"Heaven's light is our guide"

Rajshahi University of Engineering & Technology

Department of Electrical & Computer Engineering

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

Lab Report

Submitted To	***Submitted By***
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Experiment Name: *i. Finding delay using Auto Correlation for Discrete & Continuous Signal in MATLAB.*

ii. Finding Z-transform & Plotting on Z-plane on MATLAB.

Theory:

Auto Correlation of a signal produce the highest result when the signals fully overlapped on each other. So, if a delayed signal of shifted input fully overlapped on its fixed version of signal, the maximum value will be not in the middle of correlation, rather the maximum value will be in the index value same as the delay between two signals. Using this method, we can able to find the delay using Auto Correlation method for both Discrete & Continuous signal.

Z-transform is a method to convert Discrete Linear Time Invariant (LTI) System from Time Domain to Frequency Domain in order to make the calculation easier. Z-transform can be performed only for discrete convergence series. It is represented by,

$$X(z) = \sum_{n=-\infty}^{\infty} x[n]z^{(-n)}$$

From Z-transform, we get an equation **f(z)**. where the roots of the numerator are called **zeros**. Which is represented with 'O' & the roots of denominator are the poles. Which is represented with 'X' in the Z-plane.

Code with corresponding Output:

- ***Code for finding delay of discrete signal:***

```
x = [2 3 5 6];
d = 6;                %delay
h = zeros(1,d);

disp(length(x));

for i=1:length(x)
    h(i)=x(i);
end


%Cross correlation

lenx=length(x);
lenh=length(h);
```

```
N=lenx+lenh-1;
X=zeros(1,N);

count=lenx-1;
for t=1:lenx
    for i=1:lenx
       j=i+count;
       X(t)=X(t)+(x(i)*h(j));
        if(i==t)
            count=count-1;
            break;
        end
    end
end

count=1;
index=2;
for t=lenx+1:N
    for i=index:lenx
       j=i-count;
       X(t)=X(t)+(x(i)*h(j));
    end
    index=index+1;
    count=count+1;
end


%plotting section

subplot(3,1,1);
stem(x);
title('Input Signal: x(n)');

subplot(3,1,2);
stem(h);
title('Delayed Input Signal');

subplot(3,1,3);
stem(X);
title('Auto Corrrelated
Signal');
```

- ***Output of Auto Correlation for discrete signal:***

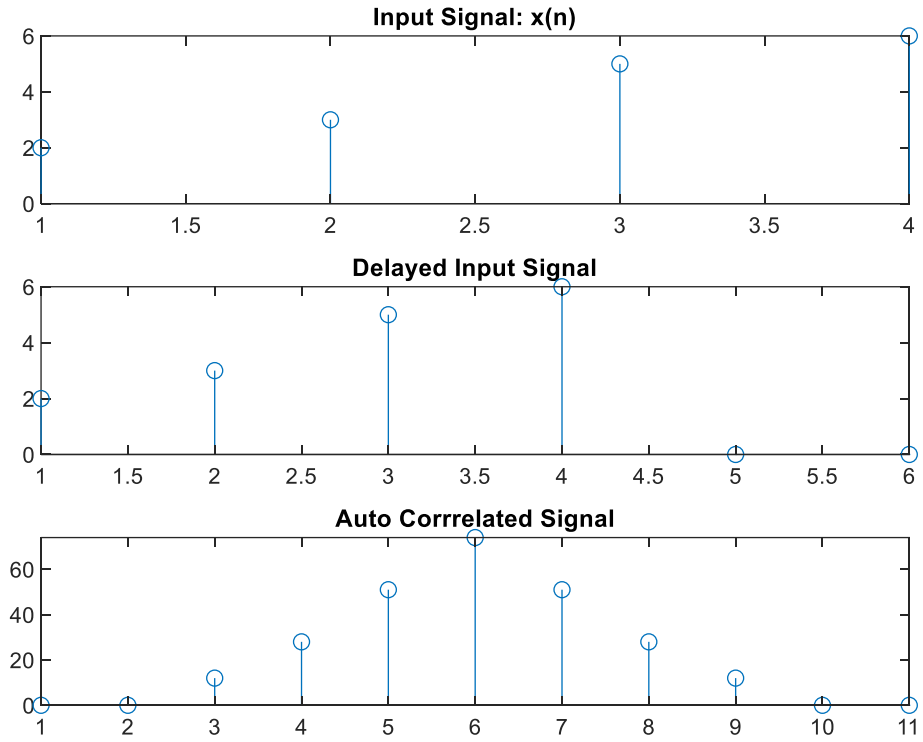

Fig. 1: Output of Auto Correlation for discrete signal.

