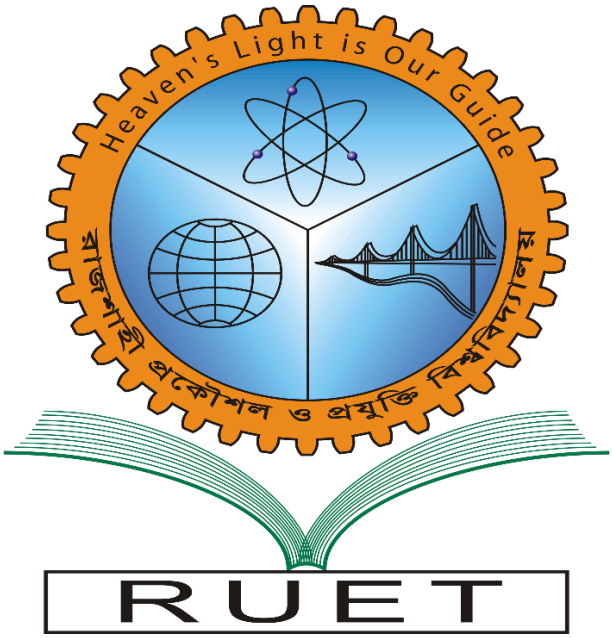
Heaven's Light is Our Guide

Rajshahi University of Engineering & Technology



Department of Electrical & Computer Engineering

Course No: ECE 4124

Course Title: Digital Signal Processing Sessional

Experiment No: 02
Experiment Name: Correlation of Signals

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Theory:

Correlation is a mathematical operation that is very similar to convolution. Correlation is an operation used in many applications in digital signal processing. It is a measure of the degree to which two sequences are similar.

Depending on whether the signals considered for correlation are same or different, we have two kinds of correlation:

(i) Auto-Correlation,
(ii) Cross-Correlation.

Auto-Correlation:
This is a type of correlation in which the given signal is correlated with itself, usually the time-shifted version of itself.
The autocorrelation of the discrete time signal $x(n)$ is expressed as,

$$r_{xx} = \sum_{n=-\infty}^{\infty} x(n) * x(n-m)$$

Cross-Correlation:
This is a kind of correlation, in which the signal in-hand is correlated with another signal so as to know how much resemblance exists between them.
The Cross-Correlation of the discrete time signals $x(n)$and $y(n)$ is expressed as,

$$r_{xy} = \sum_{n=-\infty}^{\infty} x(n) * y(n-m)$$

Code:
Auto-Correlation:

```
clc; clear all; close all;
x=input('enter the sequence');
h = fliplr(x);
z = [];
for i=1:length(x)
g = h.*x(i);
z = [z g];
end
z1=reshape(z,length(x),length(x),[]);
z2=z1';
z3 = flip(z2);
cd = 0;
y = [];
for i=length(x)-1:-1:-(length(x)-1)
cd=sum(diag(z3,i));
y=[y cd];
cd = 0;
end
auto_correlation = flip(y);
auto_correlation

subplot(2,1,1)
stem(x,'filled')
ylabel('Amplitude')
xlabel('Samples')
title('X(n)')

subplot(2,1,2)
stem(auto_correlation,'filled')
ylabel('Amplitude')
xlabel('Samples')
title('Auto Correlation')
```

Cross-Correlation:

```
clc;clear all;close all;
x= input('enter first sequence');
h = input('enter second sequence');
h1=fliplr(h);
z = [];
for i=1:length(x)
  g = h1.*x(i);
  z = [z g];
end
z1=reshape(z,length(x),length(x),[]);
z2=z1';
z3 = flip(z2);
cd = 0;
y = [];
for i=length(x)-1:-1:-(length(x)-1)
cd=sum(diag(z3,i));
y=[y cd];
cd = 0;
end
cross_correlation = flip(y);
cross_correlation
subplot(3,1,1)
stem(x,'filled')
ylabel('Amplitude')
xlabel('Samples')
title('X(n)')

subplot(3,1,2)
stem(h,'filled')
ylabel('Amplitude')
xlabel('Samples')
title('H(n)')

subplot(3,1,3)
stem(cross_correlation,'filled')
ylabel('Amplitude')
xlabel('Samples')
title('Cross Correlation')
```

Output:

For auto-correlation:

```
enter the sequence[1 2 3 4]

auto_correlation =

     4    11    20    30    20    11     4

>> xcorr(x,x)

ans =

    4.0000   11.0000   20.0000   30.0000   20.0000   11.0000    4.0000
```

