Heaven's Light is Our Guide

Rajshahi University of Engineering & Technology

Sessional Course Code: ECE 4124

Course name: Digital Signal Processing Sessional

Submitted To:

Hafsa Binte Kibria

Lecturer, ECE,

RUET

Submitted By:

Mahbuba Habib

ID: 1810026

Department: ECE

INDEX

Experiment No: 02

Experiment Date: 03/05/23

Experiment Name: Perform the following task: -

a. Circular convolution of 2 signals.
b. Sum and subtraction of 2 signals and show them in a figure.
c. Perform 2 types of trapezoid signal.

Objective:
- Familiar with the circular convolution
- Problem solving and show different types of output
- Realtime implementation and visualization of 2 outputs

Theory: Circular convolution, also known as cyclic convolution, is a special case of periodic convolution, which is the convolution of two periodic functions that have the same period. It can be performed using two methods: concentric circle method and matrix multiplication method. Assuming $x_1(n)$ and $x_2(n)$ as two finite sequences of length N.
Now let us consider $X_1(K)$ and $X_2(K)$ as the inverse DFTs of sequences $x_1(n)$ and $x_2(n)$. The DFT for the sequences is

$$X_1(K) = \sum_{n=0}^{N-1} x_1(n) e^{\frac{j2\Pi km}{N}}, k = 0,1,2, \dots N-1$$

$$X_2K = \sum_{n=0}^{N-1} x_2(n) e^{\frac{j2\Pi km}{N}}, k = 0,1,2, \dots N-1$$

Let $x_3(n)$ be one more sequence with DFT $X_3(K)$. The relation between the three finite duration sequences is given as

$$X_3K = X_1K \times X_2K$$

After taking inverse discrete Fourier transform of above sequences we have

$$x_3n = \frac{1}{N} \sum_{n=0}^{N-1} X_3(K) e^{\frac{j2\Pi km}{N}}$$

The above equation can also be written as

$$x_3(n) = \sum_{m=0}^{N-1} x_1(m) x_2[(n-m)N], m = 0,1,2, \dots, N-1$$

Required Tools: MATLAB 2015a.

Code & Output:

1. Circular convolution of 2 signals.

```
clc;
x=[1 2 3 4];
h=[1 1 1 1];
N1=length(x);
N2=length(h);
N=max(N1,N2);
N3=N1-N2;
if(N3>0)
    h=[h,zeros(1,N3)];
else
    x=[x,zeros(1,-N3)];
end
for n=1:N;
    y(n)=0;
    for i=1:N;
        j=n-i+1;
        if(j<=0)
            j=N+j;
        end
        y(n)=[y(n)+(x(i)*h(j))];
    end
end
disp('Circular convolution :');y

stem(y);
```

