Rajshahi University of Engineering and Technology

DEPT. of Electrical and Computer Engineering

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: The Z-Transform is an important tool in DSP that is fundamental to filter design and system analysis. It will help you understand the behavior and stability conditions of a system.

Poles and Zeros of a transfer function are the frequencies for which the value of the denominator and numerator of transfer function becomes infinite and zero respectively. The values of the poles and the zeros of a system determine whether the system is stable, and how well the system performs. Control systems, in the simplest sense, can be designed simply by assigning specific values to the poles and zeros of the system.

If we take a unit step signal, $x(n)=u(n)$

The z transform will be, $z[x(n)] = \frac{z}{z-1}$

Here the poles where z=1 and zeros where z=0.

The shifted version of any signal can be used to describe the delay of a function. When a signal is shifted to the right by 5 units, the delayed function is denoted by (t-5). Using the autocorrelation of the signal and a delayed version of that signal, we can use MATLAB to determine the delay of a function. The delay of the function will be at the index where the value of the associated array is greatest. For both continuous and discrete signals, it is the same.

Software used: MATLAB

Code:

Delay of discrete signal:

```
clc;
clear all;
close all;

x=[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-4));
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:

```
clc;
clear all;
close all;
%function1 = unit step signal
%ztransform = z/(z-1);
a=[1];
b=[1 -1];
zplane(a,b);
```

