23 August 2023

Lab 3 – Linear Convolution and Circular Convolution

3.1 Linear Convolution

Convolution, an essential operation in signal processing and various other fields. Convolution is used to combine two signals and produce a third signal that represents the way one signal influences the other over time.

In this task we will compute the linear convolution of following signals:

a. Generate a random sequence of length 10 and convolve with the below signals. Plot the two signals and the result of their convolution in a 3x1 subplot.
   i) unit pulse sequence starting at n = 0 to n = 9 (length 10).
   ii) unit pulse sequence starting at n = -4 to n = 5 (length 10).

b. Convolve a unit pulse sequence starting at n = 0 to n = 3 (length 4) with itself repeatedly and plot it in a 2x2 subplot.

c. The sequence x[n] = $(-1)^n$ for n = [-5, -4, …, 4, 5] and a unit pulse sequence starting at n = -3 to n = 1 (length 5). Plot the two signals and the result of their convolution in a 3x1 subplot.

d. $x_1[n] = \sin(2 \cdot \pi \cdot f \cdot n)$ for n = [0, 1, …,20] and $x_2[n] = (-1)^n$ for n = [-18, -17,…., 14]. Plot the two signals and the result of their convolution in a 3x1 subplot.

3.2 Circular Convolution

We can compute time-domain convolutions using various methods. In this MATLAB script we will compute linear convolution along with circular convolution of a pair of signals using two methods for each:

(a) Generate two finite length sequences as follows. The sequence $x_1[n]$ is a random Gaussian sequence of length 10 and $x_2[n]$ is first 10 samples of the signal $\delta[n-3]$ starting from n = 0.

(b) Perform linear and circular convolutions of $x_1[n]$ and $x_2[n]$ directly using the commands `cconv` and `conv`, respectively (read up MATLAB documentation of these commands). Make sure each result is of the expected length

(c) Plot the original signals, the linear convolution, and the circular convolution in a 2x2 subplot.