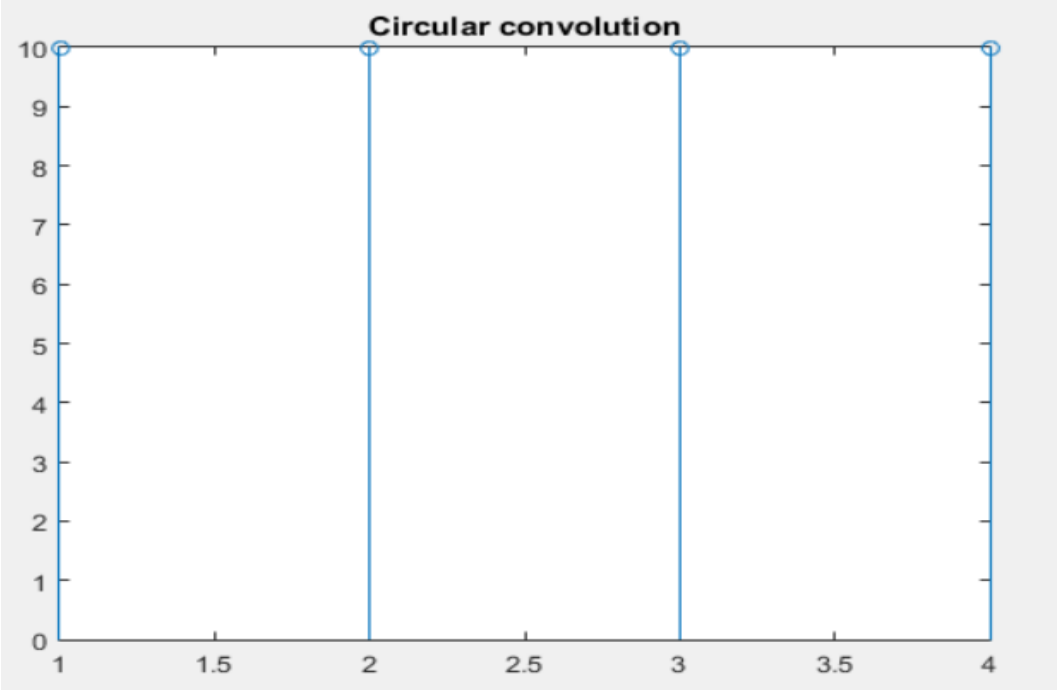


Figure1: Circular convolution of 2 signals

2. Addition and subtraction of 2 functions

```
clc;
x=[0 0 0 2 2 2 1 1 1 0 2];
h=[2 2 0 1 1 1 0 0 0 0 3];
m=x+h;
n=x-h;

subplot(4,1,1)
stem(x)
title('INPUT SIGNAL, X')
subplot(4,1,2)
stem(h)
title('INPUT SIGNAL, H')
subplot(4,1,3)
stem(m)
title('SUMMATION ')
subplot(4,1,4)
stem(n)
title('SUBSTRACTION')
```

