Heaven's Light is Our Guide

Rajshahi University of Engineering & Technology

Sessional Course Code: ECE 4124

Course name: Digital Signal Processing Sessional

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Experiment No: 03

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Experiment Name: Correlation of 2 signals using function and without using function.

Objective:
- Familiar with the correlation concept
- Problem solving with & without using function
- Realtime implementation and visualization of 2 outputs
-Find the X value of highest correlation

Theory: Correlation coefficient is a measure of how well two signals are related to each other in terms of their similarity, alignment, and dependence. It is widely used in digital signal processing (DSP) for various purposes, such as signal detection, estimation, compression, enhancement, and classification. The *correlation* of two functions or signals or waveforms is defined as the measure of similarity between those signals. There are two types of correlations −

- Cross-correlation

  The cross-correlation between two different signals or functions or waveforms is defined as the measure of similarity or coherence between one signal and the time-delayed version of another signal. The cross-correlation between two different signals indicates the degree of relatedness between one signal and the time-delayed version of another signal.

$$R_{xy}(\tau) = \int_{-\infty}^{\infty} x(t)\, y^{\star}(t-\tau)\, dt$$

- Autocorrelation

  The autocorrelation function is defined as the measure of similarity or coherence between a signal and its time delayed version. Therefore, the autocorrelation is the correlation of a signal with itself.

$$R_{xx}(\tau) = \int_{-\infty}^{\infty} x(t)\, x^{\star}(t-\tau)\, dt$$

Required Tools: MATLAB 2015a.

Code & Output:

1. Correlation using xcorr function.

```
clc;
clear all;
close all;

x=input('Enter the value of F(X): - ');
y=x;
z=x+2;


R=xcorr(x,x);
a=xcorr(x,z);

subplot(4,1,1);
stem(x);
title('INPUT SIGNAL');
grid on

subplot(4,1,2);
stem(y);
title('ANOTHER INPUT SIGNAL');
grid on

subplot(4,1,3);
stem(R);
title('AUTO CORRELATION');
grid on

subplot(4,1,4);
stem(a);
title('CROSS CORRELATION');
grid on
```

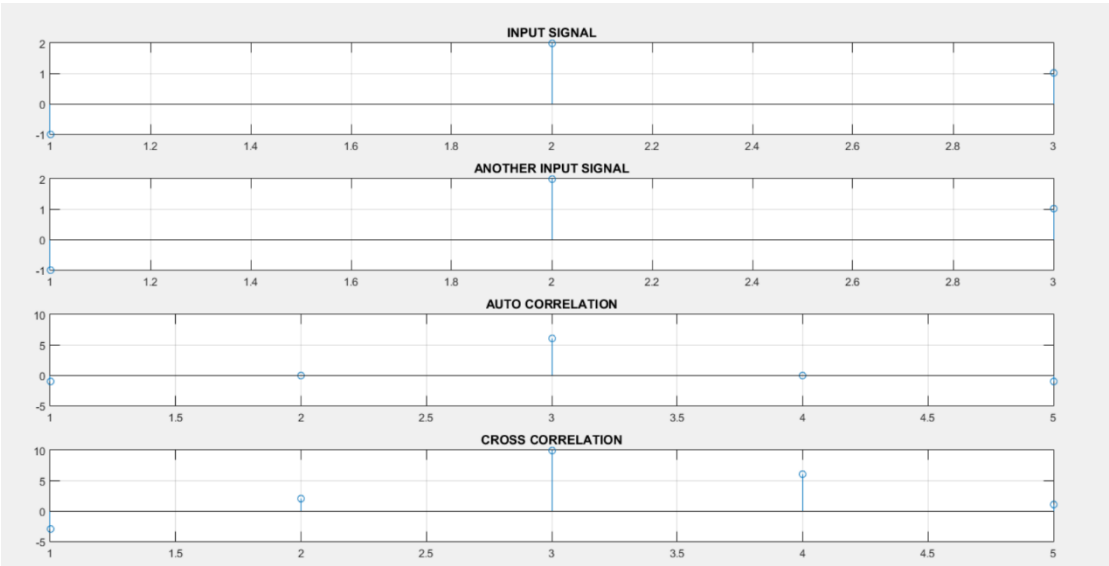


Figure1: Correlation using xcorr() function

```
x=input('Enter the value of F(X): - ');
y=input('Enter the value of H(X): - ');
z=x+2;
y=wrev(y);

a=xcorr(x,y);
XL=length(x);
YL=length(y);
z=zeros(1,XL+YL-1);
ZL=length(z);

for i=1:ZL
    for k=1:XL
        if i-k+1>0 && i-k+1 <= XL
            z(i) = z(i)+y(k)*x(i-k+1);
        end
    end
end

subplot(3,1,1);
stem(x);
title('INPUT SIGNAL');
grid on

subplot(3,1,2);
stem(y);
title('ANOTHER INPUT SIGNAL');
grid on

subplot(3,1,3);
stem(z);
title('AUTO/CROSS CORRELATION');
grid on
```

