"Heaven's light is our guide"

RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY

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Experiment No: 06

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Experiment No: 06

6.1: Experiment Name: Study of

1. Z transformation of anti-causal signal
2. Z transformation of non-causal signal

6.2: Theory

The Z-transform is a mathematical tool used in digital signal processing and control systems theory to analyze discrete-time systems. It is an extension of the Laplace transform for continuous-time systems. The Z-transform converts a discrete-time signal into a complex function of a complex variable called the Z-transform variable. [1]

Anti-causal functions are functions that depend only on future and present values of the input. In the context of Z-transform, the Z-transform of an anti-causal function may exhibit a region of convergence (ROC) that includes values inside the unit circle. The Z-transform of an anticausal function x[n] can be expressed as:

$$X(z) = \sum[x[n] * z^{(-n)}], \text{ where the summation ranges from } -\infty \text{ to } \infty.$$

Unlike causal functions, where the ROC lies outside the outermost pole, the ROC of anti-causal functions may include values inside and outside the unit circle. This is because the anti-causal function considers only future and present values, resulting in a different ROC behavior. The inclusion of values inside the unit circle indicates that the anticausal function has an infinite extent in both directions.

Noncausal functions refer to functions that have dependencies on both past and future values of the input. In the context of Z-transform, the Z-transform of a noncausal function may exhibit a region of convergence (ROC) that includes values outside the unit circle. The Z-transform of a noncausal function x[n] can be expressed as:

$$X(z) = \sum[x[n] * z^{(-n)}], \text{ where the summation ranges from } -\infty \text{ to } \infty.$$

The ROC lies outside the outermost pole, the ROC of noncausal functions may include values inside and outside the unit circle. This is because the noncausal function considers both past and future values, resulting in a broader ROC. The inclusion of values outside the unit circle indicates that the noncausal function has an infinite duration and does not decay over time. The ROC for a noncausal function is defined by $|z| > R$, where R is a positive real number. This implies that the noncausal function has an infinite extent in both directions. [2]

6.3.1: Code

```
clc;
close all;

syms m;
x= [1 2 3 4];
y=fliplr(x);
disp(y);
l= length(y);

A=0;
z=sym('z');
for i=0:l-1
    A = A + y(i+1) * z^(i);
end
disp('ztransformation output of anti-causal signal: ');
disp(A);
```

6.3.2: Output

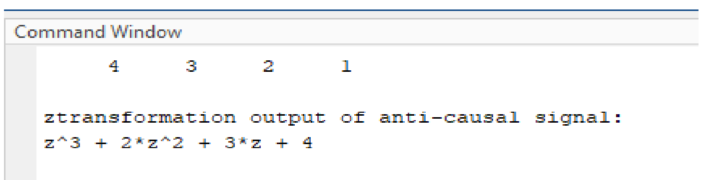

Figure 6.1: Output of anti-causal signal z-transformation

6.4.1: Code (z transformation of non-causal signal)

```
clc;
close all;

syms m;
x= [1 2 3 4 5];
disp(x);
l= length(x);
disp(l);
k= input('Enter index: ');
p=[];

for i=0:k
    p(i+1)=x(i+1);
end
disp(p);

    y=fliplr(p);
    l1=length(y);
    syms m;
    disp(y);

    A=0;
    z=sym('z');
    for i=0:l1-1
        A = A + y(i+1) * z^(i);
    end
disp('ztransformation output of anti-causal part: ');
disp(A);


A1=0;
z=sym('z');
for i=k+1:l-1
    A1 =A1 +x(i+1)*z^(-i+k);
end
disp('ztransformation output of causal part: ');
disp(A1);

disp('Non_causal signal ztransformation: ')
disp(A1+A);
```

6.4.2: Output

```
Command Window
      1     2     3     4     5

      5

Enter index: 1
      1     2

      2     1

ztransformation output of anti-causal part:
z + 2

ztransformation output of causal part:
3/z + 4/z^2 + 5/z^3

Non_causal signal ztransformation:
z + 3/z + 4/z^2 + 5/z^3 + 2

fx >>
```

Figure 6.2: Output of non-causal signal z-transformation

6.5: Conclusion & Discussion

The experiment was accomplished successfully and observed that the output of these codes was as same as the theory. Besides, mathematically, the ROC for an anti-causal function is defined by $|z| < R$, where R is a positive real number. This implies that the anti-causal function has an infinite extent in both directions, but it decays as $|z|$ approaches infinity. It's important to note that anti-causal functions have unique properties and are less common in practical applications compared to causal functions. Noncausal signals are also less common in practical applications compared to causal signals.

6.6: References

[1] https://www.tutorialspoint.com/digital_signal_processing/dsp_z_transform_existence.htm

[2] https://en.wikipedia.org/wiki/Z-transform#Example_3_(anti_causal_ROC)