```
grid
```

Output:

Delay of discrete signal:

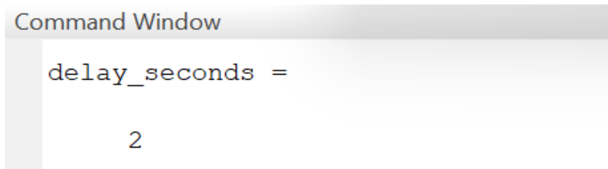

Fig. 1 Delay of the discrete function.

Figure plot:

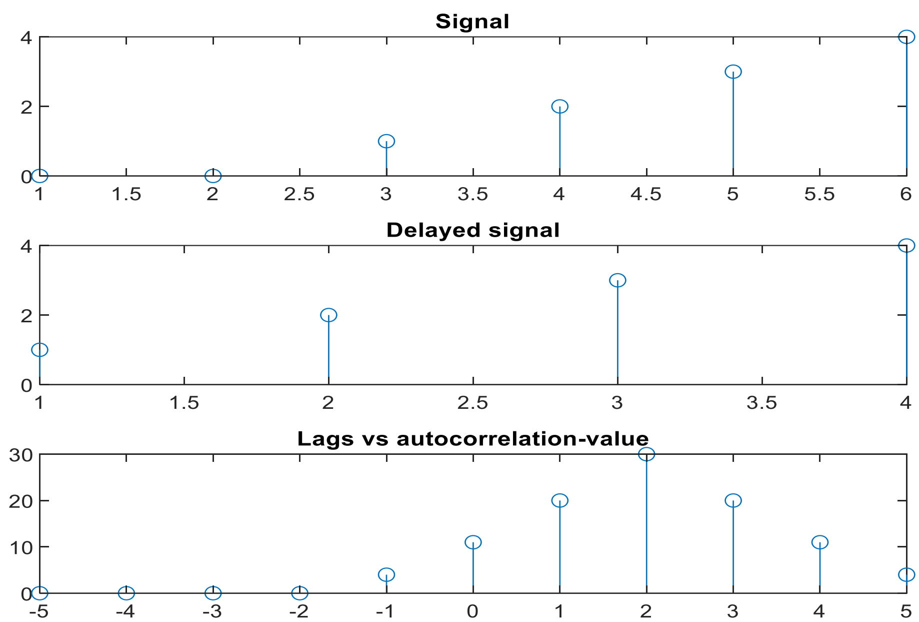

Fig. 2 Delay of the discrete function (2 seconds).

Delay of continuous signal:

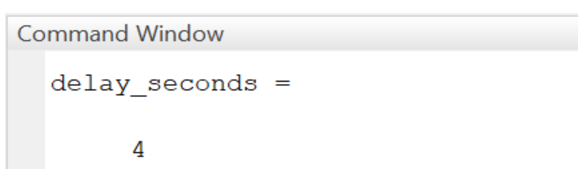

Fig. 3 Delay of the continuous function (4 seconds).

Figure plot:

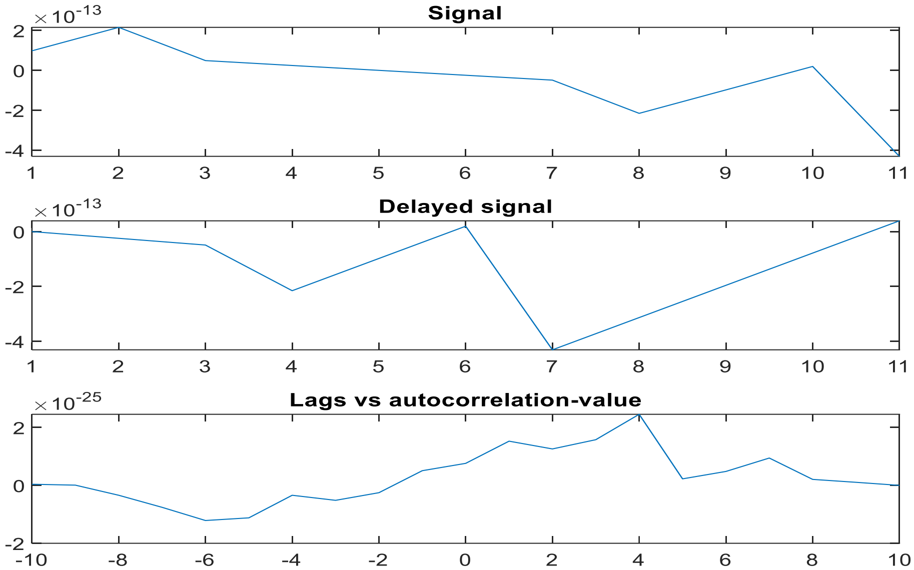

Fig. 4 Delay of the continuous function (4 seconds).

Plotting poles and zeros:

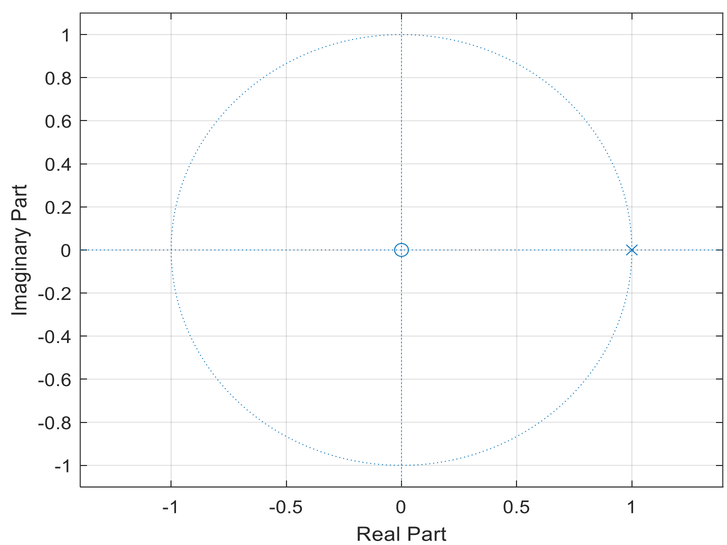

Fig. 5 Poles and zeros of the transfer function.

Discussion: In the experiment, we dealt with signal delay. Here, autocorrelation is used to determine the delay. The delay of the signal is represented by the highest value in this plot of lags vs. autocorr_value. Both the discrete and continuous signals' delays are determined. Then, we dealt with a signal's z transform's poles and zeros. Here, O stands for zeros, and X for the step function's poles that we have been working with.

Conclusion: In the experiment, all of the code and visualizations function without any errors or complications.