Heaven's Light is Our Guide

Rajshahi University of Engineering& Technology

Department of Electrical & Computer Engineering

Course No: ECE 4124
Course Name: Digital Signal Processing Sessional

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Experiment Name: Calculation and representation of auto-correlation and cross-correlation using MATLAB.

Theory: The correlation between two functions is a measure of their similarity – if two functions are very similar, then they have a high correlation.

The correlation is similar to the convolution but simpler in a fundamental way: the functions in the correlation do not represent a signal and response as in the convolution, but rather just two functions that are usually suspected of having some measurable similarity. For example, a transmitted radar signal is expected to have some similarity to its corresponding time-delayed received signal.

$$\mathrm{Corr}(p,q) = \int_{-\infty}^{\infty} p(\tau + t)q(\tau)d\tau$$

Autocorrelation is simply the correlation of a function with itself. The same mathematical techniques and numerical routines that apply to correlation. The "Weiner-Khinchin Theorem" states: [1]

$$\mathrm{Corr}(p,p) \leftrightarrow |P(\omega)|^2$$

Software used: MATLAB

Code:

Autocorrelation:

```
clc;
clear all;
close all;

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

C=x.'*h;

k=length(x);
l=length(h);
n=k+l-1;

for i=1:n
    y(i)=0;
    for j=1:k
        s=i-j;
        m=i-j+1;
        if(s<k && m>0)
            y(i)=y(i)+C(m,j);
        end
    end
```

```
end

z=xcorr(x);
fprintf('The convoluted values using function:');
disp(z);

fprintf('The convoluted values without functio:');
disp(y);

subplot(3,1,1);
stem(x);
title('The input Signal x(n)');
subplot(3,1,2);
stem(z);
title('The auto-correlation using function');
subplot(3,1,3);
stem(y);
title('The auto-correlation using logic');
```

Cross correlation:

```
clc;
clear all;
close all;

x=[1 2 3 4];
w=[4 3 2 1];
h=fliplr(w);

C=x.'*h;

k=length(x);
l=length(h);
n=k+l-1;

for i=1:n
    y(i)=0;
    for j=1:k
        s=i-j;
        m=i-j+1;
        if(s<k && m>0)
            y(i)=y(i)+C(m,j);
        end
    end
end

z=xcorr(x,w);
fprintf('The convoluted values using function:');
disp(z);

fprintf('The convoluted values without functio:');
disp(y);

subplot(4,1,1);
```

```
34. stem(x);
35. title('The 1st input Signal x(n)');
36. subplot(4,1,2);
37. stem(w);
38. title('The 2nd input Signal w(n)');
39. subplot(4,1,3);
40. stem(z);
41. title('The cross-correlation using function');
42. subplot(4,1,4);
43. stem(y);
44. title('The cross-correlation using logic');
```

Output:

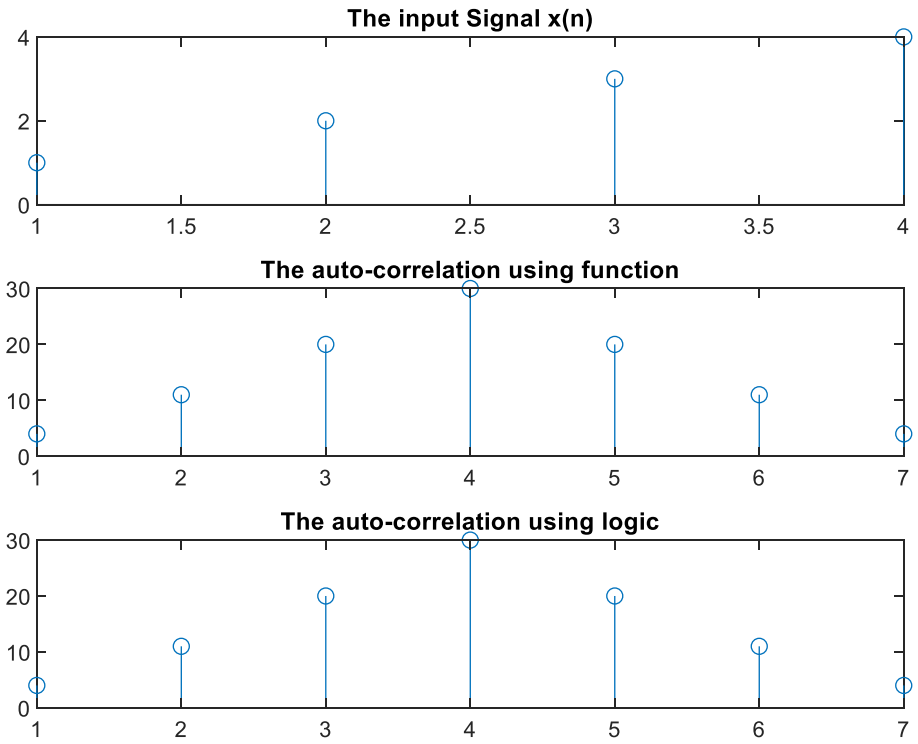
Autocorrelation:

```
Command Window
  The convoluted values using function:    4.0000   11.0000   20.0000   30.0000   20.0000   11.0000    4.0000

  The convoluted values without functio:     4    11    20    30    20    11     4
```

