Heaven's Light is Our Guide

Rajshahi University of Engineering & Technology

Department of Electrical & Computer Engineering

Course No: ECE 4124

Course Title: Digital Signal Processing Sessional

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Experiment No: 05

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Experiment Name: Study of causal signal, anti-causal signal and non-causal signal.

Theory:

A causal signal is one where the current value of the signal depends only on past and present values, but not on future values. In other words, the signal is influenced by events that occurred before the current time point. Causality in signals reflects the natural flow of events in most real-world scenarios.

The z-transform of a causal sequence x(n), designated by X(z) or Z(x(n)), is defined as

$$X(Z) = \mathrm{Z}\big(\mathrm{x(n)}\big) = \sum_{n=0}^{\infty} x(n)Z^{-n}$$

Where, z is the complex variable in Z domain. Here, the summation taken from n = 0 to n = ∞ is in accordance with the fact that for most situations, the digital signal x(n) is a causal sequence, that is, x(n) = 0 for n < 0

An anti-causal signal is the opposite of a causal signal. It's a signal where the current value depends only on future and present values, but not on past values. This concept is less common in real-world scenarios but can be encountered in some specialized contexts. In an anti-causal signal, the "cause" for a particular value occurs after the effect, which can be counterintuitive.

The z-transform of a anti-causal sequence x(n), designated by X(z) or Z(x(n)), is defined as

$$X(Z) = \mathrm{Z}\big(\mathrm{x(n)}\big) = \sum_{n=0}^{-\infty} x(n)Z^{-n}$$

A non-causal signal, also known as an acausal signal, is one where the current value of the signal depends on both past and future values. This means that events in the past and future contribute to the value of the signal at a given moment. Non-causal signals are theoretical constructs and are not typically found in practical applications. They don't align with our intuitive understanding of cause and effect and can lead to paradoxes and inconsistencies.

The z-transform of a non-causal sequence x(n), designated by X(z) or Z(x(n)), is defined as

$$X(Z) = \mathrm{Z}\big(\mathrm{x(n)}\big) = \sum_{n=-\infty}^{\infty} x(n)Z^{-n}$$

A non-causal signal is a type of signal that exists for both positive and negative value.

Code:

i) For Causal Signal:

```
clc
clear all
close all
x=[5 2 5 7 8 1];
b=0;
n=length(x);
y=sym('z');
for i=1:n

 b=b+x(i)*y^(1-i);
end
disp('Z transform of x = ');
disp(b);
```

Output:

Z transform of x =

2/z + 5/z^2 + 7/z^3 + 8/z^4 + 1/z^5 + 5

ii) For Anti Causal Signal:

```
clc
clear all
close all
x=[1 2 5 7 0 1];
b=0;
n=length(x);
y=sym('z');
for i=1:n
 b=b+x(i)*y^(i-1);
end
disp('Z transform of x = ');
disp(b);
```

Output:

Z transform of x =

z^5 + 7*z^3 + 5*z^2 + 2*z + 1

iii) For Non-causal Signal:

```
clc
clear all
close all
x=[1 2 3 4 5];
pos=input('Enter the Zero index = ');
n=length(x);
y=sym('z');
b=0;
a=0;
for i=1:n
 if i>=pos
 b=b+x(i)*y^(pos-i);
 else
 b=b+x(i)*y^((-1)*(i-pos));
 end
end
disp('Z transform of x = ');
disp( b);
```

Output:

Enter the Zero index = 3

Z transform of x =

2*z + 4/z + 5/z^2 + z^2 + 3

Discussion & Conclusion:

From this experiment, we had learned about the causal signal, anti-causal signal and non-causal signal. Firstly, I had calculated the results for each method of signals manually. Then, according to the theory of these signals, I had tried to implement each of these signals through logically in MATLAB coding. After that I had checked the output signals of each method to compare them with the manual results and it should be noted that the output signals of each method were matched perfectly to their corresponding manual result.