Experiment No: 04

Name of the Experiment: Finding the time delay using cross correlation of two signal.

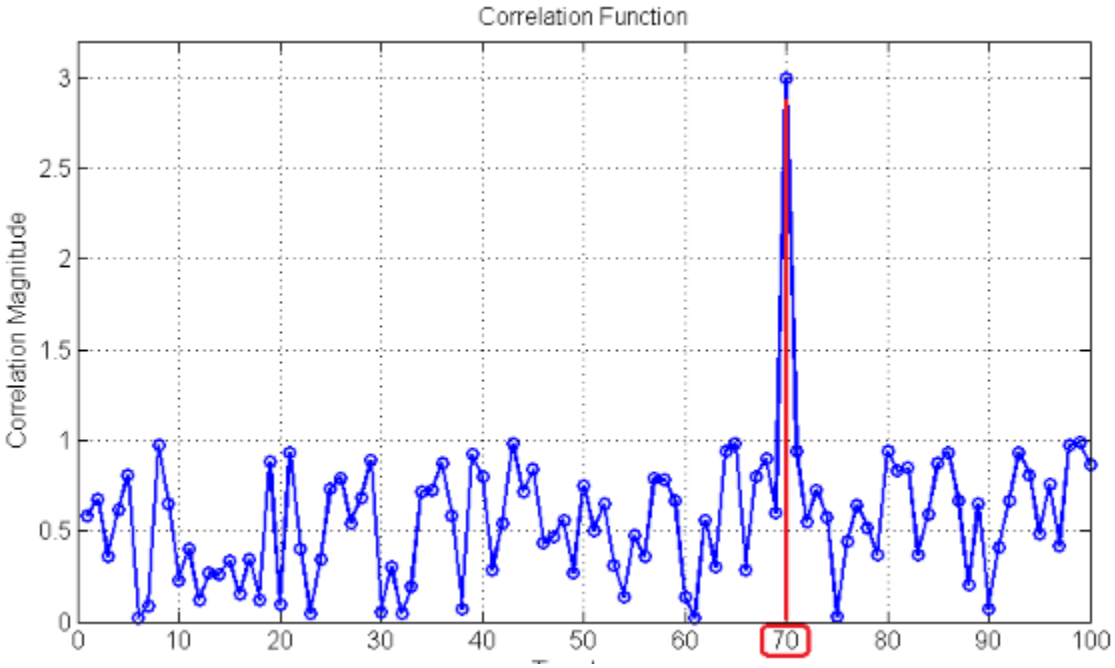
Theory: Time delay analysis finds the delay (also called the "lag") between two signals, that are shifted in time. It is the most important part of time-difference-of-arrival (TDOA) transmitter localization. The correlation function plots the similarity between two signals for all possible lags τ.

$$X12(\tau)=\int_{-\infty}^{+\infty} x1(t)x2(t-\tau)dt=\int_{-\infty}^{+\infty} x1(t+\tau)x2(t)\,dt$$

$$T_{estimated}=argmax(corr(\tau))$$

For robust determination of the delay, it is important to be able to read out the peak of the correlation function precisely. For that purpose, the correlation should have a distinct peak. If, on the other hand, many peak are potential lags or a peak is distributed among several bins, accurate measurement of delay becomes difficult ("bad quality"). The cross-correlation between two different signals or functions or waveforms is defined as the measure of similarity or coherence between one signal and the time-delayed version of another signal. The cross-correlation between two different signals indicates the degree of relatedness between one signal and the time-delayed version of another signal.

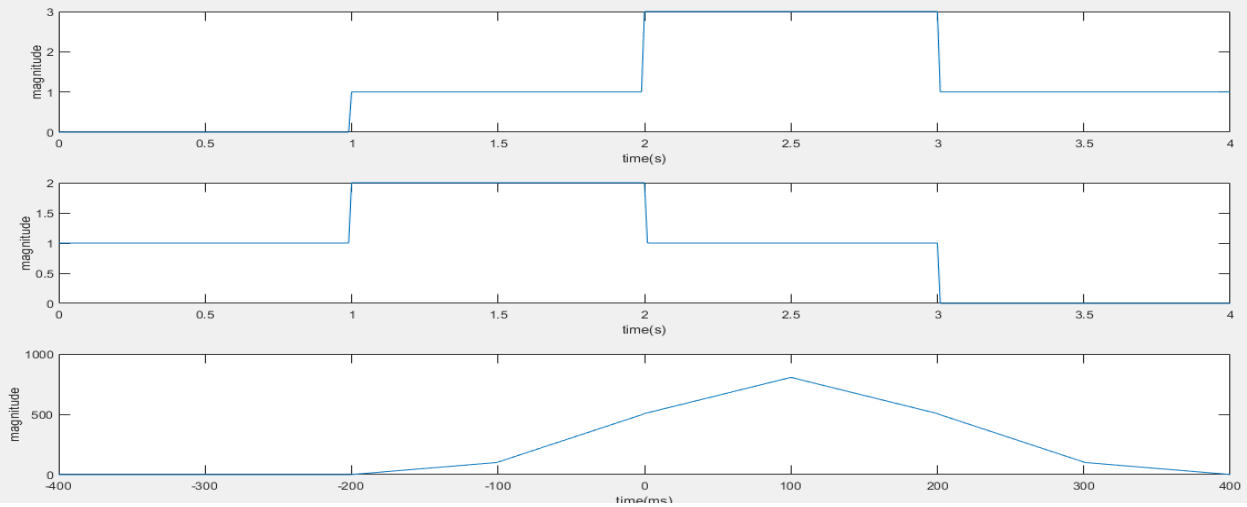
We took a square signal and it's delyed version.Then we performed cross correlation between them.After plotting the signal we can see that this signal is in it's peak at the time of delay.



Code:

```
clc;
clear all;
Fs=100;
t=0:1/Fs:4;
s1=t>=1 &t<=4;
s2=t>=2 &t<=3;
s=s1+2*s2;
d1=t>=0 &t<=3;
d2=t>=1 &t<=2;
d=d1+d2;
Maxlength=length(t)-1;
A=-Maxlength:Maxlength;
c=xcorr(s,d);
subplot(3,1,1)
plot(t,s)
xlabel('time(s)');
ylabel('magnitude');
subplot(3,1,2)
plot(t,d)
xlabel('time(s)');
ylabel('magnitude');
subplot(3,1,3)
plot(A,c)
xlabel('time(ms)');
ylabel('magnitude');
```

Output:



Conclusion and discussion:The square wave is created using conditional statement.Then it's delayed version is generated.The unit of the time axis is taken as mili second.Then cross correlation of this two signal is performed using library function.Then this signal is plotted and from seeing the peak of that signal we can know the time delay.

Heaven's Light is Our Guide

Rajshahi University of Engineering & Technology, Rajshahi

Lab report

Course No: ECE 4124

Course Title: Digital Signal Processing Sessional

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