Experiment No: 04

Experiment Date: 14.05.23

Experiment Name: Identification of Signal Delays and Periodocity using correlation.

Theory: Signal delay identification in DSP refers to the process of determining the time delay between two or more signals. It involves finding the amount of time by which one signal is shifted or delayed with respect to another signal. In DSP, signal delay identification can be achieved through various techniques, including:

Cross-correlation: Cross-correlation measures the similarity between two signals as a function of the time delay between them. By calculating the cross-correlation function and identifying the peak value, the delay between the signals can be estimated.

Autocorrelation: Autocorrelation is similar to cross-correlation, but it involves correlating a signal with a delayed version of itself. The peak in the autocorrelation function represents the delay between the original signal and its delayed version.

Identifying signal delays is crucial in various applications, such as time synchronization, audio and video processing, communications, radar systems, and more.

Periodicity refers to the property of a signal that repeats itself after a certain interval of time, called the period. In Digital Signal Processing (DSP), determining the periodicity of a signal is important for various analysis and processing tasks.

It is important to note that determining the periodicity of a signal is not always straightforward, particularly for signals with noise or complex patterns. Therefore, a combination of methods and careful analysis is often required to accurately assess the periodicity of a signal in DSP.

Required Software: MATLAB

Code & Output:

Identifying Delays:

```
clc
clear all
close all
fs=1000
t = 0:0.001:1;
frequency = 10;
dutyCycle = 50;
delay = 0.15;

signal = square(2*pi*frequency*t, dutyCycle);
subplot(3,1,1)
plot(signal)
title('Given Square Wave')
signalWithDelay = [zeros(1, round(delay*fs)), signal(1:end-round(delay*fs))];
subplot(3,1,2)
title('Delayed Version of the Square Wave')
plot(signalWithDelay)
[correlation, lag] = xcorr(signal, signalWithDelay);
```

```
subplot(3,1,3)
plot(lag, correlation)
title('Auto Correlation')
```

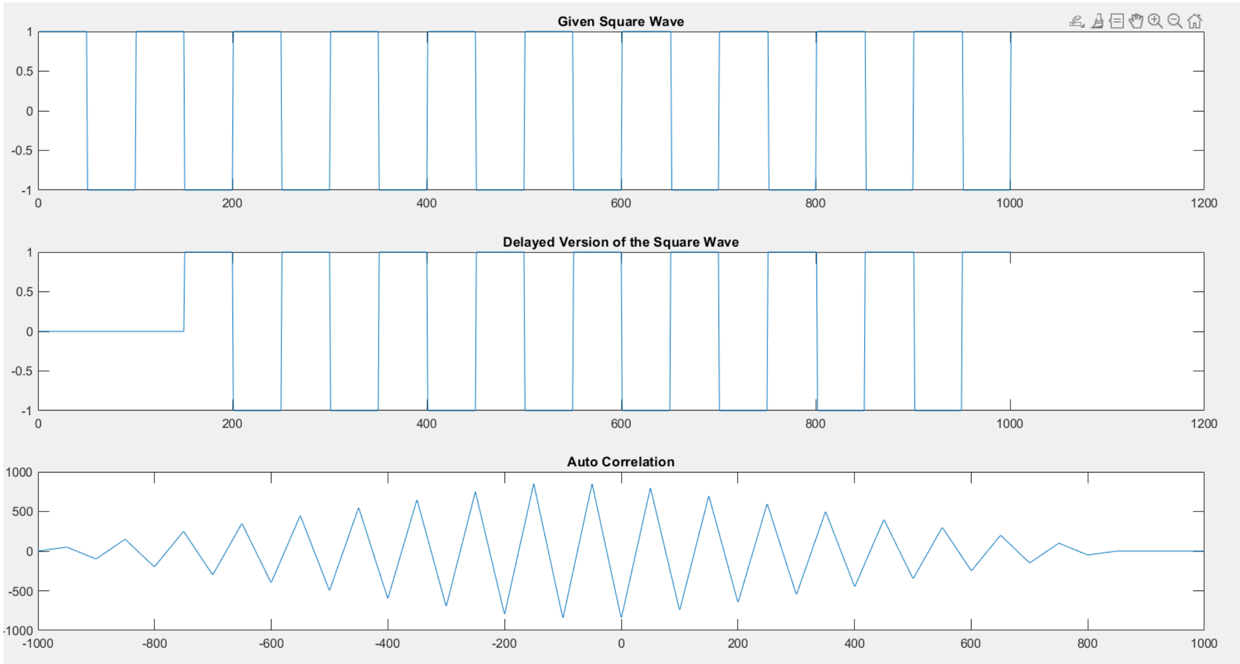

Fig 1: Identifying Delays

In this code, we used delay as 0.15. From the figure, we can see that y-axis is maximizing at x= -150 making y=851.