- ***Code for finding delay of Continuous signal:***

```
t=0:1:5;

step0 = t>=0;
step1 = t>=1;
```

```
step2 = t>=2;
step3 = t>=3;

x = 4*step0 - 2*step1 + step2 -
3*step3;

d= 5;

h = zeros(1,length(x)+d);

for i=1:length(x)
    h(i)=x(i);
end


%Y = xcorr(x,h);
%custom code section

lenx=length(x);
lenh=length(h);
N=lenx+lenh-1;
X=zeros(1,N);

count=lenx-1;
for t=1:lenx
    for i=1:lenx
       j=i+count;
       X(t)=X(t)+(x(i)*h(j));
        if(i==t)
            count=count-1;
            break;
        end
    end
end

count=1;
index=2;
for t=lenx+1:N
    for i=index:lenx
       j=i-count;
       X(t)=X(t)+(x(i)*h(j));
    end
    index=index+1;
    count=count+1;
end


%plotting section

subplot(3,1,1);
plot(x);
title('Input Signal: x(n)');

subplot(3,1,2);
plot(h);
title('Delayed Input Signal');

subplot(3,1,3);
plot(Y);
title('Auto Corrrelated
Signal');
```

- ***Output of Cross Correlation:***

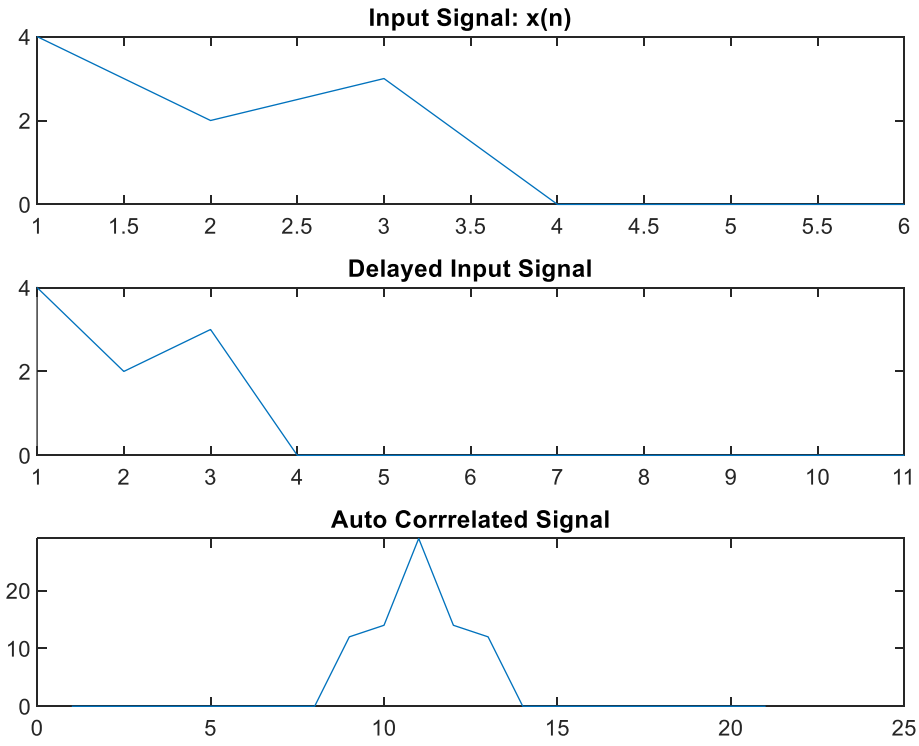

Fig. 2: Output of Cross Correlation.

- ***Code for finding Z-transform zeros & poles:***

```
1  syms n;
2  f = (1/2)^n;
3  F = ztrans(f);
4
5  disp('x[n] = ');
6  disp(f);
7
8  disp('X[z] = ');
9  disp(F);
10
11 fs = 1000;
12 ts = 1/fs;
13
14 num = [1 0];
15 den = [1 -0.5];
16
17 H=tf(num,den);
18 zplane(num,den);
```

- ***Output of zeros & poles in z-plane:***

```
>> z_transform
x[n] =
(1/2)^n

X[z] =
z/(z - 1/2)

>> H

H =

     s
  -------
  s - 0.5

Continuous-time transfer function.
```

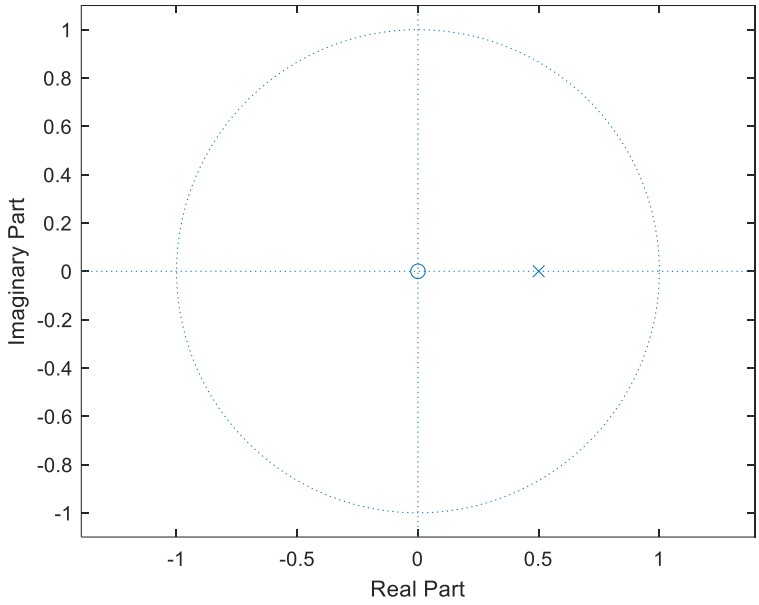

Fig. 3: Output of zeros & poles in z-plane.

Discussion:

This experiment is based on MATLAB simulation. Here we have plotted a signal then perform its Auto Correlation of that signal in order to find the delay for both discrete & continuous signal. Then Z-transform has been performed with zeros & poles plotting in the Z-plane. The program has been completed successfully & ran in MATLAB without any warning or Error.