Lab #7

Objectives

- Discrete Fourier Transform
- Use Scilab to calculate fft and sketch the signal

Report

1. Your report must include your answers in hand-written or computer-aid tools.
2. Do not share your report with your friends.
3. Finally, you upload your report to BKeL on time.

EXERCISES

Exercise 1. Compute the DFT of the given signal by hand

a. 2-point signal, x = [20, 5]

b. 4-point signal, x = [3, 2, 5, 1]

Exercise 2. The even sample of the DFT of a 9-point real signal x(n) is given by

X(0) = 3.1,

X(2) = 2.5 + 4.6j,

X(4) = -1.7 + 5.2j,

X(6) = 9.3 + 6.3j,

X(8) = 5.5 - 8.0j,

Determine the missing odd samples of the DFT. Use the properties of the DFT to solve this problem.

Exercise 3. The DFT of a 5-point signal x(n), $0 \le n \le 4$ is

X(k) = [5, 6, 1, 2, 9], $0 \le k \le 4$.

A new signal g(n) is defined by

$g(n) = W_5^{-2n}\, x(n)$, $0 \le n \le 4$.

What are the DFT coefficients G(k) of the signal g(n), for $0 \le k \le 4$?

Exercise 4. Compute by hand the circular convolution of the following two 4-point signals

g = [1, 2, 1, −1]

h = [0, 1/3, −1/3, 1/3]

Exercise 5. The 20-point signal x(n) is given by

$$x(n) = \sin[(2\pi 2 n)/N],\ 0 \le n \le N-1$$

where N = 20.

(a) Roughly sketch the signal for $0 \le n \le 19$.

(b) Find the DFT coefficients of the signal. That means, find X(k) for $0 \le k \le 19$. Show the derivation of your answer.

ADDITIONAL SCILAB EXERCISES

Exercise 6. Verify the circular convolution property of the DFT in Scilab. Write two Scilab functions to compute the circular convolution of two sequences of equal length. One function should use the DFT (fft in Scilab), the other function should compute the circular convolution directly not using the DFT. Verify that both Matlab functions give the same results.

Exercise 7. Write a Scilab function that uses the DFT (fft) to compute the linear convolution of two sequences that are not necessarily of the same length. (Use zero-padding.) Verify that it works correctly by comparing the results of your function with the Scilab command conv.

Exercise 8. The following Scilab code gives four methods to compute the linear convolution of x(n) and g(n). Identify which of the four methods are wrong! Of the remaining methods, which one do you think requires the most additions and multiplications (the least efficient) and which method requires the fewest (the most efficient). Explain!

```
x = rand(1,126);
g = rand(1,126);
% FOUR METHODS TO COMPUTE THE
% LINEAR CONVOLUTION OF x AND g
% METHOD 1
y = conv(x,g);
% METHOD 2
X = fft([x zeros(1,120)]);
G = fft([g zeros(1,120)]);
Y = X.*G;
y = ifft(Y);
% METHOD 3
X = fft([x zeros(1,125)]);
G = fft([g zeros(1,125)]);
Y = X.*G;
y = ifft(Y);
% METHOD 4
X = fft([x zeros(1,130)]);
G = fft([g zeros(1,130)]);
Y = X.*G;
y = ifft(Y);
```

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