Práctica 1: Sampling and Quantization

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1 Task 1

Question: Give your interpretation of the resulting graphs. Do the quantization levels correspond with the values you had expected?

Both graphics start at the -FS point, increase the number of bits, decrease the error and add more values we can get.

Question: For both cases, represent the quantization error as a function of input amplitude in the range $[-7, +7]$ and comment on your results. Is this error always within the $[-\Delta/2, +\Delta/2]$ interval?

The $[-\Delta/2, +\Delta/2]$ in each case is as follows:

- For N = 2 the Δ value we get is $\Delta = 3{,}5$, so the interval should be $[-1{,}75, 1{,}75]$.
- For N = 4 the Δ value we get is $\Delta = 0{,}875$, so the interval should be $[-0{,}4375, 0{,}4375]$.

So yes, the error is always inside the range.

2 Task 2

Question: Assume a full-scale sinusoidal input and plot the histogram of the quantization error. Do you observe what you expected, or not?

$\Delta = \frac{2*FS}{2^N} = 0{,}0098$, so the $[-\frac{\Delta}{2}, +\frac{\Delta}{2}]$ interval should be $[-0{,}0049, +0{,}0049]$. In the histogram we can see that in that interval the error is uniformly distributed, but there is an error tail in the positive extreme. It means that there is **clipping** in the positive.

Question: Explain the operation of the Matlab command var. Estimate the variance of the quantization error using var, and compare it to its theoretical value. Estimate the value (in dB) of the Signal to-Quantization Noise Ratio (SQNR) and compare it to its theoretical value (1). ADD

3 Task 3

Question: Suppose that you have an N-bit A/D converter with tunable FS, and you know that your input samples follow a symmetric triangular pdf in some interval $[-x_0, x_0]$. Intuitively, how would you set the FS value of your converter? What would the resulting rms value σ_x in dBFS be?

The value of FS should be x_0. And the value of $\sigma_x = \frac{x_0}{\sqrt{2}}$ and in dBFS would be $20\log_{10}(\sqrt{2})$ dBFS.

Question: Explain how to generate in Matlab samples of a random variable following a symmetric triangular pdf with zero mean and rms value σ_0. Check the histogram and use the commands mean and var to validate your approach

Rand function allows to give a distribution to generate the values following that distribution. So we need to create that distribution and then give it to rand().