

Experiment No: 04

Experiment Date: 15-05-2023

Experiment Name: Study of Time Delay of a Signal Using the Cross-correlation Method

Theory: Time delay basically refers to the delay that separates the occurrence of two events, it is the time required for a signal to travel through a system or under certain processing conditions. Time delay plays a huge role in signal processing applications. It occurs in various stages of signal processing such as DSP filters, multi-rate filters, signal conversion etc. In signal processing, cross-correlation is a measure of the similarity between two series as a function of the transition from one series to another. It is also known as sliding dot product or sliding inner product. This is usually used to search for a shorter known feature of a long signal. It has applications in pattern recognition, single particle analysis, electron tomography, averaging, cryptanalysis, and neurophysiology. Cross correlation is similar in nature to the convolution of two functions.

Code:

```
clc
clear all
t=0:0.1:40
x1=(t>=0 & t<=10);
x2=(t>=10 & t<=15);
x3=(t>=15 & t<=25);
x4=(t>=25 & t<=40);
s1 = 1*x1+0*x2-1*x3+0*x4;
subplot(3,1,1);
plot(t,s1);
title('Signal');
d = input('Enter delay value:');
x5=(t>=0+d & t<=10+d);
x6=(t>=10+d & t<=15+d);
x7=(t>=15+d & t<=25+d);
x8=(t>=25+d & t<=40+d);
s2 = 1*x5+0*x6-1*x7+0*x8;
subplot(3,1,2); plot(t,s2);
title('Delayed Signal');
```

```

s3 = xcorr(s1,s2);
subplot(3,1,3);
plot(s3);
title('Cross-correlation');
max_index= max(s3);
fprintf('Delay = %d\n', d);
fprintf('Max Index = %d\n', max(s3));

```

Output:

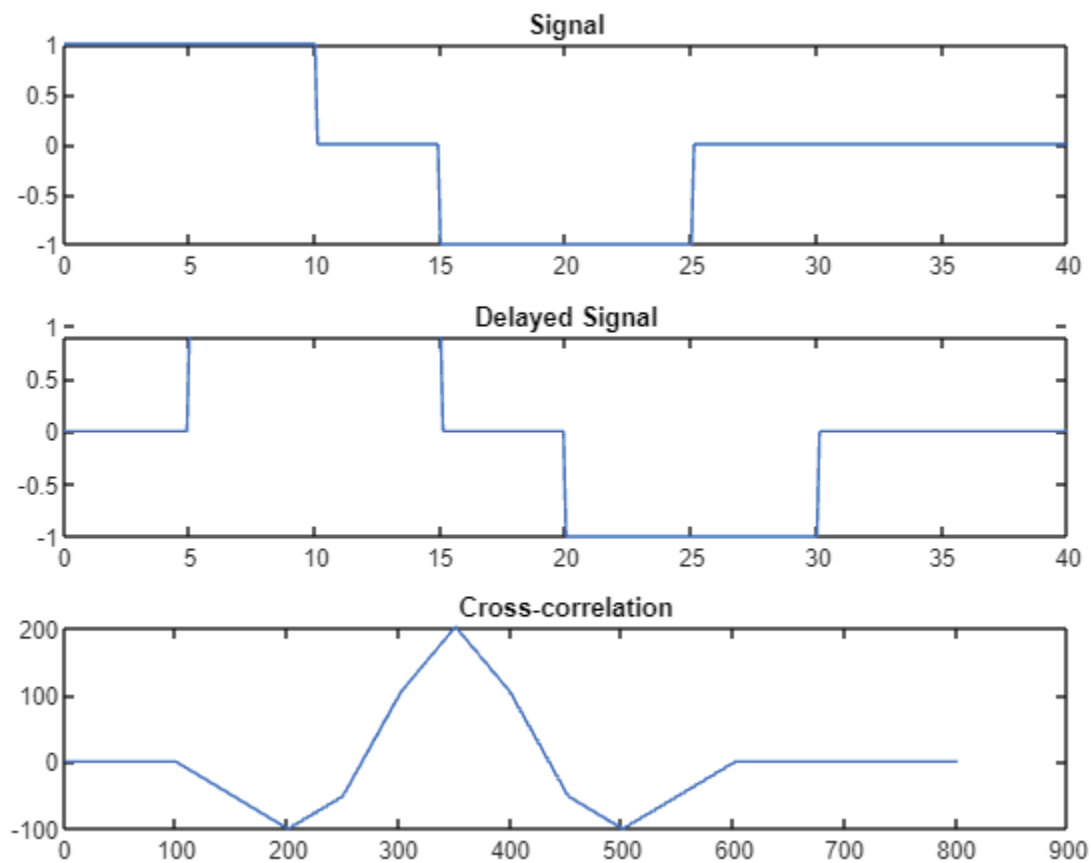


Figure 01: Cross-correlation of Delayed Signal Output

Discussion and conclusion: First the signal was plotted, then the delayed signal with the delay value. The built-in cross-correlation function was used to correlate the first and last signals and was also visualized. The expected result of the experiment was obtained, the value of the delayed time and the maximum index were also shown. The test was successfully completed.

