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2 | Experiment Name

1. Study of Auto-correlation using MATLAB code.
2. Study of Cross-correlation using MATLAB code.
3. Study of identifying delay of a function using correlation

3 | Introduction

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. [1]

3.1 | Auto Correlation

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

3.2 | Cross correlation

In signal processing, cross-correlation is a measure of the similarity of two series as a function of the displacement of one relative to the other. This is also known as a sliding dot product or sliding inner product. It is commonly used for searching a long signal for a shorter, known feature.

3.3 | Application of correlation: Identifying delay

In correlation, if the correlation between a signal & its delayed copy is calculated then maximum magnitude will be obtained at a delayed time. That is, the peak of the correlation function occurs at the lag with the best similarity between the two signals, i.e. the estimated delay.

4 | Objectives

The main objectives of this experiment were:

- To find the autocorrelation & cross-correlation of the input sequence without using the built function **'xcorr()'**
- To develop an algorithm to identify the delay time of a given function.

5 | Equipment Required

MATLAB

6 | Matlab Code

Here is the input code of above experiments-

6.1 | Auto Correlation

```
clc;
clear all;
x=input('X ');
m1=length(x);
len=2m1-1;
y=[x,zeros(1,(m1-1))];
n=len;
while(n>=1)
    r(len-n+1)=0;j=n;i=m1;
    while(i>=1 && j>=1)
        r(len-n+1) = r(len-n+1)+x(i)*y(j);
        j=j-1;  i=i-1;
    end
   n=n-1;
end
```

6.2 | Cross Correlation

```
clc;
clear all;
x=input('X ');
y=input('Y ');
m1=length(x);
m2=length(y);
len=m1+m2-1;
y=[y,zeros(1,(m1-1))];
n=len;
while(n>=1)
    r(len-n+1)=0;j=n;i=m1;
    while(i>=1 && j>=1)
        r(len-n+1) = r(len-n+1)+x(i)*y(j);
        j=j-1;  i=i-1;
    end
   n=n-1;
end
```

6.3 | Identifying Delay

```
clc;
clear all;
t=1:1:20;
x=2*t;
m1=length(x);
len=2*m1-1;
delay=input('delay: ');n=len;
y=[zeros(1,m1-1-delay), x ,zeros(1,delay)];
while(n>=1)
    r(len-n+1)=0;j=n;i=m1;
    while(i>=1 && j>=1)
        r(len-n+1) = r(len-n+1)+x(i)*y(j);
        j=j-1;  i=i-1;
    end
   n=n-1;
end
```

