Introduction

Fourier transform is the most widely used tools in applied mathematics to analyze signals. The essence of the Fourier transform of a waveform is to decompose or separate the waveform into a sum of sinusoids of different frequencies. If these sinusoids sum to the original waveform, then we have determined the Fourier transform of the waveform. Mathematically speaking, is it possible to write this relation as:

$$\mathcal{S}(f) = \int_{-\infty}^{+\infty} s(t) e^{i2\pi f t} dt,$$

where s(t) is the waveform to be decomposed into a sum of sinusoids and $\mathcal{S}(f)$ is the Fourier transform of s(t). As an example, consider the pulse waveform (1) and its Fourier transform (2) shown the following figures.

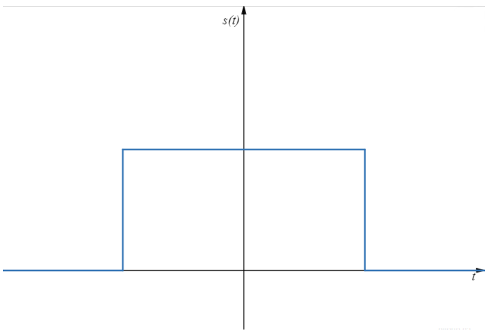

Figure 1: pulse waveform

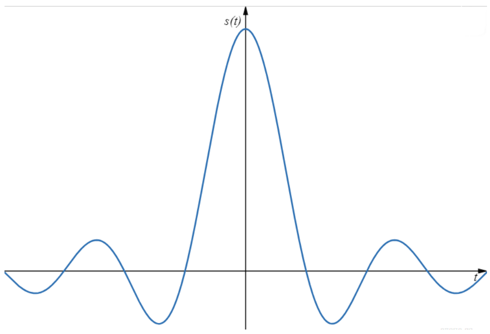

Figure 2: Fourier transform

The Fourier transform is a powerful tool for signal analysis and is also highly effective for reducing noise within a signal. In this experiment, we analyze a sinusoidal signal affected by noise, where the noise is represented as a set of discrete random variables that are uncorrelated, have zero mean and finite variance. Given this, we apply the square root law, anticipating that the standard deviation of the mean will decrease proportionally with the square root of the number of acquisitions. Thus, the primary goals of this experiment are: first, to demonstrate that we can use the Fourier transform to reduce noise and obtain a cleaner signal, and second, to verify that the standard deviation of the mean indeed decreases as predicted by the square root of the number of acquisitions.

1 Materials and Methods

1.1 Equipment And Tools

- Digital storage oscilloscope (Siglent - SDS5034X)
- Waveform generator (Siglent - SDG6022X)
- Two BNC-to-BNC cables
- USB flash drive

1.2 Experimental Procedure

We started by connecting the digital oscilloscope to the waveform generator using BNC-to-BNC cables. Then, we proceeded to generate a sinusoidal signal with a frequency of 1 kHz and an amplitude of 2 Vpp, along with a noise signal, using the waveform generator. Next, using a function of the digital oscilloscope, we were able to add the two signals. The resulting waveform can be seen in the following figures.

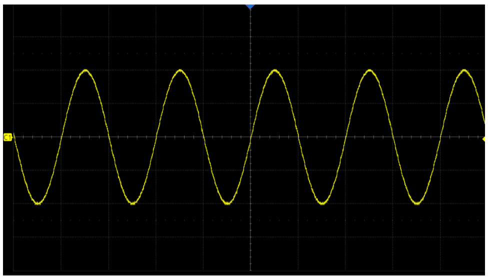

Figure 3: Sinusoidal signal

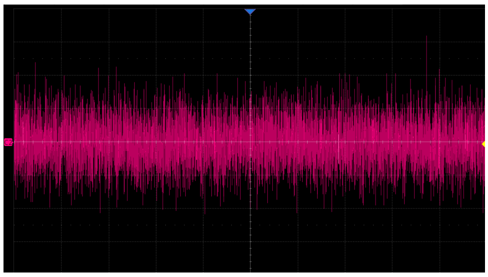

Figure 4: Noise signal

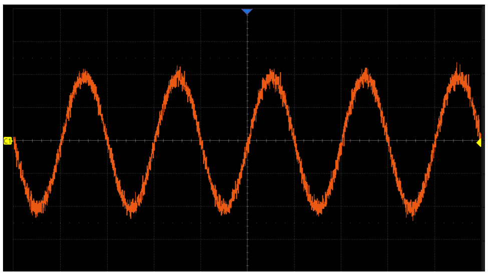

Figure 5: Resulting signal from the addition of the two signals

Finally, we proceeded to acquire the data from the oscilloscope and saved it to a USB flash drive. To acquire the data from the oscilloscope, we followed the steps below:

- press the save/recall button, to open the file acquisitions menu
- select the the file extension, in our case .csv
- select our USB flash drive from the acquisition menu
- press on the touch screen the save as window
- select the file name and press the save button

All the data acquired was analyzed using Julia programming language