Heaven's Light is Our Guide

Rajshahi University of Engineering & Technology

Department of Electrical & Computer Engineering

Lab Reports

Course Title : Digital Signal Processing Sessional

Course No: ECE 4124

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Experiment Name: Experiment on finding delay of a function and plotting poles and zeros of the z-transform of a function.

Theory:

In digital signal processing, a delay refers to a time-shift or phase-shift applied to a signal. It's a fundamental operation used to shift the signal's entire waveform in time, either forward or backward. Delaying a signal can have various effects on its characteristics, such as time alignment, synchronization, or achieving specific processing goals. Mathematically, the effect of delaying a discrete-time signal x[n] by a certain number of samples (k) can be represented as:

$y[n] = x[n - k]$

Where:

y[n] is the delayed output signal.

x[n] is the original input signal.

k is the number of samples by which the signal is delayed.

Poles and zeros are properties associated with the transfer function of a system. The transfer function describes the relationship between the input and output signals of a linear time-invariant (LTI) system. In the Z-transform domain, the transfer function is represented as a rational function of the Z variable.

Software Used: MATLAB

Code:

Delay of discrete signal:

```
clc;
clear all;
close all;
x=[0 0 0 1 2 3 4];
x1=[1 2 3 4];
[autocorr, lags] = xcorr(x,x1)
subplot(3,1,1);
stem(x);
title('Signal');
subplot(3,1,2);
stem(x1);
title('Delayed signal');
subplot(3,1,3);
stem(lags,autocorr);
title('Lags vs autocorrelation-value');
[~, index] = max(autocorr);
delay_sample = abs(lags(index))
Fs=1;
delay_seconds = delay_sample/Fs
```

Delay of continuous signal:

```
clc;
clear all;
close all;
t= 0:1:10;
f=10;
x=10*sin(2*f*pi*(t-2));
x1=10*sin(2*f*pi*t);
plot(xcorr(x,x1));
z=xcorr(x,x1);
[autocorr, lags] = xcorr(x,x1)
subplot(3,1,1);
plot(x);
title('Signal');
subplot(3,1,2);
plot(x1);
title('Delayed signal');
subplot(3,1,3);
plot(lags,autocorr);
title('Lags vs autocorrelation-value');
[~, index] = max(autocorr);
delay_sample = abs(lags(index))
Fs=1;
delay_seconds = delay_sample/Fs
```

Plotting poles and zeros:

```
% Define the transfer function coefficients
b = [0 1];
a = [1 -1];

% Create the transfer function object
H = tf(b, a, 1);

% Display the transfer function
disp('Transfer Function:');
disp(H);

% Obtain the poles of the transfer function
poles = pole(H);

% Display the poles
disp('Poles:');
disp(poles);

% Plot the poles on the z-plane
figure;
zplane([], poles);
title('Pole Locations');
```

Output:

For Discrete signal:

```
delay_seconds =

     3
```

Figure 1: Delay of the discrete function

Plot:

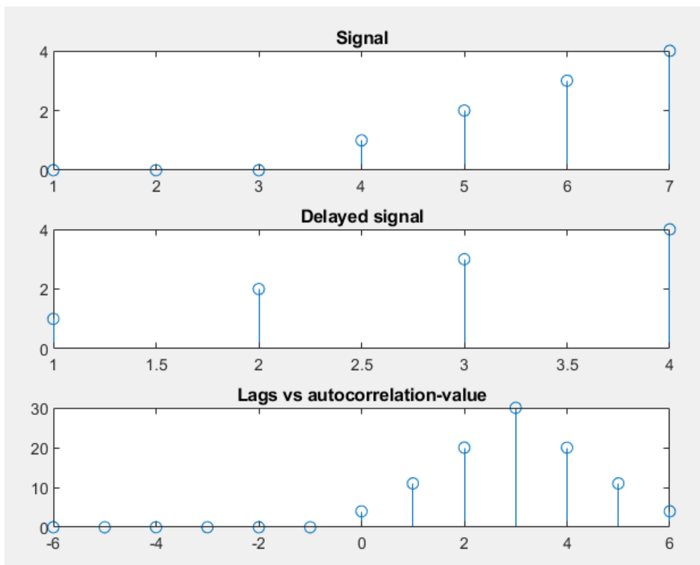

Figure 2: Delay of the discrete function

For Continuous signal:

```
delay_seconds =

     2
```

Figure 3: Delay of the continuous function

Plot:

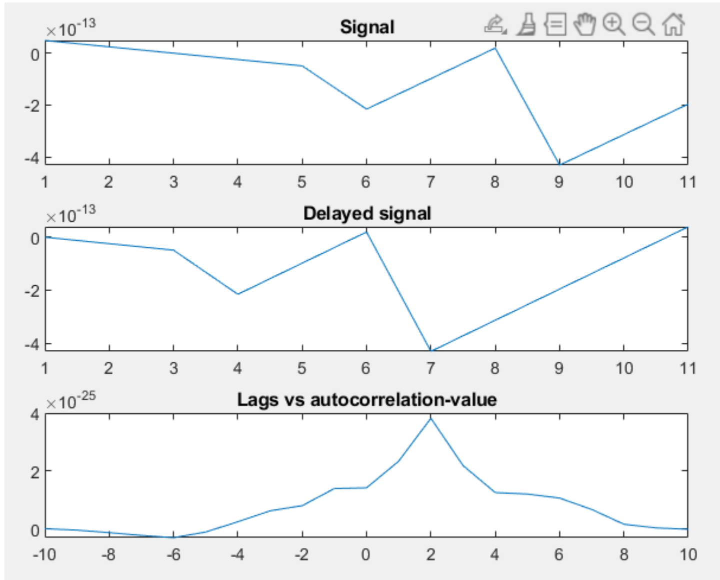

Figure 4: Delay of the continuous function

Plotting poles and zeros:

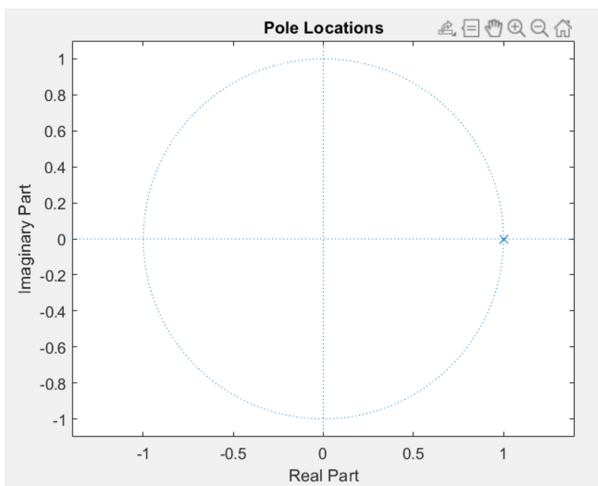

Figure 5: Poles and zeros of the transfer function

Discussion:

Firstly, the signal delay was calculated. Both the discrete and continuous signals' delays was computed. Secondly, A signal's z-transform's poles and zeros has been plotted using matlab.

Conclusion:

The experiment had been done successfully without any issue.