Experiment No: **5** Date: 10/09/24

Experiment Name: Linear Convolution using CircularConvolution and Vice versa.

Aim:

1. To perform Linear Convolution using Circular Convolution.
2. To perform Circular Convolution using Linear Convolution.

Theory:

Performing Linear Convolution Using Circular Convolution

Method:

1. **Zero-Padding:**
   - Pad both sequences *x[n]* and *h[n]* with zeros to a length of at least *2N-1*, where *N* is the maximum length of the two sequences. This ensures that the circular convolution will not wrap around and introduce artificial periodicity.
2. **Circular Convolution:**
   - Perform circular convolution on the zero-padded sequences.
3. **Truncation:**
   - Truncate the result of the circular convolution to the length *N1 + N2 - 1*, where *N1* and *N2* are the lengths of the original sequences *x[n]* and *h[n]*, respectively.

Example:

Consider the sequences *x[n] = [1, 2, 3]* and *h[n] = [4, 5]*.

1. Zero-padding:
   - Pad *x[n]* to [1, 2, 3, 0, 0] and *h[n]* to [4, 5, 0, 0].
2. Circular Convolution:
   - Perform circular convolution on the zero-padded sequences. The result will be [4, 13, 21, 15, 0].
3. Truncation:
   - Truncate the result to [4, 13, 21, 15].

This result is the same as the linear convolution of *x[n]* and *h[n]*.

Performing Circular Convolution Using Linear Convolution

Method:

1. **Zero-Padding:**
   - Pad both sequences *x[n]* and *h[n]* to a length of at least *2N-1*, where *N* is the maximum length of the two sequences.
2. **Linear Convolution:**
   - Perform linear convolution on the zero-padded sequences.
3. **Modulus Operation:**
   - Apply the modulus operation to the indices of the linear convolution result, using the period *N*. This effectively wraps around the ends of the sequence, making it circular.

Example:

Using the same sequences as before, *x[n] = [1, 2, 3]* and *h[n] = [4, 5]*.

1. Zero-padding:
   - Pad *x[n]* to [1, 2, 3, 0, 0] and *h[n]* to [4, 5, 0, 0].
2. Linear Convolution:
   - Perform linear convolution. The result will be [4, 13, 21, 15, 0].
3. Modulus Operation:
   - Apply the modulus operation to the indices: [4, 13, 21, 15, 0] becomes [4, 13, 2, 15, 0].

Program:

1. Linear Convolution using Circular Convolution

```
clc;

clear all;

close all;

x = [1 2 3 4];

h = [1 1 1 ];

l = length(x);

m = length(h);

k = l+m-1;

x = [x zeros(1,k-l)];

h = [h zeros(1,k-m)];
```

```
X_k = fft(x);
H_k = fft(h);
Y_k = X_k.*H_k;
y = ifft(Y_k);
disp("Linear Convolution using Circular Convolution :");
disp(y);
```

2.Circular convolution using Linear Convolution

```
clc;

close all;

clear all;

x = [1 2 3 4];
h = [1 1 1 ];
l = length(x);
m = length(h);
Lc = max(l,m);
Ll= l+m-1;
y = conv(x,h);
for i=1:Ll-Lc
  y(i) = y(i) + y(Lc+i);
end
for i=1:Lc
y1(i) = y(i);
end
disp("Circular convolution using Linear Convolution:")
disp(y1);
```

Result

Performed

a) Linear Convolution using Circular Convolution;

b) Circular Convolution usingLinear Convolution

and verified result.

Observation

1) Linear Convolution using Circular Convolution :

Linear Convolution using Circular Convolution:

1 3 6 9 7 4

2.Circular convolution using Linear Convolution

Circular convolution using Linear Convolution:

8 7 6 9