Fig 2.1: Auto Correlation Output

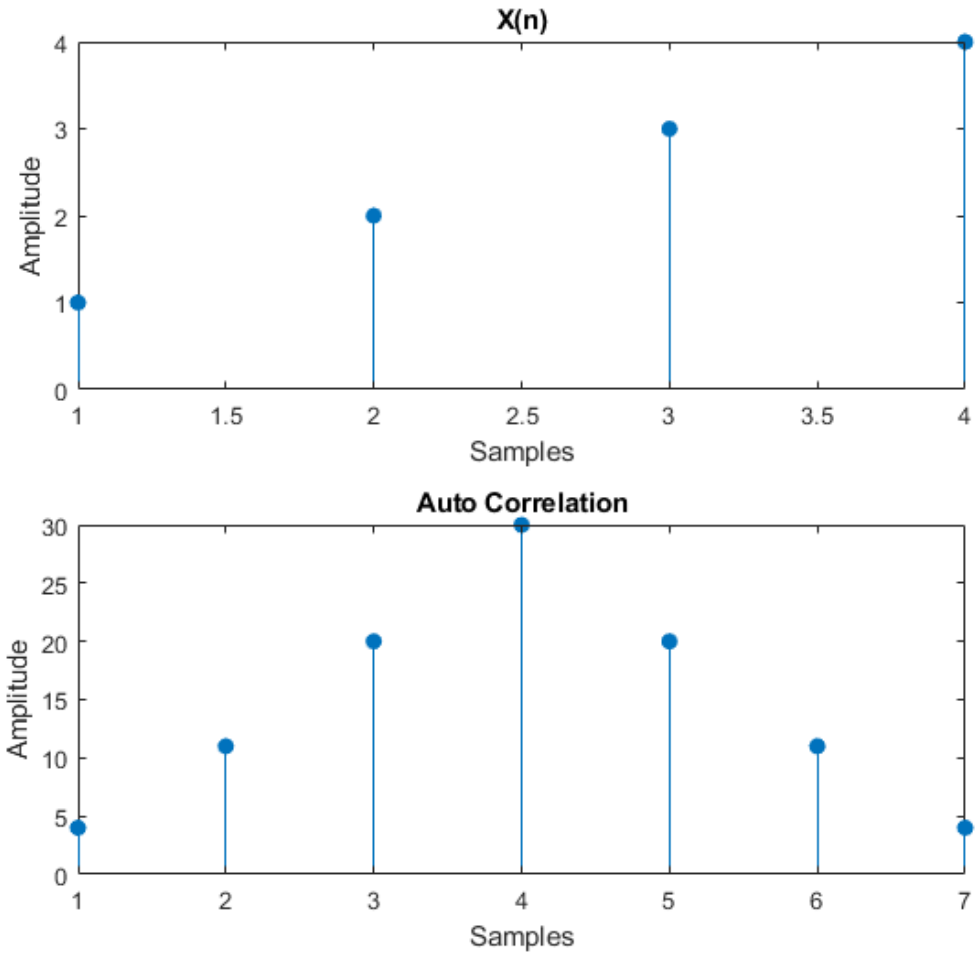

Fig 2.2: Auto Correlation Plot

For cross-correlation:

```
enter first sequence[1 0 0 1]
enter second sequence[4 3 2 1]
     4     3     2     5     3     2     1


cross_correlation =

     1     2     3     5     2     3     4

>> xcorr(x,h)

ans =

    1.0000    2.0000    3.0000    5.0000    2.0000    3.0000    4.0000
```

Fig 2.3: Cross Correlation Output

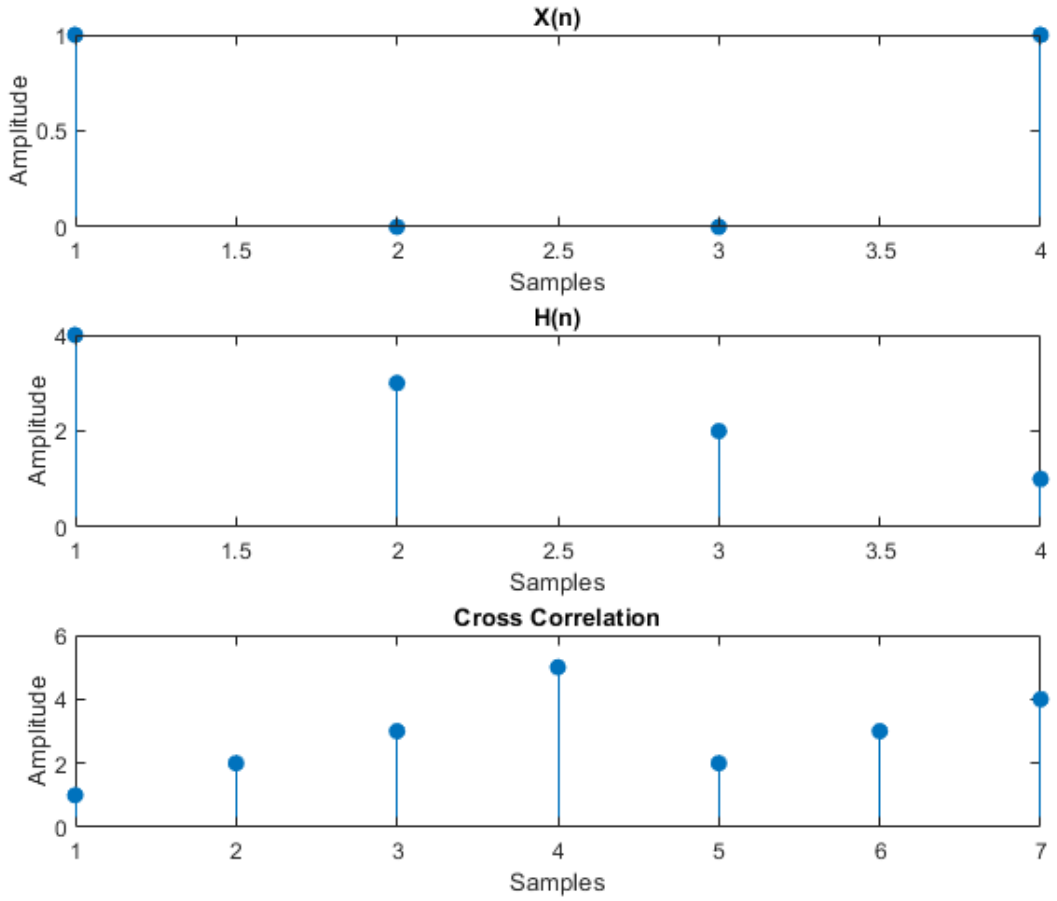

Fig. 2.4: Cross Correlation Plot

Conclusion:

In this experiment we were familiarized with auto-correlation and cross-correlation. We implemented both of these operation in MATLAB and verified the produced result by comparing with built in function output.