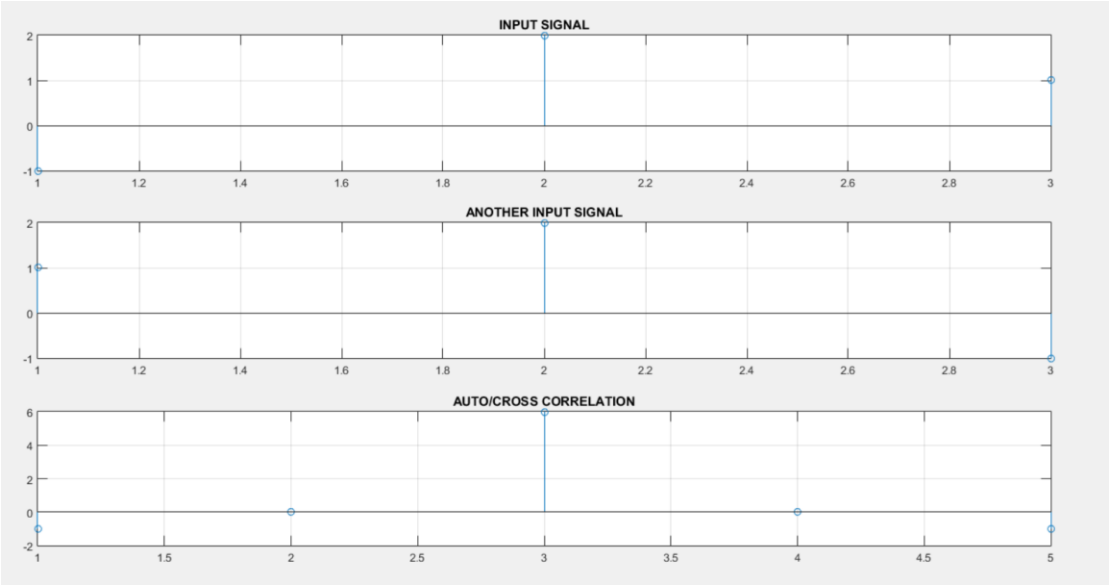
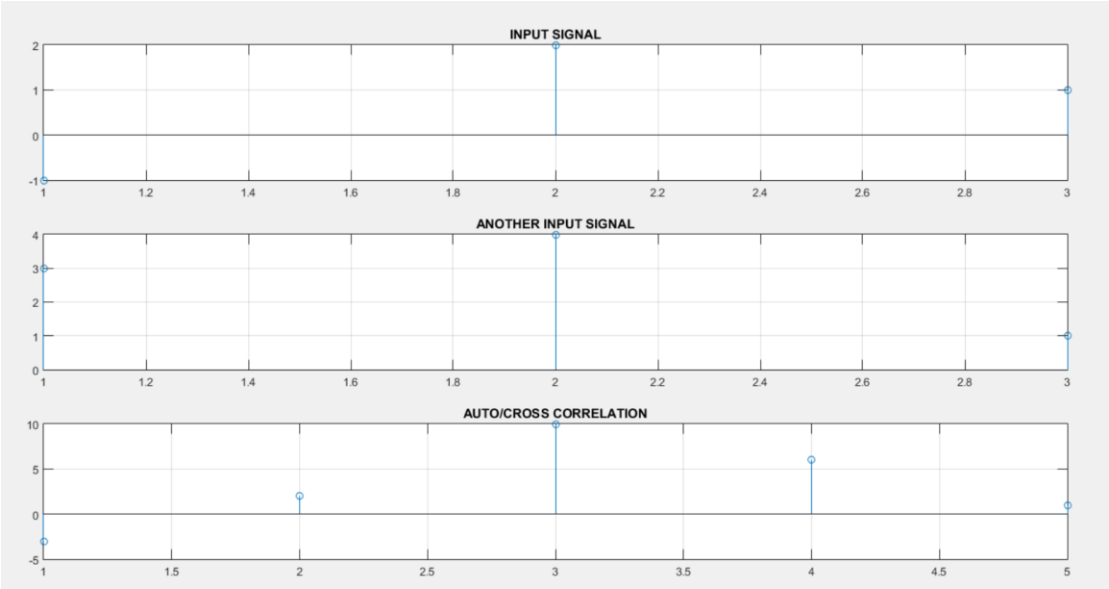


