FFT Assignment

Fourier and Wavelet Analysis CTH & GU

October 31, 2006

Assignment

The purpose of this assigment 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 unkown 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. $\sin 100t + 0.5 \sin 200t,\ t = 2\pi k/1024,\ k = 1, 2, ..., 1024$

   See the spikes in the power spectrum!

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

   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