Heaven's Light is Our Guide

RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

LAB REPORT

Course No: EEE 4108

Course Name: Digital signal processing Sessional

Experiment No: 02

Experiment Name: Study of auto correlation and cross correlation of the given signals using MATLAB code

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Submitted By:	**Submitted To:**
Name: Md Maruf Hassan Roll: 1801105 Section: B Registration No: 285 Session: 2018-2019	Dr. Mohammod Abdul Motin Assistant Professor, Department of Electrical & Electronic Engineering Rajshahi University of Engineering & Technology

Experiment No: 02

2.1 Experiment Name:

Study of auto correlation and cross correlation of the given signals using MATLAB code

2.2 Objectives:

1. To get introduced to auto correlation and cross correlation

2. To know about auto correlation and cross correlation by using MATLAB code

2.3 Theory:

Auto-correlation and cross-correlation are concepts commonly used in signal processing, statistics, and various fields of science and engineering. They both deal with measuring the similarity or relationship between two signals or sequences, but they do so in different ways.

Auto-correlation:

Auto-correlation measures the similarity of a signal with a delayed version of itself. In other words, it quantifies how a signal correlates with a time-shifted version of itself. This is particularly useful in finding repeating patterns or periodicities within a signal. The auto-correlation function is often used to analyze time-series data and signals in fields like signal processing, audio processing, finance, and more.

Mathematically, the auto-correlation of a discrete signal or sequence x with a lag of k is denoted as R_xx(k) and is calculated as follows:

$$R_{xx}(k) = \sum_{n=0}^{N-1} x(n) \cdot x(n-k)$$

Where:

N is the length of the signal.

x(n) represents the signal value at time index

x(n−k) represents the signal value at time index n shifted by k time units.

Auto-correlation can help identify the period of a periodic signal, or it can be used to detect similarities in patterns within a signal.

Cross-correlation:

Cross-correlation measures the similarity between two different signals as a function of the time shift applied to one of the signals. It is used to find similarities between two signals and identify potential time delays between them. Cross-correlation is widely used in various applications, including image registration, pattern recognition, communication systems, and more.

Mathematically, the cross-correlation of two discrete signals x and y with a time lag of k is denoted as R_xy(k) and is calculated as follows:

$$R_{xy}(k) = \sum_{n=0}^{N-1} x(n) \cdot y(n-k)$$

Where:

N is the length of the signals.

x(n) and y(n) represent the signal values of the two sequences at time index

y(n−k) represents the signal value of sequence y at time index n shifted by k time units.

Cross-correlation can be used for tasks like finding similarities between two audio signals, aligning signals in time, and identifying patterns in different data sequences.

In both auto-correlation and cross-correlation, the resulting function provides information about the similarity or dissimilarity between the two signals at different time lags (for cross-correlation) or self-similarities at different lags (for auto-correlation). Peaks in the correlation functions often indicate strong similarities or repeating patterns.

2.4 Code for Auto-correlation:

```
clc
clear all
x=[1,2,3,4];%define the sequence
n1=0:1:3;%define the time interval
h=fliplr(x);%define flip version of x
n2= -fliplr(n1);%define auto correlation
mat=[];
% mutiply row wise matrix
for i=1:length(x)
    g=h.*x(i);
    mat=[mat;g];
end
% Summation of the Values
[r c]=size(mat);%to represent the number of rows and columns
lim= r+c;% it is the limit used for summation
t=2;% to define an iterator
y=[];%store the diagonal sum
s=0;%Temporary variable for sum
%diagonal sum part
while (t<=lim)
    for i=1:r
        for j=1:c
            if ((i+j)==t)
                s=s+mat(i,j);
            end
        end
    end
    t=t+1;
    y=[y s];
    s=0;
end
% Printing & Plotting
n3=min(n1)+min(n2);
n4=max(n1)+max(n2);
n5=n3:1:n4;
```

```
stem(n5,y)
title('Auto correlation');
xlabel('lag of n');
ylabel('X[n]');
```

