CS-330 Assignment 2 2025
Resampling, Path Loss models

Deadline: 15/11/2025 23:59 via turnin

November 5th, 2025

General Information

The goal of this assignment is to become familiar with some up-sampling issues to better understand the challenges of sampling theorem. Also, we will discuss various path-loss models and calculate some real maximum transmission distances.

Exercise 1

In this exercise you will investigate the accuracy of the three different up-sampling/interpolation schemes. Consider the case of tripling the sample rate, thus for each input sample three are being output.

1. Build the logic of the three schemes in a single flowgraph called *lab2_1.grc*:
   (a) For each input sample two more samples are produced with zero amplitude (zero padding).
   (b) For each input sample two more samples are produced with the exact same amplitude (duplication/repetition).
   (c) For each input sample two more samples are produced each with an amplitude splitting the difference of amplitudes the current and next input samples in equal part. For example, if the current sample has amplitude 0 and the next has amplitude 1, the produced samples will have amplitudes of 0, 1/3, 2/3, 1.
2. Test the three schemes by using the following parameters:
   (a) Input sample rate 50 kHz.
   (b) Output sample rate 150 kHz.
   (c) A test cosine signal from 0 up to 25 kHz. Use a QT Range slider to adjust the frequency in real time.
3. Report and discuss your findings. How is the frequency domain affected? Which system is the best?
4. Recall, the decimation process of the previous assignment. In that case, after the decimation aliasing artifacts appeared. In the interpolation schemes above, do you observe any kind of artifacts? If yes, explain why they appear and try to compensate for them.

   NOTE: You can evaluate all the schemes at the same time by using a spectrum analyzer block with three input ports
5. After evaluating the three schemes, do you consider of a better scheme to up-sample? If yes, report the reasoning, build the scheme, test it against the others, and report your findings.

Exercise 2

In this exercise you will implement a resampler, by combining properly decimation and interpolation implemented in the previous assignment and at Exercise 1. Note that your final result should compensate as much as possible any aliasing or other artifacts. The SNR between the signal tone and any other artifact should be at least 20 dB. For the interpolation process you can choose one of the three proposed schemes of Exercise 1.

- Create a flowgraph with the name *lab2_2.grc*
- Assume a source sampling rate of $srcs$ = 50 kHz and a test cosine signal from 0 up to 25 kHz. Use a QT Range slider to adjust the frequency in real time.
- Resample properly the signal to 75 kHz, by combining properly decimation and interpolation. Use a frequency sink operating at 75 kHz to visually inspect the result.

Exercise 3

In this exercise you will compare various models for calculating the signal power at the receiver. To be realistic, we will use the values from commercial devices. The communication happens over 802.11n, at 5 GHz, with a bandwidth of 40 MHz, MCS7 (don't worry too much about it), targeting 130 Mbps. We will assume that the transmitter is a Cisco Catalyst 9136I Access Point, and that the receiver is similar to TP-Link TL-WN722N.
On the transmitter datasheet (found here and here) we can find the all the relevant information:

- Power: 22 dBm
- Gain: 5 dBi

For the receiver assume these values:

- Sensitivity: -68 dBm
- Gain: 4 dBi

Based on those, answer the following questions:

1. Using the Free Space model, what is the maximum distance from the access point where the transmission will be successful? Based on your experience, is this distance realistic? Why or why not?
2. Using the log-distance model, what is the maximum distance from the access point where the transmission will be successful? For the path-loss exponent at 5 GHz for an office building use a realistic value: 4.5. Is the distance you found realistic? Assume $d_0 = 1$ and that for $d \leq 1$ the free-space model holds. Compare the answer you got in this question with the one from the previous and explain the difference.

3. Use the log-distance model to find the maximum distance from the access point where the transmission will be successful, as a function of the path-loss exponent, for $1 \leq n \leq 6$. Plot the function and include a screenshot. Consider using a logarithmic scale for the y-axis. What do you see, regarding small changes to the value of n? How do you interpret this? 📷

About Submission

The submission of the Assignments will be done through the course's e-learn site. If needed, more info will be sent to the list prior to the deadline. You can turn in this assignment until **15/11 23:59**.

You should provide a report as a **single pdf file**, containing your comments, screenshots or anything that you believe will be helpful for your grading. Also include any .grc files that you have created or changed.

About Oral Examination

All the students who have submitted their exercises are requested to attend the oral exam session, in order to present their solutions. A short quiz will also take place during that time. You will need to choose a timeslot for the oral exam using Doodle. More details will be sent to you via email.

Attention

- Each student will only be examined during the timeslot chosen.
- During this session both Assignments 1 and 2 will be examined.
- Both the timely submission and the oral exam session will contribute to the grading of the assignment.