ENP 612 Sampling and Filtering Lab

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Lab Goals and Objectives

- Understand the principles of digital data acquisition
- Acquire waveforms and perform analysis on over-, under-, and correctly sampled signals using Nyquist criteria.
- Use signal filtering techniques to analyze unknown spectra, identifying any radioisotopes present, and use this information to synthesize a compound spectra.
- Report your results using a journal formal and scientific writing

Overview

In this lab you will utilize a NI data acquisition module to capture signals from a waveform generator. You will sample from a number of different signals, varying both signal frequency and sampling rate, to demonstrate the importance of the Nyquist criteria and consequences of over- and undersampling.

The second part of this lab is using filtering techniques on real data to extract extra information that may not be readily apparent. Once this is done, you will take the parameters you calculated and produce a synthetic compound spectra and compare it to a measured one.

The use of NI hardware for data acquisition, in conjunction with the LabView software, can greatly speed up experimental setup for data analysis with only a minimum knowledge of the Labview. Data processing is done in Matlab, with a programming interface that is very flexible and familiar to most users.

Equipment Required

- NI 6218 DAQ
- Pulse generator.
- Laptop

Lab Procedures (pt.1)

1. Power on pulse generator
2. Connect it to the NI 6218 in the Ai1 BNC
3. Set the output to sine (default), with a frequency of 10 Hz and amplitude of 2 V
4. Connect the NI 6218 to the laptop USB
5. The Labview software will launch automatically, just close it out.
6. Navigate to

`C:Users`\Public\Public Documents\National Instruments\612 data

7. Launch nyq.vi
8. In the VI, go to window->show block diagram
9. Double click on the DaQ Assistant block
10. Set min V to -10 and max V to +10
11. At the bottom (Acquisition Mode), set to N samples, 100 samples, and 20 Hz sample rate
12. Press the output button on the wave generator
13. Click the run button on the DaQ assistant to generate a graph showing the samples
14. Hit the OK button at the bottom.
15. On the main block diagram, click run; select the folder and file name you want to save the data to (tab delim text file)

16. Open excel and import the data, then plot using scatterplot (straight line)

To demonstrate sampling limits, you are going to repeat steps 11-16 for the following parameters:

Generator frequency	Sample frequencies
1 kHz	500, 1000, 2000, 8000 Hz
100 kHz	1, 10, 100, 250 kHz

The number of samples (N samples) that you will need can be calculated from the sample frequency and the wave frequency.
Download the data to the provided portable drive to transfer to your laptop or AFIT desktop.

Lab Procedures (pt.2)

This part of the lab requires Matlab and access to the L: drive on the AFIT network. There are several deconvolution/filters already built for this lab, located here:

L:\Courses\NENG\NENG 612\Summer 2018\Lab2_Nyquist\deconvolution Matlab codes

The ones you will be using are the van cittert, constrained van cittert, and Metz 1-D filters.

In the Lab2_Nyquist folder, there are three measured radiation detector spectra: test1, test2, and test3. You are to use the three filters mentioned previously to process these spectra, using your notes to generate the appropriate unknown parameters.

Once you have cleaned up the spectra, identify any radioisotopes present based on the assumptions that the first spectra is from a Ba-133 source and the other two were made with the exact same detection system.

Use the parameters you found above and generate a synthetic PSF (point spread function). Create an ideal spectra combining the test1 and test2 peaks, e.g. single column per peak at the correct number of counts. Convolve the spectra with the PSF, then compare this to simply adding the test1 and test2 spectra together.

Article

The write up for this lab will be a 2-3 page journal article (1 per group) in the IEEE format. The article should include:

1. Introduction
2. Description of work
3. Results
4. Conclusions
5. References

All plots should be labeled, with proper units, clearly visible, and follow standard practice. Writing should be done in journal article, not lab report, format. The key questions to address in your article are:

1. In progress