7 | Result & Discussion

Here is the outcome of above code-

7.1 | Output of auto Correlation

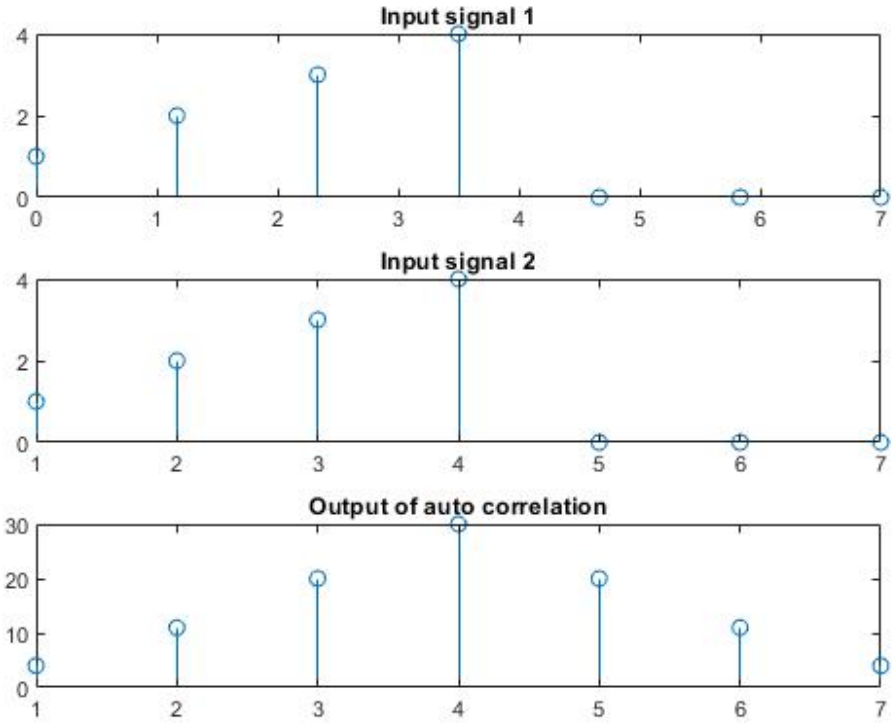

Figure 7.1: Graphical Plot of autocorrelation

7.2 | Output of cross Correlation

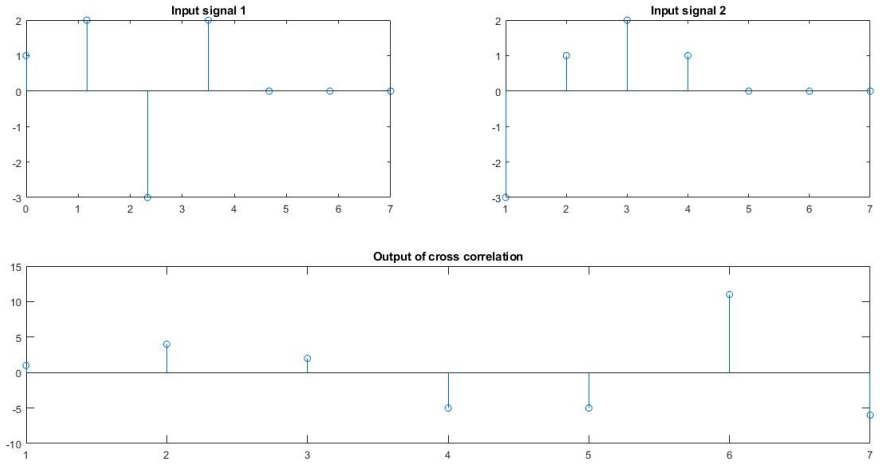

Figure 7.2: Graphical Plot of crosscorrelation

7.3 | Plotting for identifying delay signal

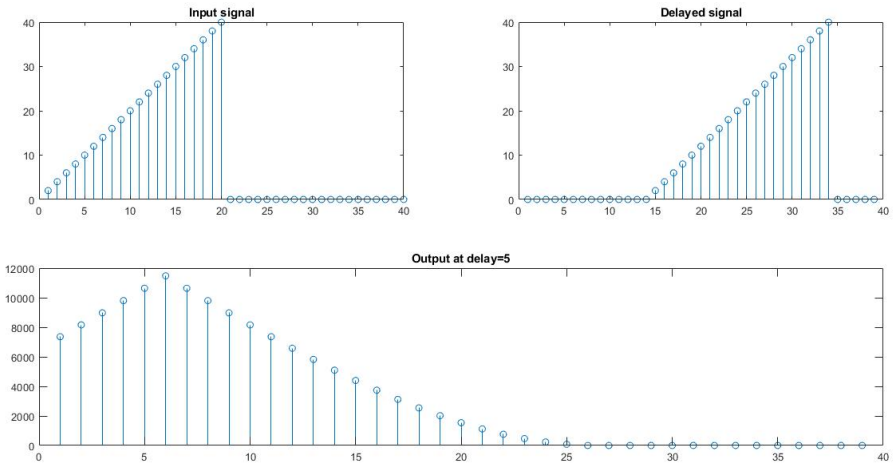

Figure 7.3: Graphical Plot delay signal

The outcomes of this experiment were achieved as desired. For both the auto & cross-correlation we used the same lines of code except a second input sequence was taken for cross-correlation. At first, we shifted one of the input sequences n-1 times where n is the length of the signal. As the array index can not be zero or negative we have shifted the signal by inserting zeros at the end which gave the padding effect. The input sequences were added with the corresponding value. Then this signal was shifted to the right one by one & kept repeating the previous step.
For identifying the delay time of a signal we used the above correlation method where a second signal was generated by delaying the input signal. And the delay was included by adding zeros from the beginning of an array for padding. We observed that the peak value was obtained at the time of delay from Fig. 7.3.

8 | Conclusion

The experiment was successful & we did not encounter any error while running the ***Matlab*** code.

9 | References

[1] Understanding Correlation - Technical Articles, 1 2017.