Heaven's Light is Our Guide

Rajshahi University of Engineering& Technology

Department of Electrical & Computer Engineering

Course No: ECE 4124
Course Name: Digital Signal Processing Sessional

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Experiment Name: Experiment on finding delay of a function and plotting poles and zeros of the ztransform of a function.

Theory: Delay of a function can be represented as the shifted version of any signal. If any signal is shifted right by 2 unit, then the delayed function will be represented by (t-2). We can find out delay of a function by using MATLAB using autocorrelation of the signal and delayed version of that signal. Where the value of the correlated array will be maximum, that index will be the delay of the function. It is the same for both continuous and discrete signal.

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

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

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:

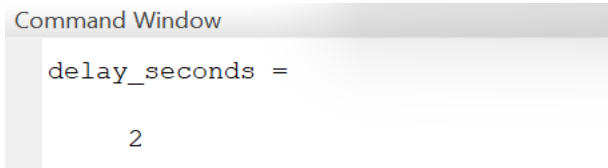

Fig. 1 Delay of the discrete function.

Figure plot:

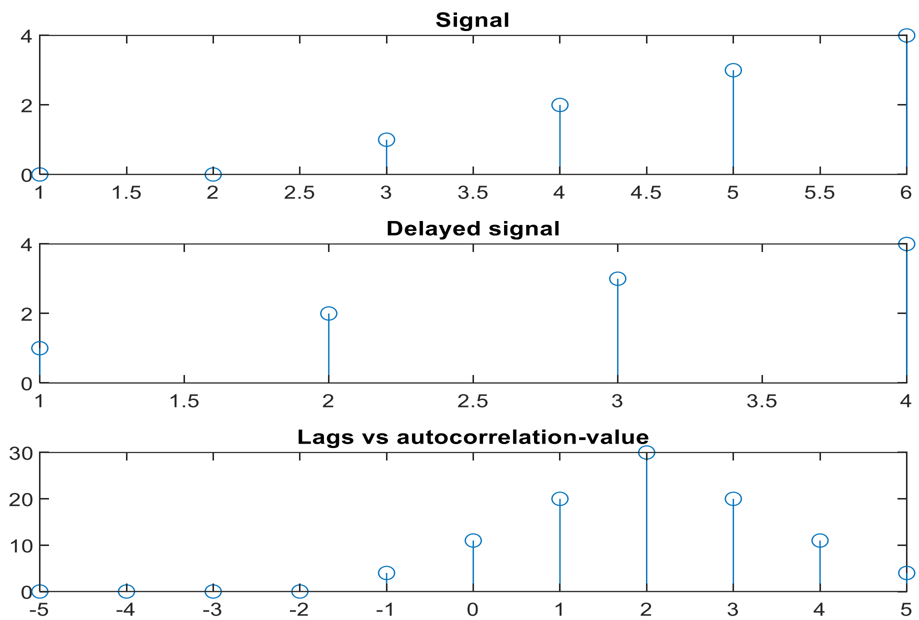

Fig. 2 Delay of the discrete function (2 seconds).

Delay of continuous signal:

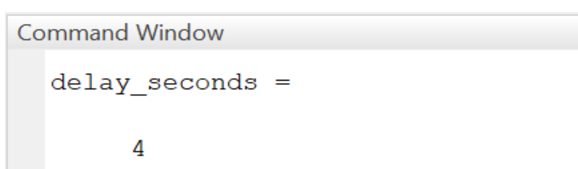

Fig. 3 Delay of the continuous function (4 seconds).

Figure plot:

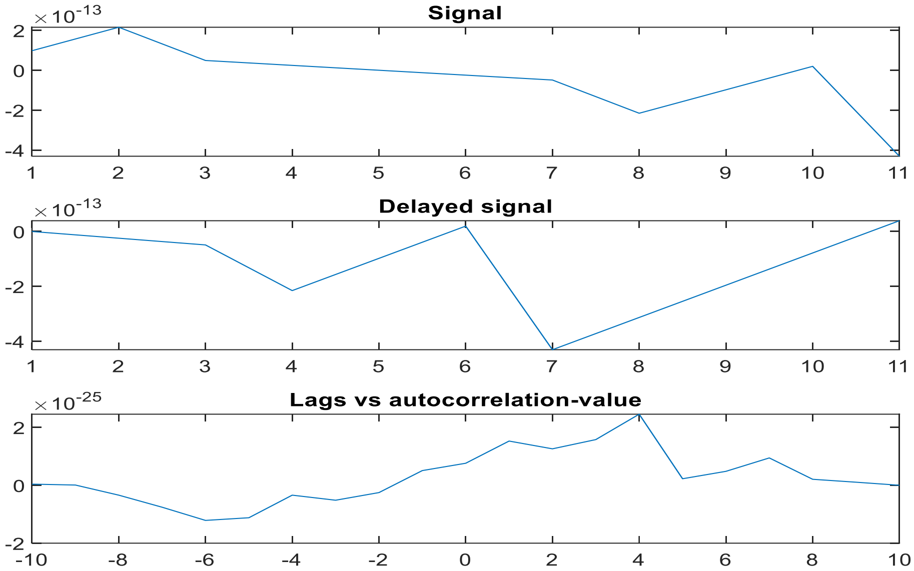

Fig. 4 Delay of the continuous function (4 seconds).

Plotting poles and zeros:

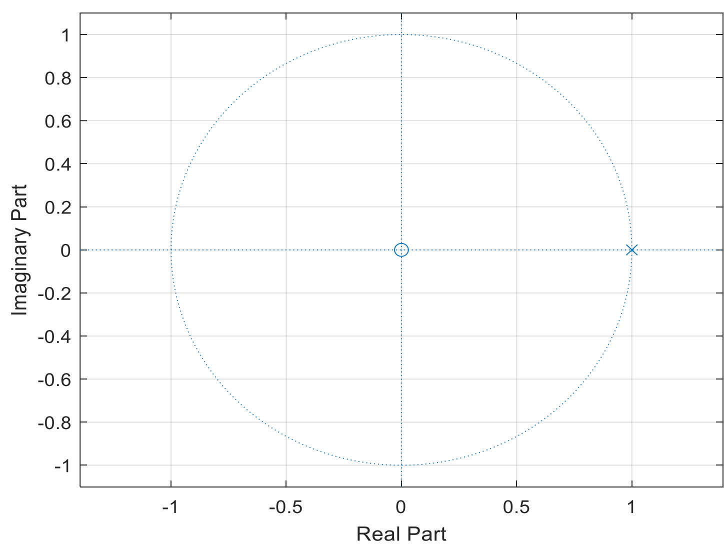

Fig. 5 Poles and zeros of the transfer function.

Discussion: In the experiment, we have worked with delay of a signal. Here delay is found out by using autocorrelation. Here the value of plot of lags vs autocorr_value in which the value is highest is the delay of the signal. We find out delay for both the discrete and continuous signal. Then, we worked with the poles and zeros of the ztransform of a signal. Here O denotes zeros and X denotes poles of the step function with which we have worked.

Conclusion: All the code and plots run successfully in the experiment without any type of error or complexities.