Figure2: Correlation without using xcorr() function

```
x=input('Enter the value of F(X): - ');
y=x+2;
z=x+2;
y=wrev(y);
a=xcorr(x,y);
XL=length(x);
YL=length(y);
z=zeros(1,XL+YL-1);
ZL=length(z);
for i=1:ZL
    for k=1:XL
        if i-k+1>0 && i-k+1 <= XL
            z(i) = z(i)+y(k)*x(i-k+1);
        end
    end
end
display(z);
l=max(z);
for i=1:ZL
    if(z(i)==l)
        m(i)=i;
    end
end
m(m==0)=[];
display(m);
subplot(3,1,1);
stem(x);
title('INPUT SIGNAL');
grid on
subplot(3,1,2);
stem(y);
title('ANOTHER INPUT SIGNAL');
grid on
subplot(3,1,3);
```

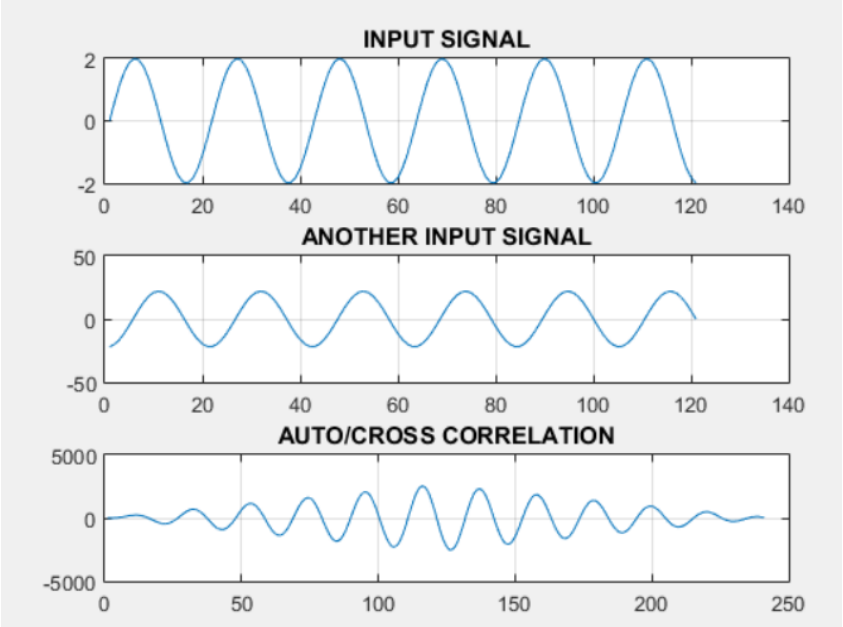



```
m =

     3
```

Figure3: Finding the X position of highest correlation.

```
t=0:0.1:12;
x=2*sin(3*t);
y=22*sin(3*t);
y=wrev(y);
a=xcorr(x,y);
ZL=length(a);
l=max(a);
for i=1:ZL
    if(a(i)==l)
        m(i)=i;
    end
end
m(m==0)=[];
display(m);
subplot(3,1,1);
plot(x);
title('INPUT SIGNAL');
grid on
subplot(3,1,2);
plot(y);
title('ANOTHER INPUT SIGNAL');
grid on
```




```
m =

   116
```

Figure4: Finding the X position of highest correlation in continuous signal

Discussion: This experiment is mainly focused on the correlation of 2 signals. The code is done in 2 different ways. Both give the same output. Later the position of X value is calculated.

Conclusion: We tried to find out the correlation of 2 signals. The output resembles our theory.

References:

1. What is Correlation in Signals and Systems?
https://www.tutorialspoint.com/what-is-correlation-in-signals-and-systems [Online]. [Accessed May8, 2023]

2. Understanding Correlation
https://www.allaboutcircuits.com/technical-articles/understanding-correlation/ [Online].
[Accessed May8, 2023]

3.correlation coefficient in DSP

https://www.linkedin.com/advice/0/what-some-common-applications-correlation [Online].
[Accessed May8, 2023]