Experiment No: 4 Date: 22/08/2024

Circular Convolution

Aim

Circular Convolution using FFT, Matrix Method, Concentric Method

Theory

Circular convolution is a mathematical operation which is like Linear Convolution but particularly useful in Discrete Time Signal Processing where signals are often periodic.

Mathematically,

$$x_1(n)^* x_2(n) = \sum_{m=0}^{N-1} x_1(m) x_2(n-m)_N$$

where $x_1(n)$ and $x_2(n)$ are two periodic sequences

Program

➔ Circular Convolution using FFT

```
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]:');
figure;
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 output y[n]');
xlabel('time');
ylabel('amplitude');
grid;
```

➔ Circular Convolution 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,h1);
title('h[n]');
xlabel('time');
ylabel('amplitude');
grid;
subplot(3,1,3);
Ny=0:3;
stem(Ny,y);
title('Circular convolution output y[n]');
xlabel('time');
ylabel('amplitude');
grid;
```

→ Circular Convolution using Concentric Circle Method

```
%Circular convolution using concentric circle method
clc;
close all;
clear all;
x=[2 1 2 1];
x=x(:,end:-1:1);
disp("Reversed x");
disp(x);
h=[1 2 3 4];
for i=1:length(x)
 x=[x(end) x(1:end-1)];
 y(i)=sum(x.*h);
end
disp("Convolution product y:");
disp(y);
```

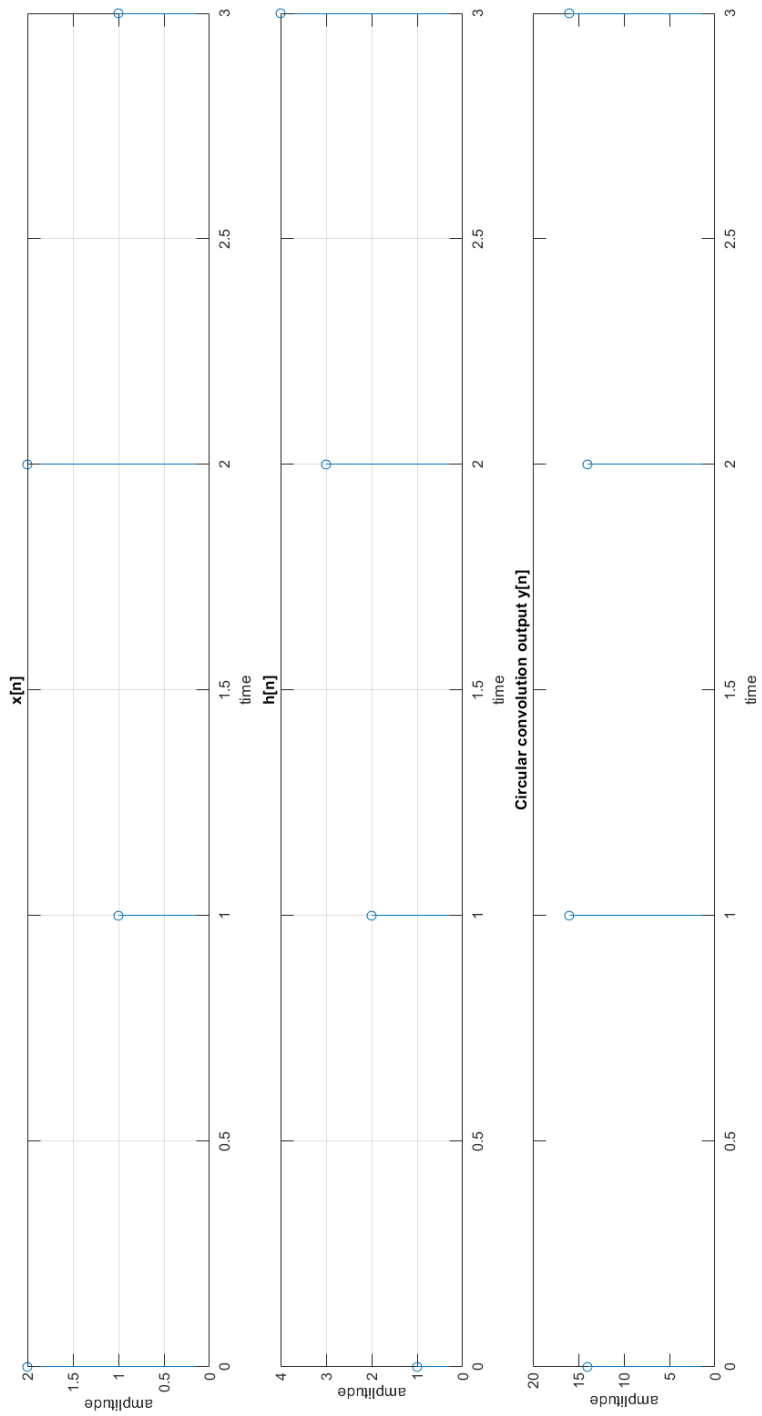
Result

Performed Circular Convolution using FFT, Matrix and Concentric Circle Methods.

Observation

➔ Circular Convolution using FFT

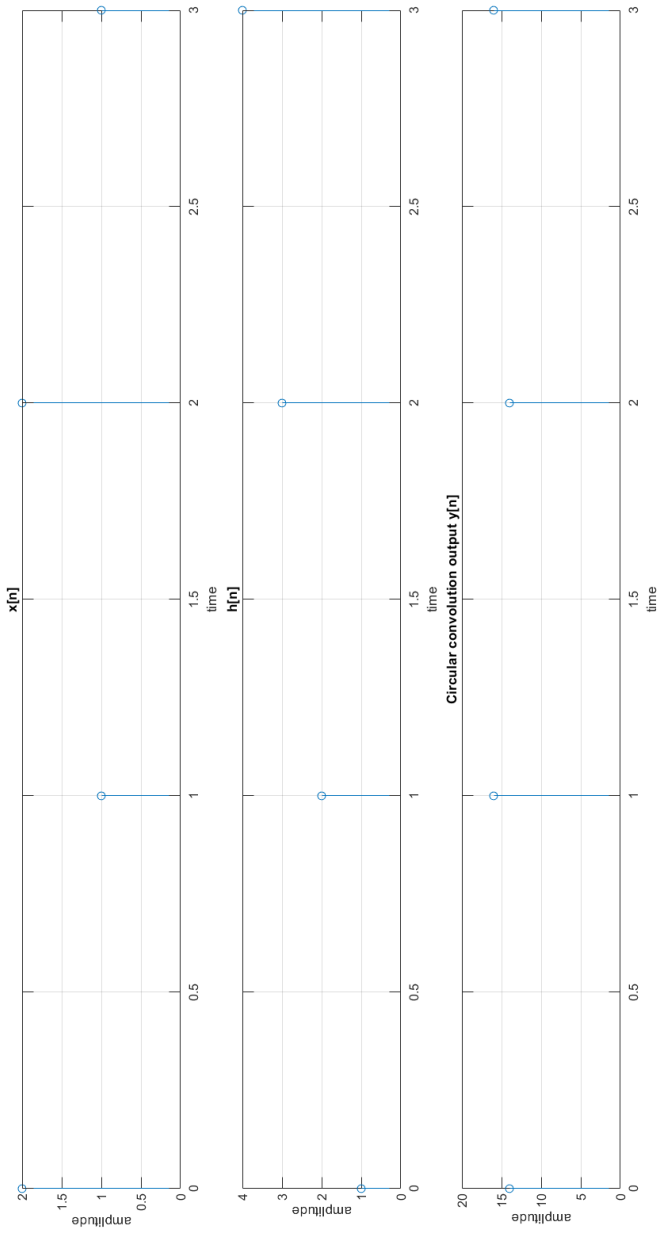
```
enter the elements in x[n]:[2 1 2 1]
enter the index of x[n]:[0 1 2 3]
enter the elements in h[n]:[1 2 3 4]
enter the index of h[n]:[0 1 2 3]
    14    16    14    16
```



Observation

➔ Circular Convolution using Matrix Method

```
enter the elements in x[n]:[2 1 2 1]
enter the index of x[n]:[0 1 2 3]
enter the elements in h[n]:[1 2 3 4]
enter the index of h[n]:[0 1 2 3]
    14
    16
    14
    16
```



Observation

➔ Circular Convolution using Concentric Circle Method

```
Reversed x
     1     2     1     2

Convolution product y:
    14    16    14    16
```