Signal Interpolation - Upsampling

This example we illustrates the process of signal interpolation using existing MatDeck functions. The interpolation is the increase of the sampling rate. First, the test signal is generated. We use the sum of two sinusoidal signals of different frequencies.

$Fs := 20000$ Hz, original sampling rate

$Ts := 1/Fs$ Sampling period

$Dt := \text{curve2d}(x, 0, 0.005 - Ts, 100)$ Time axis

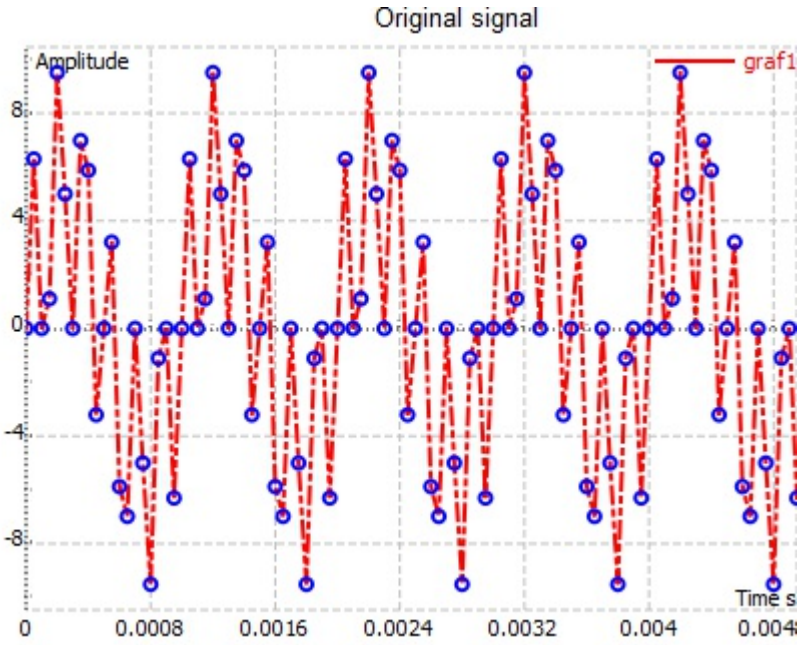
$dt := \text{col2vec}(Dt, 0)$

$f1 := 1000$ Hz, frequency of the first sinusoidal signal

$f2 := 6000$ Hz, frequency of the second sinusoidal signal

$y := 5\sin(2\pi \cdot f1\ dt) + 5\sin(2\pi \cdot f2\ dt)$ The input test signal, sum of two sinusoidals

$graf1 := \text{join mat cols}(dt, y)$ Time domain graph of the test signal



We can investigate the signal spectrum as well. We determine the spectrum by using fft.

$nfft := \text{size}(y)$ Length of the input signal

$fy := \text{fft1}(y)$ Spectrum of the input signal

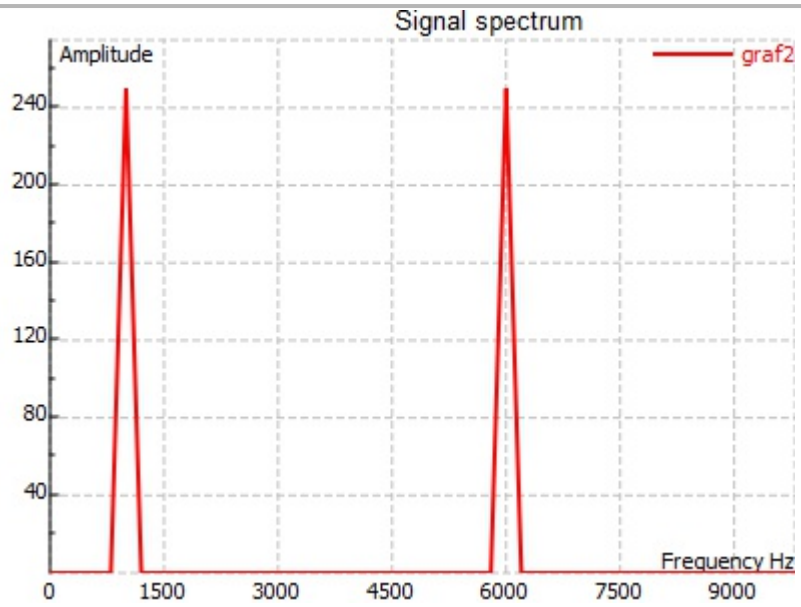
$fy1 := \text{subset}(fy, 0, 0, nfft/2 - 1, 0)$ Only half of the periodic spectrum is taken due to symmetry