Fig. 1 Values of autocorrelation with and without function.

Plotting:



ig. 2 Plotting of autocorrelation with and without function.

Cross correlation:

```
Command Window
  The convoluted values using function:    1.0000    4.0000   10.0000   20.0000   25.0000   24.0000   16.0000

  The convoluted values without functio:     1     4    10    20    25    24    16
```

Fig. 1 Values of cross correlation with and without function.

Plotting:

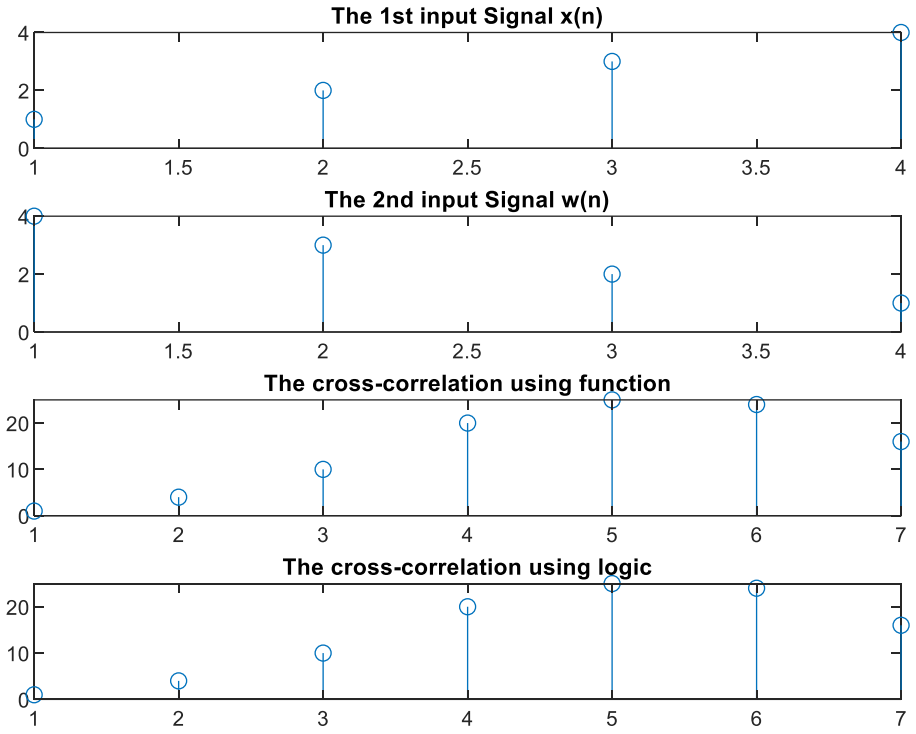


Fig. 2 Plotting of cross correlation with and without function.

Discussion: In the experiment, we have worked with the correlation between two signals. At first, we observed the autocorrelation of a signal that is the correlation of a signal with its delayed version. Then, we observed the cross correlation of the two different signals. In both of the cases, the value or plot with the built in function and with using logic were identical.

Conclusion: All the code and plots run successfully in the experiment without any type of error or complexities.