

FFT Assignment

Fourier and Wavelet Analysis CTH & GU

November 8, 2007

Assignment

The purpose of this assignment is to study how the truncation of a signal can affect its spectrum, and to try out some possible countermeasures.

For this purpose, start MATLAB and create a discretized sine function of length 1024. (Why 1024?) The corresponding continuous sine function has an exact frequency, and has a Fourier transform with Dirac's delta. (Which?)

Create another discretized function of length 2048, where the just chosen sine function generates the values for the first 1100, say, places and put 0 in the remaining places at the end.

Compute the Fourier transforms in MATLAB of both signals, using the command `fft(x)`. Plot the power spectra in a conventional log-log diagram in a scale which allows a direct comparison in frequency content. (You have to make a suitable choice of the frequency of the sine signal to make the effect clear.)

When satisfied, print these power spectra, and hand in.

Two aspects may be considered in practice when considering a spectrum: either the signal is cut out from a longer one and/or there is spectral noise present. These motivate distinct approaches when processing the signal to diminish unwanted effects. Think about how to do this when the spectrum is *unknown*.

Try out your filtering ideas (for the case of an unknown spectrum) on the padded signal, using both of the time domain and the frequency domain aspects. **When satisfied, print the result, and hand it in together with a description of the filtering.** (You need not construct your own filters from scratch: there is a SIGNAL PROCESSING TOOLBOX. Use the command `help signal .`)

Warm-up

To warm up, you could analyze some signals with the commands `fft` and `plot` in MATLAB, and the commands `spectrum` and `specplot` in the SIGNAL PROCESSING TOOLBOX:

1. $\sin 100t + 0.5 \sin 200t$, $t = 2\pi k/1024$, $k = 1, 2, \dots, 1024$

See the spikes in the power spectrum!

2. $\sin 100.5t + 0.5 \sin 200t$, $t = 2\pi k/1024$, $k = 1, 2, \dots, 1024$

Compare the result to the previous one!

3. $(2 + \sin 8t) \sin 100t$ — an example of amplitude modulation

See both negative frequencies and the - still in our time disputed - side bands! Some practitioners refuse to believe they - the side bands - exist. However, receiving a single side band convinces a majority.

4. $\sin(100(1 + 0.1 \sin 8t)t)$ — an example of frequency modulation