Date:22/08/24

Experiment No:4

Circular Convolution

Aim:

To find circular convolution

a. Using FFT and IFFT.
b. Using Concentric Circle Method.
c. Using Matrix Method.

Theory:

Circular convolution is a mathematical operation that is like linear convolution but is performed in a periodic or circular manner. This is particularly useful in discrete-time signal processing where signals are often represented as periodic sequences.

Mathematical Definition:

Given two periodic sequences *x[n]* and *h[n]*, their circular convolution is defined as:

$$y[n] = (x[n] \circledast h[n]) = \sum_{k=0}^{N-1} x[k]h[(n-k) \bmod N]$$

Applications:

- Discrete-Time Filtering: Circular convolution is used for filtering discrete-time signals.
- Digital Signal Processing: It's a fundamental operation in many digital signal processing algorithms.
- Cyclic Convolution: In certain applications, such as cyclic prefix OFDM, circular convolution is used to simplify the implementation of linear convolution.

Program:

a. Using FFT and IFT

```
clc;

clear;

close all;

x=input("Enter the elements in x[n]:");

x_ind = input("Enter the index of x[n]:");

h=input("Enter the elements in h[n]:");
```

```
h_ind = input("Enter the index of h[n]:");
subplot(3,1,1);
stem(x_ind,x);
title('x[n]');
xlabel ('time');
ylabel ('amplitude');
grid;
subplot(3,1,2);
stem(h_ind,h);
title('h[n]');
xlabel ('time');
ylabel ('amplitude');
grid;
len_x= length(x);
len_h= length(h);
N= max(len_x,len_h);
new_x=[x zeros(1,N-len_x)];
new_h=[h zeros(1,N-len_h)];
x1= fft(new_x);
h1= fft(new_h);
y1=x1.*h1;
y=ifft(y1);
ny=0:N-1;
disp(y);
subplot(3,1,3);
stem(ny,y);
title('Circular convolution of y[n] using FFT and IFFT');
xlabel ('time');
ylabel ('amplitude');
grid;
```

b.Using Matrix method

```
clc;
clear;
close all;
x=input("Enter the elements in x[n]:");
x_ind = input("Enter the index of x[n]:");
h=input("Enter the elements in h[n]:");
h_ind = input("Enter the index of h[n]:");
hr=[];
h1=h;
h=h(:,end:-1:1);
for i=1:length(h)
    h=[h(end) h(1:end-1)];
    hr=[hr;h];
end
y=hr*x';
disp(y);
subplot(3,1,1);
stem(x_ind,x);
title('x[n]');
xlabel ('time');
ylabel ('amplitude');
grid;
subplot(3,1,2);
stem(h_ind,h);
title('h[n]');
xlabel ('time');
ylabel ('amplitude');
grid;
subplot(3,1,3);
Ny=0:3;
stem(Ny,y);
title('Circular convolution of y[n] using Matrix method');
xlabel ('time');
ylabel('amplitude')
```

c. Using Concentric Circle Method

```
clc;
clear;
close all;
x=[2 1 2 1];
x=x(:,end:-1:1);
h=[1 2 3 4];
for i=1:length(x);
    x=[x(end) x(1:end-1)];
    h1=h;
    y(i) = sum(x.*h1);
end
disp(y);
ny=0:3;
stem (ny,y);
xlabel('time');
ylabel('amplitude');
title ('Circular convolution using concentric circles method ');
```

Result

Performed Circular Convolution using a) FFT and IFFT; b) Matrix method and c) Concentric circles method

and verified result.

Observation

a) USING FFT AND IFFT

Using FFT and IFFT:

16 14 16 14

b) USING Matrix Method

Using Matrix Method.:

16 14 16 14

c) USING Concentric Circle Method

Using Concentric Circle Method:

16 14 16 14