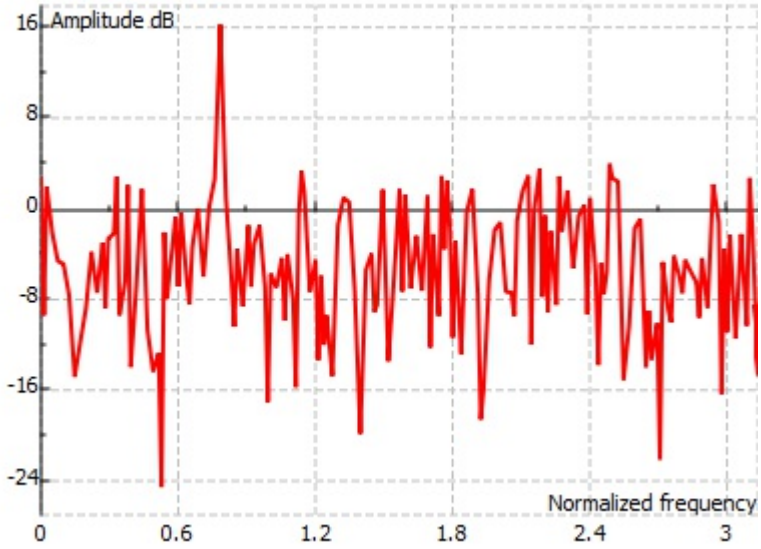
then plot the obtained periodogram versus a normalized frequency, which means that the one in the peridogram graph stands for half of the sampling rate.

nfft := 512 Number of samples for periodogram

Pxx := periodogram(xs , "rectangular" , nfft) Periodogram, rectangular window is used

f := ynodes(f1 , 0 , 1 - 1/nfft , nfft/2 + 1) Frequency axis

Pxxgr := join mat cols(f · π , 10 log10(Pxx)) Peridogram graph



Example II

In the following example we calculate the periodogram of a noisy signal which consists of two sinusoidal functions. We generate the test signal, by combining the noisy signal above with an additional sine wave. The periodogram is displayed in the following graph. The peaks in the periodogram differ for the same amount as the signal amplitudes differ in domains of samples.

xg := xs + 0.5 sin((π/3) · n) Noisy signal with two cosine/sine waves

Pxxg := periodogram(xg , "hamming" , nfft) Periodogram, Hamming window is used

Pxxggr := join mat cols(f · π , 10 log10(Pxxg)) Periodogram graph