Rajshahi University of Engineering & Technology

Department of Electrical & Computer Engineering

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Submitted to

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Experiment No: 03

Experiment Name: Study of Auto Correlation & Cross Correlation

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Theory :

Auto Correlation: The autocorrelation technique is used in signal processing to measure how similar a signal is to a delayed version of itself. Calculating autocorrelation involves using a mathematical tool called the autocorrelation function. At various lags, the autocorrelation function calculates the correlation between a signal and a delayed version of itself. It is frequently used to find cyclic or periodic patterns in a signal. The signal is multiplied by a time-delayed version of itself to determine the autocorrelation function. All time lags are added together, and the result is then normalized.

Autocorrelation is really applied to a variety of signal processing tasks, including audio, picture, and video processing. For instance, autocorrelation can be utilized to derive pitch information from a speech signal in speech recognition. Autocorrelation in image processing can be used to find recurring patterns in pictures, like the texture of a cloth or the placement of pixels in a digital image.

Cross Correlation: A mathematical method called cross-correlation is used in signal processing to calculate how similar two signals are in relation to their time delay. It is frequently used to identify and quantify the phase shift or time delay between two linked signals. In cross-correlation, the "test signal" is slid across the "reference signal" to compare it to another signal, the "reference signal," and to determine how similar the two signals are at each time point. This calculation yields a brand-new signal known as the cross-correlation function, which measures how similar the two signals are in relation to the gap in time between them.

Cross-correlation is a signal processing technique that is actually applied to a number of signal processing tasks, including audio processing, voice recognition, image processing, and video processing. Cross-correlation, for instance, in audio processing can be used to identify and gauge the temporal delay between two microphones, which is crucial for applications like spatial audio processing and noise reduction. Cross-correlation can be used in image processing to find and follow objects in video streams.

Software: MATLAB

Code:

Auto Correlation:

```
clc
clear all
close all

x = [1, 4, 1, 4, 2];
n = length(x);
y = zeros(1, 2*n-1);
z = xcorr(x);

    for delay = -n+1:n-1
    if delay <0
    y(delay+n) = sum(x(1:n+delay) .* x(-delay+1:n));
    elseif delay == 0
    y(delay+n) = sum(x.^2);
    else
    y(delay+n) = sum(x(delay+1:n) .* x(1:n-delay));
    end
    end

    subplot(3,1,1)
    stem(x);
    title('General Function');

    subplot(3,1,2)
    stem(z);
    title('Auto Correlation with Correlation Function');

    subplot(3,1,3)
    stem(y);
    title('Auto Correlation without Correlation
Function');
```

Cross Correlation:

```
clc
clear all
close all

x1 = [-3, 2, -1, 1];
x2 = [-1, 0, -3, 2];
n = length(x1);
y = zeros(1, 2*n-1);
z = xcorr(x1, x2);

    for delay = -n+1:n-1
    if delay <0
    y(delay+n) = sum(x1(1:n+delay) .* x2(-delay+1:n));
    elseif delay == 0
    y(delay+n) = sum(x1.^2);
    else
    y(delay+n) = sum(x1(delay+1:n) .* x2(1:n-delay));
    end
    end

    subplot(4,1,1)
    stem(x1);
    title('General Function 1');

    subplot(4,1,2)
    stem(x2);
    title('General Function 2');

    subplot(4,1,3)
    stem(z);
    title('Cross Correlation with Correlation Function');

    subplot(4,1,4)
    stem(y);
    title('Cross Correlation without Correlation
  Function');
```

Output :

Auto Correlation:

