Rajshahi University of Engineering & Technology

Department of Electrical & Computer Engineering

LAB REPORT

Course No: ECE 4124

Course Title: Digital Signal Processing Sessional

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Experiment No: 04

Name of the Experiment:

i) Take a continuous square wave signal, make a delay of that signal and do the auto correlation of the two signals. Write a code for that signal using MATLAB.

ii) Take a discrete square wave signal, make a delay of that signal and do the auto correlation of the two signals. Write a code for that signal using MATLAB.

iii) Write a code for calculating z-transform of a signal using MATLAB.

Theory:

Correlation refers to the measurement of similarity between two functions, signals, or waveforms. There are two types of correlations: autocorrelation and cross-correlation. Autocorrelation determines the coherence or similarity between a signal and its delayed version, essentially measuring how well a signal matches with itself. It is useful for identifying repeating patterns in a signal, detecting periodicity hidden within noise, or uncovering the fundamental frequency implied by its harmonic frequencies.

On the other hand, cross-correlation measures the coherence or similarity between two distinct signals or waveforms at different time offsets. It reveals the degree of relatedness between one signal and the time-shifted version of another. Cross-correlation is commonly employed in signal processing to search for a known feature within a longer signal by computing a sliding dot product or sliding inner-product.

Continuous-time signals are defined along a continuous range of time and are represented by a continuous independent variable. They exhibit continuity in both amplitude and time, with values assigned to each instant. Examples of continuous-time signals include sine and cosine functions.

Discrete signals, on the other hand, are defined at specific time instances, with distinct values assigned to each time point. These signals are represented as sequences of numbers and have discrete amplitudes. Although speech and video signals can be represented in both continuous and discrete formats, they often possess identical characteristics under certain circumstances.

When analyzing discrete signals and systems, the z-transform plays a crucial role. While analog signals are continuous in the time domain, modern communication and systems rely on digital processing. To convert analog signals to the digital domain, the first step is to sample the analog signal at a rate above the Nyquist sampling rate, resulting in a discrete sequence of points. These points are then quantized to predefined levels and encoded into binary for storage, analysis, or transmission purposes.

Code:

Code for autocorrelation of continuous signal:

```
1. clc
2. clear all
3. close all
4. t = 0:0.001:4;
5. a1 = t>=0 & t<=1;
```
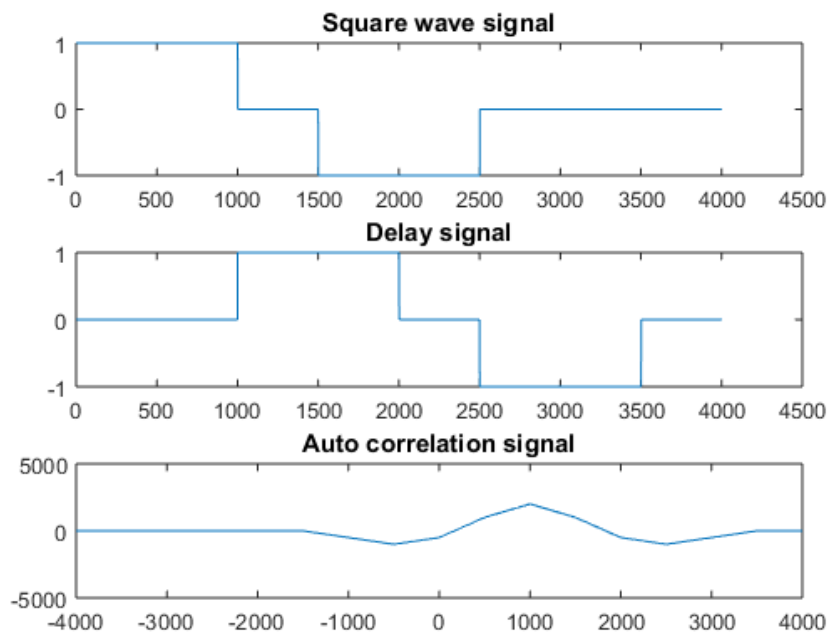
```
6. a2 = t>=1.5 & t<=2.5;
7. a = a1-a2;
8. subplot(3, 1, 1);
9. plot(a);
10.      title('Square wave signal');
11.      d1 = t>=1 & t<=2;
12.      d2 = t>=2.5 & t<=3.5;
13.      d = d1-d2;
14.      subplot(3, 1, 2);
15.      plot(d);
16.      title('Delay signal');
17.      N = -(length(t)-1):(length(t)-1);
18.      corr = xcorr(d,a);
19.      subplot(3, 1, 3);
20.      plot(N,corr);
21.      title('Auto correlation signal');
22.      % max value calculation
23.      maxx = max(corr);
24.      F = find(corr == maxx);
25.      maximum_value = F-length(t)
```

