Experiment No.: 03

Experiment Date: 08/03/2023

Experiment Name: Study of Auto Correlation and Cross Correlation with and Without Using Built In Function

Theory:

In the realm of digital signal processing (DSP), autocorrelation is a methodology that is utilized to determine how similar or correlated a signal is to itself at different points in time. This technique is widely used in fields like audio processing, speech recognition, and image processing. The autocorrelation of a discrete-time signal x[n] can be mathematically described using the following equation:

$$Rxx[k] = sum(x[n] * x[n-k])$$

In this equation:

- Rxx[k] represents the autocorrelation at lag k.

- x[n] is the input signal at time index n.

- k is the lag, which denotes the time delay between two instances of the signal.

By calculating the autocorrelation function, it is possible to determine the similarity between the original signal and a shifted version of itself at different time lags. This method is commonly used to identify repetitive or periodic patterns within a signal, as the autocorrelation will exhibit peaks at the corresponding lag values.

Cross-correlation is another technique that is frequently utilized in DSP to measure the correlation or similarity between two signals. It is commonly used in fields such as audio processing, image registration, and communication systems. The cross-correlation of two discrete-time signals x[n] and y[n] can be expressed using the following equation:

$$Rxy[k] = sum(x[n] * y[n-k])$$

In this equation:

- Rxy[k] represents the cross-correlation at lag k.

- x[n] is the first input signal at time index n.

- y[n] is the second input signal at time index n.

- k is the lag, indicating the time delay between the two signals.

By using the cross-correlation function, it is possible to determine the similarity between the two signals at different time lags. This technique is often used to identify the time delay or phase shift between signals, detect signal echoes or echoes, align signals in synchronization, and analyze the similarity between two signals.

Software Used:

Matlab

Matlab Code:

Autocorrelation:
Code:

```
clc

clear all

%x = input('Enter x: ')

x=[1 2 3 4];

y = fliplr(x);

N1 = length(x);

N2 = length(y);

n = N1+N2-1


R_man= zeros(1,n);


for i=0: n

   for j=0: n

       if((i-j+1)>0 && (i-j+1)<=N2 &&
(j+1)<=N1)

R_man(i+1)=R_man(i+1)+x(j+1)*y(i-j+1);

       end

   end

end


R_man

R_fun = xcorr(x,x)


subplot(3,1,1); stem(x); title('X');

subplot(3,1,2); stem(R_man);
title('R_{manual}');

subplot(3,1,3); stem(R_fun);
title('R_{function}');
```

Output:

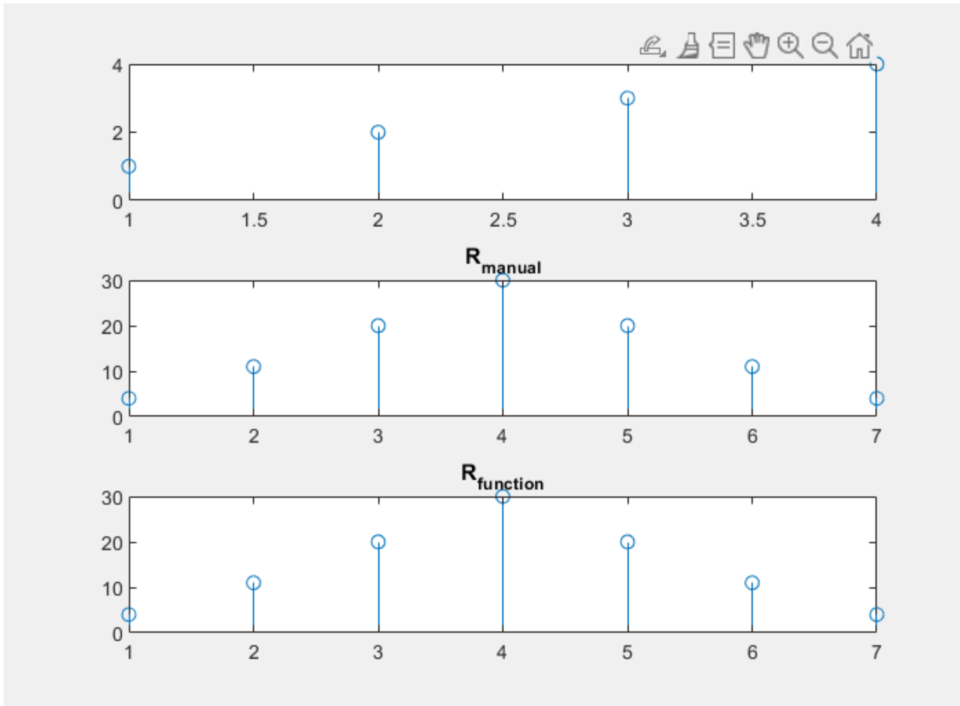

Fig. 1: Autocorrelation

Crosscorelation:

Code:

```
clc
clear all
x = input('Enter x: ')
%x=[-3 2 -1 1];
y = input('Enter y: ')
%y=[-1 0 -3 2];
R_fun = xcorr(x,y);
y = fliplr(y);
N1 = length(x);
N2 = length(y);

n = N1+N2-1;
R_man = zeros(1,n);

 for i=0: n
   for j=0: n
      if((i-j+1)>0 && (i-j+1)<=N2 && (j+1)<=N1)
R_man(i+1)=R_man(i+1)+x(j+1)*y(i-j+1);
      end
   end
 end
%p=[1 2 3]
```

```
%p'
%p(1)
%p=fliplr(p)
%p(1)
R_man
R_fun
subplot(4,1,1); stem(x); title('X');
subplot(4,1,2); stem(y); title('Y');
subplot(4,1,3); stem(R_man); title('R_{manual}');
subplot(4,1,4); stem(R_fun); title('R_{function}');
```

Output:

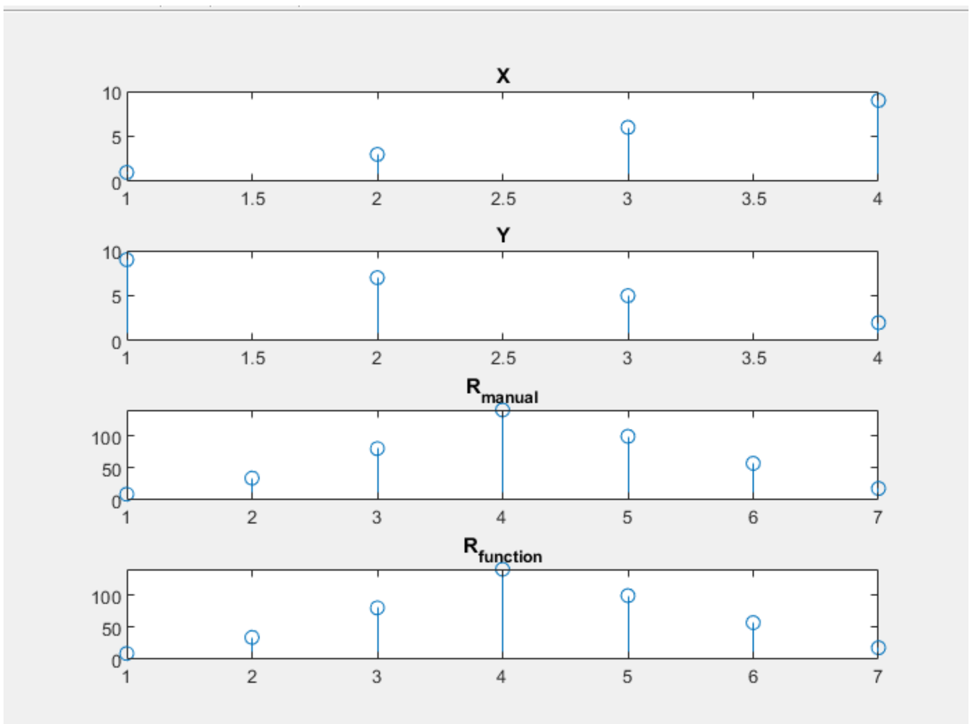

Fig. 2: Cross Correlation

Discussion:

In this report, we have discussed the fundamental concepts of auto and cross correlation and how they are employed in signal processing. Moreover, we have demonstrated MATLAB computation examples for both auto- and cross-correlation, where all the sample inputs have produced accurate results consistent with the theory. The output curves have also been plotted, allowing us to verify the correct sequence. In summary, auto and cross correlation are powerful techniques for analyzing data, and they find extensive application in various engineering and scientific fields.

Conclusion:

The experiment was successful since the resulting output agreed with the theory.