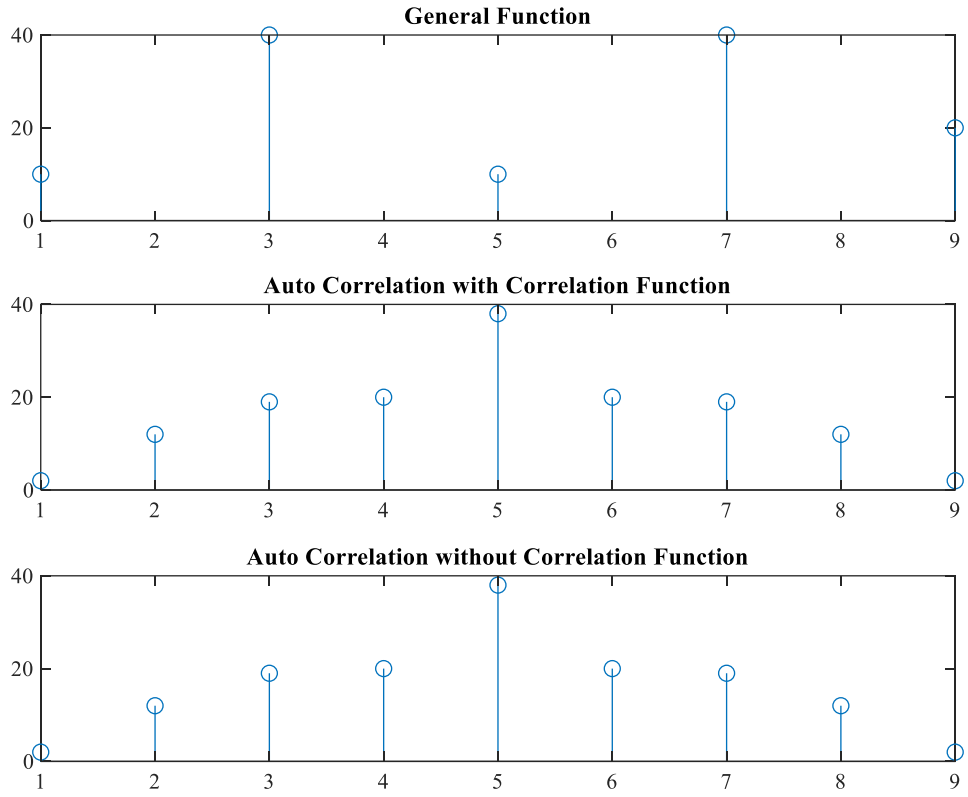

Fig 3.1 Auto Correlation

Cross Correlation:

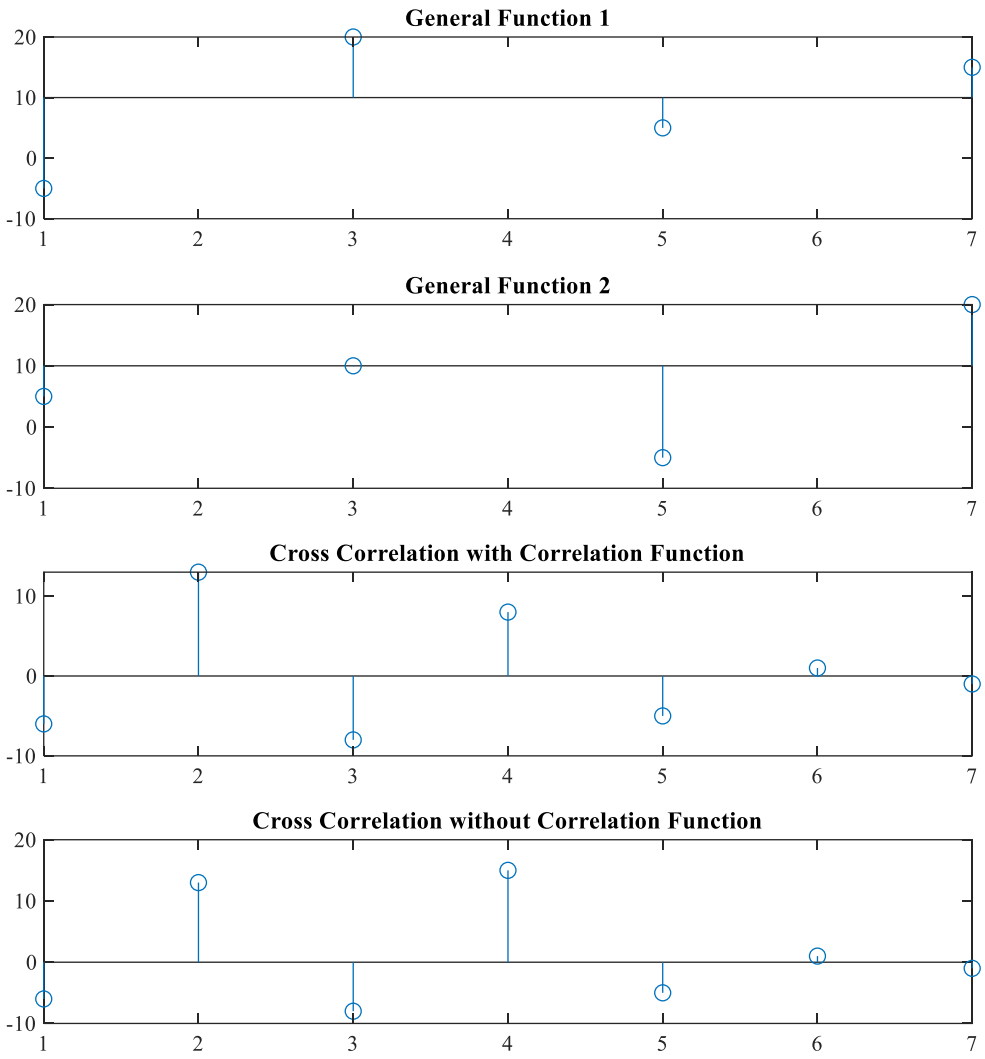

Fig 3.2 Cross Correlation

Discussion : In this experiment, we learned how to use 'xcorr' function to implement auto correlation and cross correlation in MATLAB. Also, we implemented auto correlation and cross correlation without using the 'xcorr' function; hence, we coded manually.

Conclusion : The graphs we got were as expected. The codes worked as intended and were executed without any errors. So, we can come to a conclusion that the experiments were done successfully.