Periodicity:

```
clc
clear all
close all

fs = 1000;
t = 0:1/fs:1;
f = 10;
x = sin(2*pi*f*t);

shift_amount = 0.25;
shifted_x = [zeros(1, round(shift_amount*fs)), x(1:end-round(shift_amount*fs))];

autocorr_x = xcorr(x);
autocorr_shifted_x = xcorr(shifted_x);

lags = -length(x)+1:length(x)-1;
figure;
subplot(4, 1, 1);
plot(x);
title('Main Signal');
subplot(4, 1, 2);
plot(shifted_x);
title('Shifted Signal');
subplot(4, 1, 3);
plot(lags, autocorr_x);
title('Autocorrelation of Original Signal');

```

```
subplot(4, 1, 4);
plot(lags, autocorr_shifted_x);
title('Autocorrelation of Time-Shifted Signal');
if autocorr_x(length(x)+1) > 0.9 * max(autocorr_x)
    disp('Signal exhibits periodicity with a time-shifted version.');
else
    disp('Signal does not exhibit clear periodicity with a time-shifted version.');
End
```

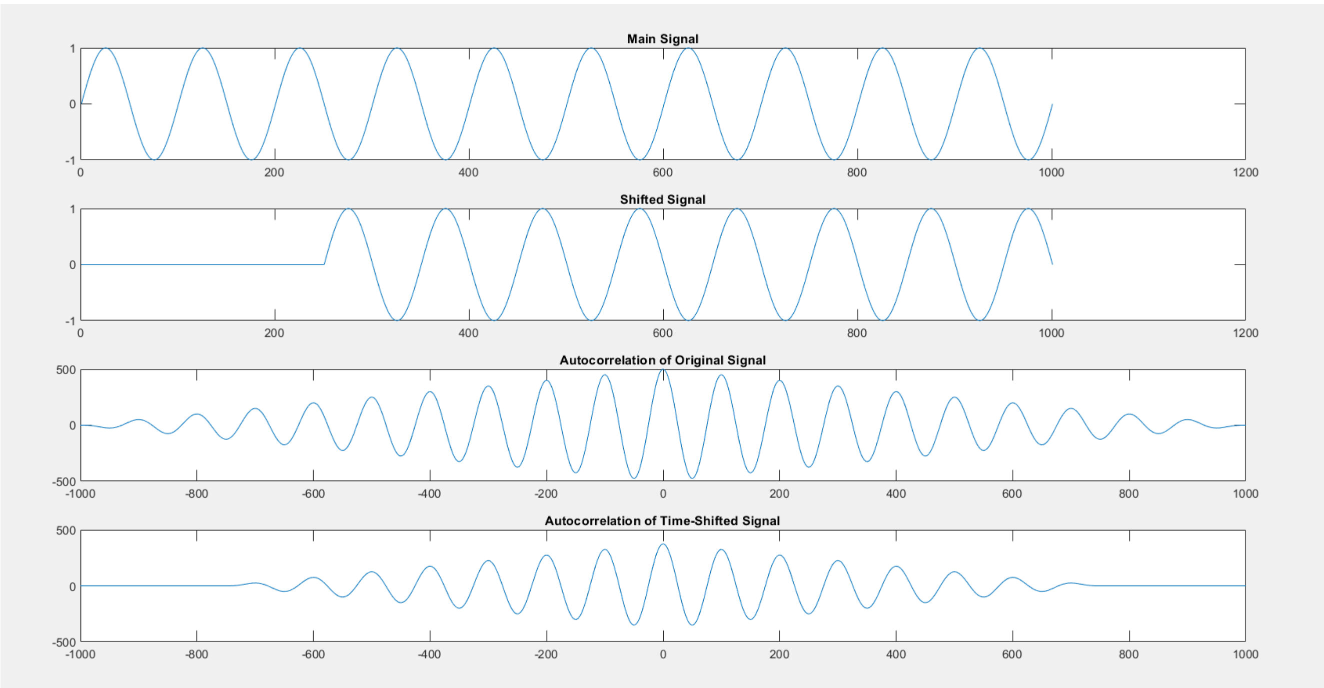

Fig 2: Identifying Periodicity

In this code, if the peak value is above a threshold, it indicates that the signal exhibits periodicity with a time-shifted version.

Discussion: From this experiment, we learnt how to identify periodicity and delays. We used autocorrelation method for this system.

Conclusion: The experiment was done successfully and expected result was found.