"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: 03

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Experiment No: 03

Experiment Name: Study of

1. Auto correlation using and without using built-in function
2. Cross correlation using without using built-in function

Theory

In digital signal processing, correlation refers to the mathematical operation that measures the similarity between two signals. It is a commonly used technique in various applications such as pattern recognition, speech recognition, and audio processing. Correlation is used in many signal processing algorithms such as cross-correlation, auto-correlation, and correlation-based feature extraction. Auto-correlation and cross-correlation are two related but distinct concepts in digital signal processing.

Auto-correlation measures the similarity of a signal with a delayed version of itself. It is a specific type of correlation used to analyze time series data. The auto-correlation function is defined as:

Rxx(k) = sum[x(n) * x(n-k)], where k is the time delay (or lag), and x(n) is the signal.

In contrast, cross-correlation measures the similarity between two different signals. The cross-correlation function is defined as:

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

where k is the time delay (or lag), and x(n) and y(n) are two different signals. The cross-correlation function measures how much one signal resembles another signal at different time lags. A positive cross-correlation value indicates that the two signals are correlated, while a negative cross-correlation value indicates that the two signals are anti-correlated.

Both auto-correlation and cross-correlation are useful tools in digital signal processing. Auto-correlation is useful for analyzing periodicity and estimating the fundamental frequency of a signal, while cross-correlation is useful for detecting similarities between two different signals and for estimating time delays between signals. Both auto-correlation and cross-correlation are widely used in various applications such as speech processing, audio analysis, and time series analysis. [1]

Code: (Auto correlated signal)

```
clc;
clear all;
close all;

x=[1,2,3,4];
y=fliplr(x);

z=zeros(1,length(x) + length(y)-1);

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

figure(1);
subplot(3,1,1);
stem(x);
title('Signal');
subplot(3,1,2);
stem(z);
title('Auto correlated Signal');
grid on;
subplot(3,1,3);
w=xcorr(x,x);
stem(w);
title('checked Auto correlated Signal');
grid on;

```

Output:

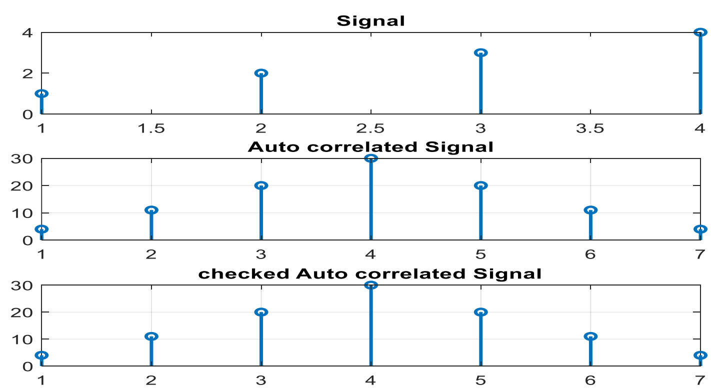

Figure 3.1: Output of auto correlation

Code: (Cross correlated signal)

```
clc;
clear all;
close all;

x=[1 2 3 4 5];
y=[4 5 1 2 3];

z=zeros(1,length(x) + length(y)-1);

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

figure(1);
subplot(4,1,1);
stem(x);
title('Signal 1');

subplot(4,1,2);
stem(y);
title('Signal 2');

subplot(4,1,3);
stem(z);
title('cross correlated Signal');
grid on;

subplot(4,1,4);
w=xcorr(x,y);
stem(w);
title('checked cross correlated Signal');
grid on;
```

Output:

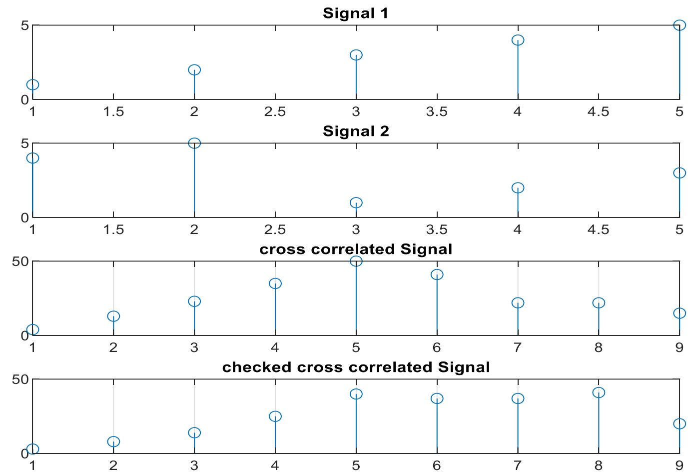

Figure 3.2: Output of cross correlation

Conclusion & Discussion

The code was executed successfully and no errors were found. Form this experiment, we had learned that Auto and cross correlation are two important concepts in signal processing and are commonly used in various applications such as pattern recognition, communications, and control systems. Auto correlation can be computed using different methods, such as direct correlation, FFT-based correlation, and Wiener-Khinchin theorem. Cross correlation, on the other hand, measures the similarity between two signals as a function of their relative time shift. It is commonly used for aligning two signals, detecting signal delays, and finding similarities between different signals. Cross correlation can be computed using different methods, such as direct correlation, FFT-based correlation, and normalized correlation.

In this report, we have discussed the basic concepts of auto and cross correlation and their applications in signal processing. We have also provided examples of how to compute auto and cross correlation using MATLAB. Overall, auto and cross correlation are powerful tools for analyzing and processing signals, and their applications are widespread in various fields of engineering and science.

References:

[1] http://brennen.caltech.edu/fluidbook/measurement/expttechniques/correlation.pdf