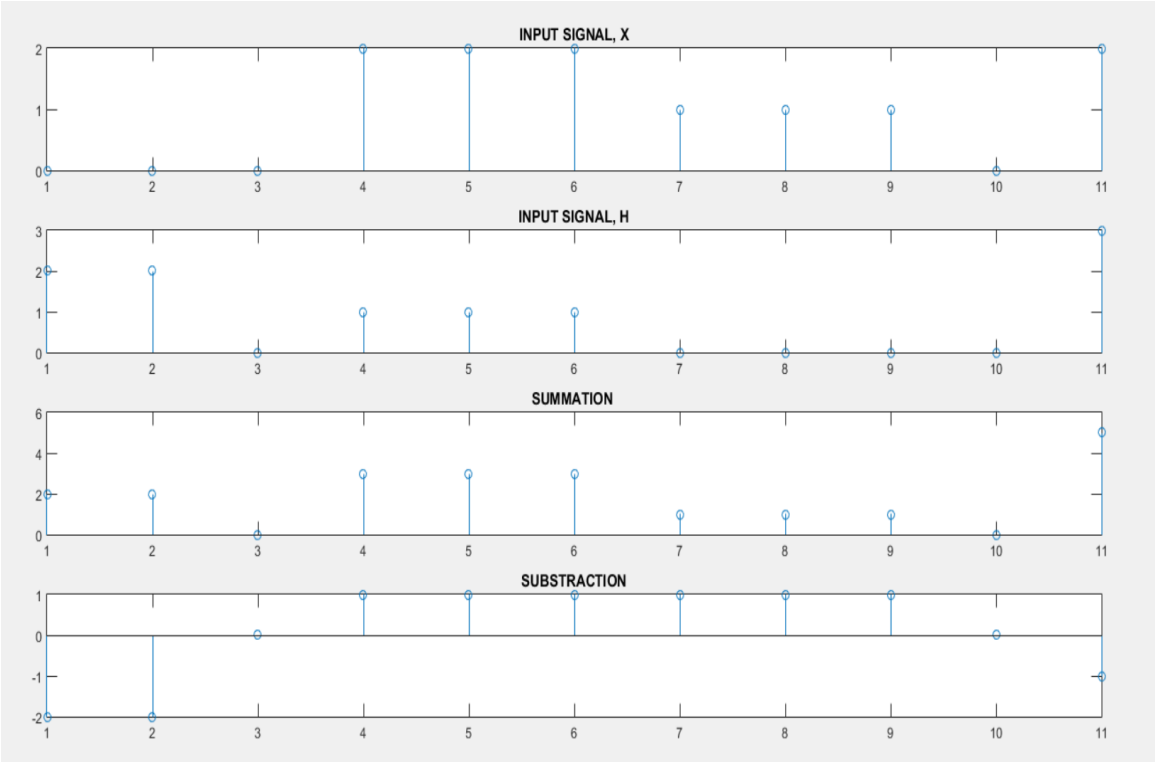


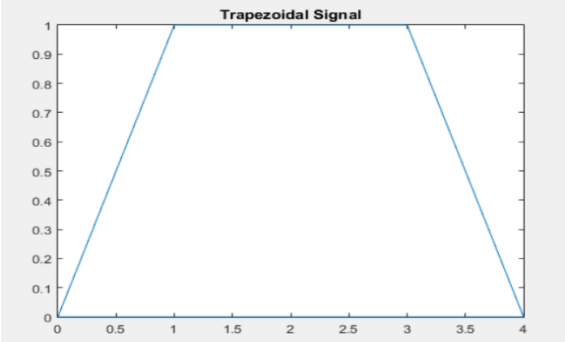
Figure2: Addition and subtraction of 2 signals

3. Trapezoidal signal

```
h=1;
a=2;
b=4;

A=[0 0];
B=[b 0];
C=[0.5*(b-a)+a h];
D=[0.5*(b-a) h];

co_ordinate=[A;B;C;D;A];
plot(co_ordinate(:,1),co_ordinate(:,2))
```




```
A=[0 0];
B=[9 0];
C=[2 2];
D=[7 2];
E=[3 2];
F=[6 2];
G=[4 4];
H=[5 4];

co_ordinate=[A;B;D;F;H;G;E;C;A];
plot(co_ordinate(:,1),co_ordinate(:,2))
```

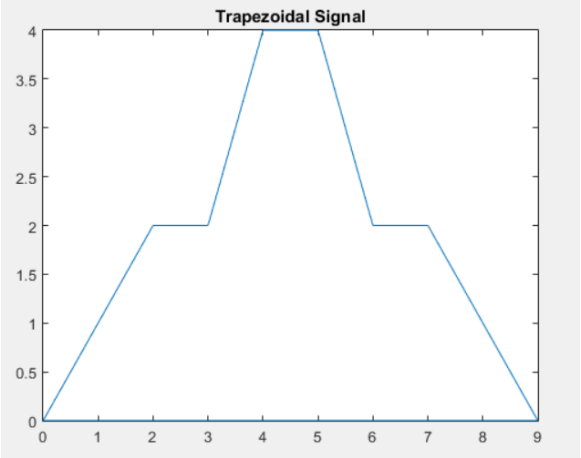


Figure2: Generation of trapezoidal signals

Discussion: This experiment is mainly focused on the circular convolution of 2 signals and implementation of different types of signals. The code is done in 3 steps. All of them give the desired output.

Conclusion: We tried to find out the circular convolution of 2 signals. Besides, we tried to implement code for given signals. The output resembles to our theory.

References:

1. DSP - Circular Convolution
https://www.goseeko.com/blog/what-is-circular-convolution// [Online]. [Accessed May3, 2023]

2. Discrete-Time Signal Processing
https://ocw.mit.edu/courses/6-341-discrete-time-signal-processing-fall-2005/6e5190ef6e0d66c78bfdce2be6ce7125_lec16.pdf [Online].
[Accessed May3, 2023]

3. Circular Convolution
https://en.wikipedia.org/wiki/Circular_convolution// [Online]. [Accessed May3, 2023]