Experiment 2 : Discrete Correlation

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Experiment No.	2

AIM:	The aim of this experiment is To study mathematical operation correlation and measure degree of similarity between two signals.
OBJECTIVE:	1. Write a function to find Correlation Operation 2. Calculate correlation of a DT signals and verify the results using mathematical formula
INPUT SPECIFICATION:	1. Length of first Signal L and signal values. 2. Length of second Signal M and signal values.
PROBLEM DEFINITION:	1. Find auto correlation of input signal and find the significance of value of output signal at n=0. Let y[n] = x[n] O x[n] Classify the resultant signal(Even / Odd). Calculate the energy of the signal . Q. What is the significance of value of y[0]. 2. Find auto correlation of delayed input signal. Let p[n]= x[n-1] O x[n-1]. Compare the resultant signal p[n] with y[n]. Give your conclusion. 3. Find cross correlation of input signal and delayed input signal q[n] = x[n] 0 x[n-1]. Compare the resultant signal q[n] with p[n] and y[n] Give your conclusion. 4. Find cross correlation of input signal and scaled input signal. Let s[n] = x[n] O a x[n-2] where "a" is any constant.Compare the resultant signals.Give your conclusion.

CODE and result analysis

X[n]={ 6 , 12 , 7 , 14 }

- **Case 1: y[n] = x[n] o x[n]**

Code result :

```
/tmp/wpd6z48hmU.o
Enter the number of discrete points in the first signal (n1): 4
Enter the first signal (x): 6 12 7 14
Enter the number of discrete points in the second signal (n2): 4
Enter the second signal (y): 6 12 7 14

Correlation result y[n]:
84.00   210.00   254.00   425.00   254.00   210.00   84.00

Maximum correlation value: 425.00
Hence n=0 is at : 425.00
```

Result analysis :

x = [6, 12, 7, 14] L = 4
a = [6, 12, 7, 14] M = 4
Final Correlation Sequence for (k = -3) to (k = 3):
Y[n] = [84, 210, 254, 425, 254, 210, 84]

Here, y[n] = y[-n] That means, autocorrelation output signal y[n] is an even signal.
AT n=0, y[0] is Maximum value. y[0] is the energy of signal x[n]

- **Case 2 : p[n] = x[n-1] o x[n-1]**

Code result :

```
Enter the number of discrete points in the first signal (n1): 5
Enter the first signal (x): 0 6 12 7 14
Enter the number of discrete points in the second signal (n2): 5
Enter the second signal (y): 0 6 12 7 14

Correlation result y[n]:
0.00   84.00   210.00   254.00   425.00   254.00   210.00   84.00   0.00

Maximum correlation value: 425.00
Hence n=0 is at : 425.00
```

Result anaylsis :

x = [0, 6, 12, 7, 14]   L=5
y = [0, 6, 12, 7, 14]   M=5
Final Correlation Sequence for(k = -4) to (k = 4):
P[n] = [0, 84, 210, 254, 425, 254, 210, 84, 0]

We can observe that when we perform autocorrelation on the delayed output then the result is same as y[n] in the above case . hence p[n] = y[n]

- **Case 3 : q[n] = x[n] o x[n-1]**

Code result :

```
Enter the number of discrete points in the first signal (n1): 4
Enter the first signal (x): 6 12 7 14
Enter the number of discrete points in the second signal (n2): 5
Enter the second signal (y): 0 6 12 7 14

Correlation result y[n]:
84.00   210.00   254.00   425.00   254.00   210.00   84.00   0.00

Maximum correlation value: 425.00
```

Result analysis :

x = [6, 12, 7, 14]
y = [0, 6, 12, 7, 14]
Final Correlation Sequence for k = -4 to k = 4:
q[n] = [84, 210, 254, 425, 254, 210, 84, 0]

When we perform the correlation operation on x[n] and x[n-1] (delayed signal) the result obtained is an advanced signal . i.e. q[n] = y[n+1] = Advanced y[n] . If one of the signal is delayed by ‘1’ unit then the zero n=0 point of original result is advanced (shifted to left)by ‘1’unit .

- **Case 4 : r[n] = x[n] o x[n-2]**

Code result :

```
Enter the number of discrete points in the first signal (n1): 4
Enter the first signal (x): 6 12 7 14
Enter the number of discrete points in the second signal (n2): 6
Enter the second signal (y): 0 0 6 12 7 14

Correlation result y[n]:
84.00    210.00    254.00    425.00    254.00    210.00    84.00    0.00    0.00

Maximum correlation value: 425.00
```

Result analysis :

x = [6, 12, 7, 14]
y = [0 ,0 , 6, 12, 7, 14]
Final Correlation Sequence for k = -5 to k = 5:
s[n] = [0, 0, 84, 210, 254, 425, 254, 210, 84, 0, 0]

When we perform the correlation operation on x[n] and x[n-2] (delayed signal) the result obtained is an advanced signal . i.e. q[n] = y[n+2] = Advanced y[n] . If one of the signal is delayed by '2' unit then the zero (n=0) point of original result is advanced (shifted to left) by '2'unit . Hence we can conclude that If one of the signal is delayed by 'A' unit then the zero (n=0) point of original result is advanced (shifted to left) by 'A'unit

- **Case 5 : s[n] = x[n] o x[n-2]**

Code result :

```
Enter the number of discrete points in the first signal (n1): 4
Enter the first signal (x): 6 12 7 14
Enter the number of discrete points in the second signal (n2): 6
Enter the second signal (y): 0 0 12 24 14 28

Correlation result y[n]:
168.00    420.00    508.00    850.00    508.00    420.00    168.00    0.00    0.00


Maximum correlation value: 850.00
```

Result analysis :

x = [6, 12, 7, 14]
y = [0, 0, 12, 24, 14, 28]
Final Correlation Sequence for k = -5 to k = 5:
rxy = [0, 168, 420, 508, 850, 508, 420, 168, 0, 0, 0]

When we perform the correlation operation on x[n] and a*x[n-2] (delayed and scaled signal) the result obtained is an scaled advanced signal . i.e. q[n] = a*y[n+2] . If one of the signal is delayed and scaled by ‘2’ unit then the zero (n=0) point of original result is advanced (shifted to left) and scaled by ‘2’unit . Hence we can conclude that If one of the signal is scaled ‘A’ unit then the result is scaled by ‘A’unit

CONCLUSION:	• The value at n=0 represents the energy of the original signal. This is because it is the sum of the squares of the signal's values.Therefore, y[0] gives us the total energy of the signal. • The auto correlation of x[n-1] is same as x[n] • The result obtained by correlation of x[n] and x[n-1] is advanced by 1 unit. • The result obtained by correlation of x[n] and x[n-m] is advanced by m unit . • The result obtained by correlation of x[n] and a*x[n-1] is scaled by a units . • Delay and scaling impact the correlation functions but don’t change the fundamental nature of the signals, like energy or symmetry. The analysis of these factors is crucial in many practical applications such as communication systems, signal processing, and time series analysis. • Cross-correlation of input signal with delayed signal is same as advanced autocorrelated input signal.