

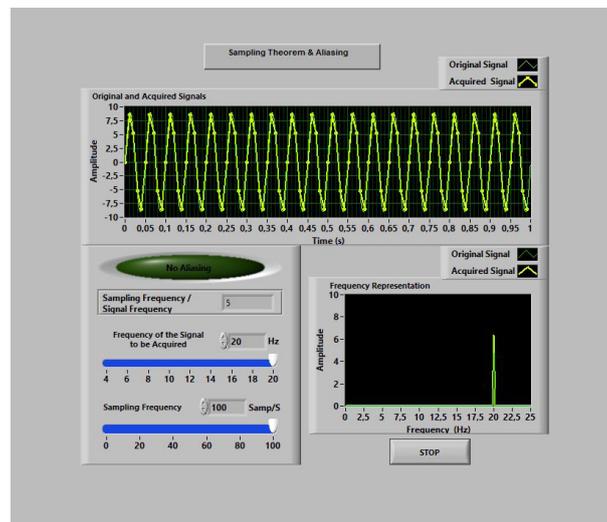
COMPUTERGESTÜTZTES EXPERIMENTIEREN I (Computer-Assisted Experimentation I)

PRACTICAL Digital Signal Processing

Processing time-dependent signals using DFT

In this practical exercise you will deepen the understanding on the topic "Acquisition of time-dependent signals and their processing using discrete Fourier transform (DFT)", that was covered in the chapter of the lecture "Digital Signal Processing".

We will use the LabVIEW demo program **Sampling_Theorem**, that you may find in the folder Manuals and Documents/Signalverarbeitung. For a pure sinusoidal signal, it demonstrates the effect of sampling and the consequences thereof on the Fourier transformed signal. The frequency of the signal and the sampling rate can be chosen in the given range. The original and the sampled signal are displayed in the uppermost panel Original and Acquired Signals. In the input area on the left-hand side the signal frequency and the sampling rate can be chosen and in the panel on the right the amplitude of the Fourier transforms of both, the original and the sampled, signals are displayed.



Exercises

1. Run the program **Sampling_Theorem** and make yourself familiar with it. First vary the signal frequency. What do you observe? Then reset the frequency to the maximum value of 20 Hz and reduce the sampling frequency to 20 samples/s. What do you observe now?
2. Now we shall be more quantitative: set the sampling rate to exactly 20 Hz. What is now the Nyquist frequency f_{Ny} ? What is the highest frequency that will be unaltered? Verify by continuously sweeping the signal frequency from maximum to minimum.

Describe your observations in detail, when you first set the signal frequency to 7.5 Hz and then to 15 Hz. Where are the original and sampled signals, respectively? Explain the observed frequencies.

3. Now we go one level deeper into details: Set a minimal signal frequency, e.g. 2 Hz, and reduce the sampling rate to exactly 10 Hz. Locate f_{Ny} and the sampling frequency in the Frequency Representation pannel. Next increase the frequency to 5 Hz. Slowly scan the frequency from 5 Hz to 10 Hz, from 10 Hz to 15 Hz, and, eventually, from 15 Hz to 20 Hz. For each of the four regions explain the observed frequencies in detail.

Objectives: sampling theorem; Nyquist frequency; aliasing; to be able to explain the occurring effects in a visual way