2.5 Output waveform for Auto-correlation:

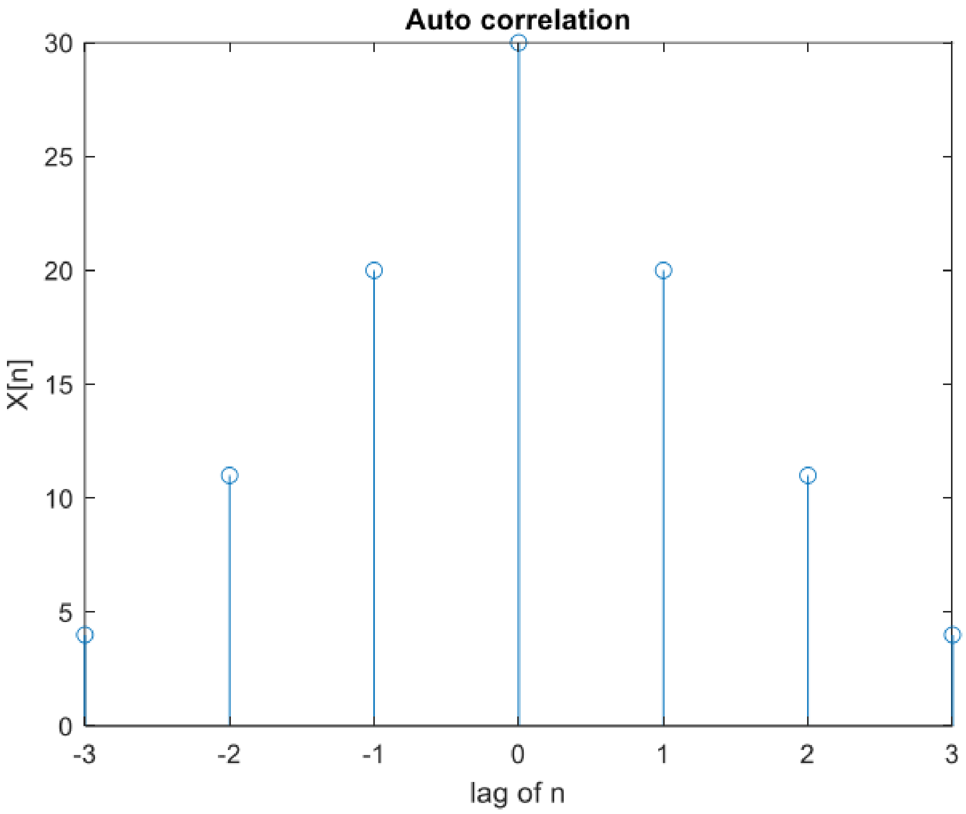

Fig.2.1. Auto correlation output waveform

2.6 Code for Cross-correlation:

```
clc
clear all
x = [1 2 3 4]; % define the first sequence
h = [4 3 4 3]; % define the second sequence
n1 = 0:1:3; % define the time interval for x
n2 = 0:1:3; % define the time interval for y
n2= -fliplr(n2); % define cross-correlation time interval
mat = [];
for i = 1:length(x)
   g = h.*x(i);
   mat = [mat;g];
end
% Summation of the Diagonal Values
[r, c] = size(mat);%to represent the number of rows and columns
lim= r+c;% it is the limit used for summation
t=2;% to define an iterator
y=[];%store the diagonal sum
```

```
s=0;%Temporary variable for sum
% Diagonal sum part
while (t <= lim)
   for i = 1:r
      for j = 1:c
         if ((i + j) == t)
            s = s + mat(i, j);
         end
      end
   end
   t  =t+1;
   y =[y s];
   s =0;
end
% Printing & Plotting
n3 = min(n1) + min(n2);
n4 = max(n1) + max(n2);
n5 = n3:1:n4;
stem(n5, y)
title('Cross correlation');
xlabel('lag of n');
ylabel('X[n]');
```

2.7 Output waveform for Cross-correlation:

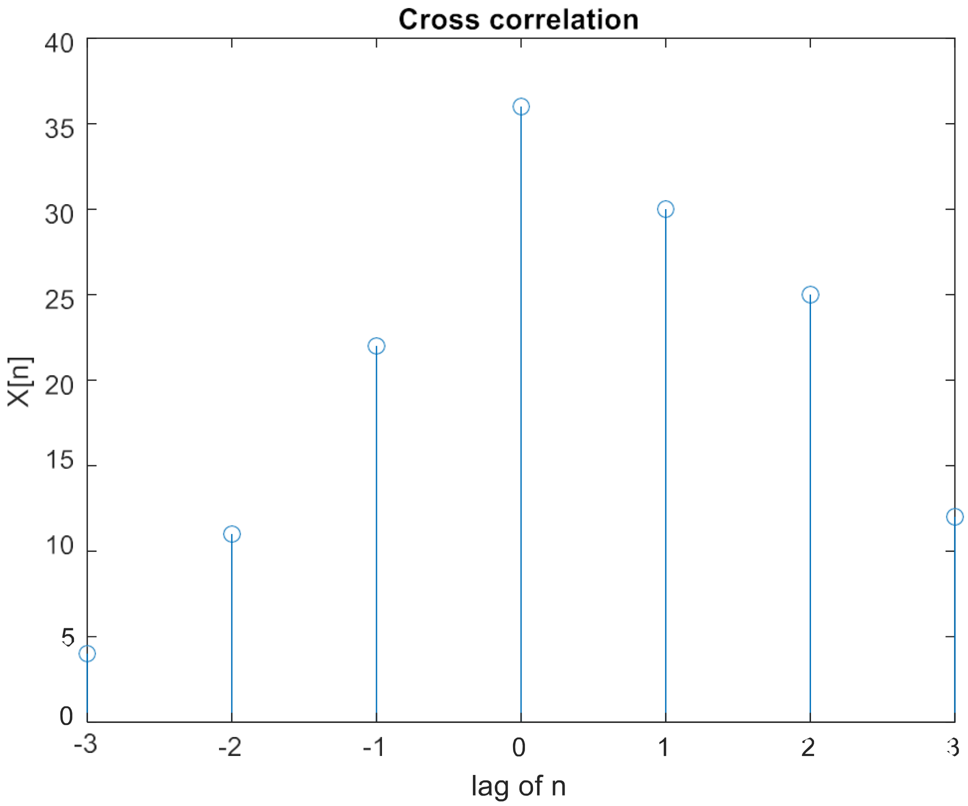

Fig.2.2. Cross correlation output waveform

2.8 Discussion and Conclusion: Auto-correlation and cross-correlation are indispensable tools for analyzing signals and data in diverse domains. They help in understanding the patterns, relationships, and time delays present within signals. In this experiment auto correlation and cross correlation graph plot and compare each other. Therefore, the experiment was successfully done.