$xfft := \text{curve2d}(x, 0, (Fs/2) \cdot (nfft/2 - 1)/(nfft/2), 50)$ Frequency axis

$xfft1 := \text{col2vec}(xfft, 1)$

$fyy1 := |fy1|$ Amplitude spectrum of the input signal

$graf2 := \text{join mat cols}(xfft1, fyy1)$ Graph of the amplitude spectrum of the test signal



The following task is to increase the sampling rate by a factor of two, increasing the number of samples. When interpolation is performed, one should take care about proper timing, in order to illustrate the decimation.

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N := 2                                  Upsampling factor
yinter := upsample(y , N)               Upsampled signal
Fs1 := Fs N                             New sampling rate
Ts1 := 1 / Fs1                          New sampling period
Dt1 := curve2d(x , 0 , 0.005 - Ts1 , 200)   New time axis
dt1 := col2vec(Dt1 , 0)
graf3 := join mat cols(dt1 , yinter)    Graph of the upsampled signal
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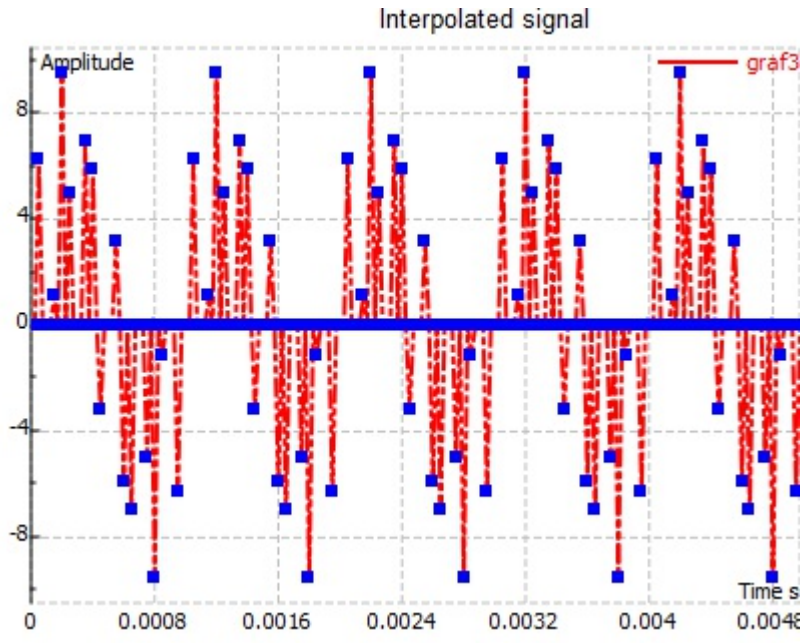

We can analyze the frequency spectrum of the interpolated signal

nfftd := size(yinter) Size of the upsampled signal

fyinter := fft1(yinter) Spectrum of the upsampled signal

fy1d := subset(fyinter , 0 , 0 , nfftd / 2 - 1 , 0) Only half of the periodic spectrum is taken due to symmetry

xfftd := curve2d(x , 0 , (N Fs / 2) · (nfftd / 2 - 1) / (nfftd / 2) , 100) New frequency axis

xfft1d := col2vec(xfftd , 1)

fyy1d := |fy1d| Amplitude spectrum of the upsampled signal

graf4 := join mat cols(xfft1d , fyy1d) Graph of the amplitude spectrum of the upsampled signal