CS-330 Assignment 1
Introduction:
GNU Radio, Sampling, Nyquist frequency, Aliasing

Deadline: 17-21 October Lab sessions

October 11, 2016

General Information

For each assignment some code examples with complete working flowgraphs or blocks are provided, but in some cases there are missing elements. The code is available at **Github** https://github.com/surligas/gr-cs330 and will be updated accordingly, prior to each assignment announcement.

For every assignment you should provide before the lab session your report, reporting your findings.

Exercise 1

The goal of this exercise is to help you to become familiar with the GNU Radio platform and the Nyquist frequency. Furthermore, you will be able to visually inspect/observe signal properties on-the-fly using the corresponding GNU Radio graphical tool.

First, at *apps* folder of the provided project, open the *lab1_1.grc* flowgraph using **GRC**.

1. Execute the flowgraph. Show that you are able to handle the Time Sink functions in order to inspect visualy the signals.
2. Are the signals provided going to be properly transmitted without loss of information? *Report!*
3. Perform the proper modifications to produce visually smoother signals, **without** changing the frequency of the signals. Compare the CPU usage between the previous run and the new one and *report* your findings.
4. Which is the minimum possible sampling rate that you can use at the flowgraph? *Report!*

Exercise 2

The second exercise explores signal properties on the frequency domain rather than the time domain. It will help you become familiar with the spectrum analysis graphical tool of GNU Radio and learn some basic properties of the Fourier Transform. Copy the flowgraph of the previous exercise as *lab1_2.grc*.

1. Drop the Time Sink and insert a Frequency Sink. At the **Spectrum Width** option select **Half**.
2. Instead of fixed parameters for the frequency and amplitude of the signals, use QT widgets to dynamically and graphically change their values. Which are the minimum and maximum values allowed? *Report!*

3. Set the frequency of both signal A and B at 4 kHz.
   (a) What do you observe about the spectrum of signal A+B compared to the spectrum of signal A and B respectively? *Report!*
   (b) Why the spectrum of signal A and signal B is the same regardless the fact that the first is a cosine and the second a sine? *Report!*

Exercise 3

This exercise will help you understand the notion of signal phase and what happens when two signals are transmitted concurrently.

Open the *lab1_3.grc* file. The flowgraph included is incomplete and you should perform some modifications.

1. Without adding any other block, try to produce a zeroed signal for the A+B signal. **You are not allowed to alter the signal sources parameters or the sampling rate.**
2. Which is the value that you used for the parameter of the delay block? Why and how did you choose this value? *Report!*

Exercise 4

The goal of this exercise is to present the insights of sampling, aliasing and filtering.

Open the *lab1_4.grc* file. The flowgraph provides a signal source block that operates on a sampling rate of 32 kHz. This signal is plotted using the Frequency Sink block of GNU Radio. In order to emulate properly a down sampled signal, the flowgraph utilizes the de-interleaver block which drops out 3 of every 4 samples and keeps only the first (down-sampling/decimation by a factor of 4). The resulting signal is also plotted together in the same Frequency Sink block.

1. Use the slider to change the frequency. What do you observe? *Report!*
2. Which is the frequency range of the down-sampled signal? Why? *Report!*
3. **Before** the down-sampling (de-interleaver block), insert a proper filter block in order to cutoff the undesired aliasing effect. GNU Radio provides a variety of filter blocks under the category *Filters*. *Report* the type of the filter you chose, the parameters you applied, and the reasoning.
4. Think of and *report* a simple way/function to calculate/predict the frequency f_{alias} of the alias, by two parameters: sampling frequency f_s & signal frequency f_{signal}.