Output for autocorrelation of continuous signal:

```
maximum_value =

     1000
```

Code for autocorrelation of discrete signal:

```
1. clc
2. clear all
3. close all
4. t = 0:0.1:4;
5. a1 = t>=0 & t<=1;
6. a2 = t>=1.5 & t<=2.5;
7. a = a1-a2;
8. subplot(3, 1, 1);
9. stem(a);
10.    title('Square wave
    signal');
11.    d1 = t>=1 & t<=2;
12.    d2 = t>=2.5 & t<=3.5;
13.    d = d1-d2;
14.    subplot(3, 1, 2);
15.    stem(d);
16.    title('Delay signal');
17.    N = -(length(t)-
    1):(length(t)-1);
18.    corr = xcorr(d,a);
19.    subplot(3, 1, 3);
20.    stem(N,corr);
21.    title('Auto correlation
    signal');
22.    % max value calculation
23.    maxx = max(corr);
24.    F = find(corr == maxx);
25.    maximum_value = F-
    length(t)
```

Output for autocorrelation of discrete signal:

```
maximum_value =

    10
```
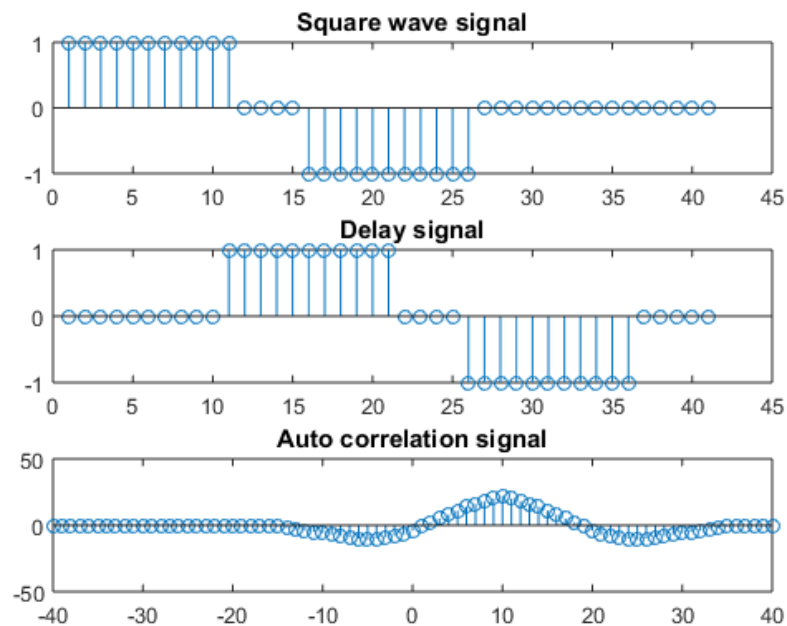
Code for z-transform of a signal:

```
1. clc
2. clear all
3. close all
4. syms n z
5. x = 2^n
6. z_transform = ztrans(x)
```

Output for z-transform of a signal:

```
z_transform =

z/(z - 2)
```

Discussion:

A MATLAB code was developed to implement the autocorrelation of continuous signals and the z-transform. For the autocorrelation code, the time variable 't' was defined, and conditions were set to create the desired continuous square wave signal. The signal was then plotted. Similarly, conditions were set to create the delayed version of the signal, which was also plotted. The two signals were auto-correlated using the 'xcorr' function, and the resulting autocorrelation signal was plotted. The length of the signal was determined, and the maximum delay value was calculated. The implementation of the autocorrelation of discrete signals followed a similar approach, but the 'stem' function was used instead of 'plot' to visualize the discrete signal.

For the z-transform code, a symbolic variable 'z' and an index variable 'n' were declared using the 'syms' command. A signal of interest was defined. Finally, the z-transform of the signal was computed using the 'ztrans' function and displayed.

Conclusion:

The code was successfully run, and no mistakes were discovered. We learnt about autocorrelation, the z-transform, and how to use MATALB to plot the signal from this experiment.