CIRCULAR CONVOLUTION

AIM

To perform circular convolution using FFT method, matrix method, concentric circle method.

THEORY

Circular convolution is a mathematical operation used primarily in signal processing. It involves wrapping one signal around a circular buffer and performing the convolution operation on it, often used when signals are periodic or when working with discrete Fourier transforms (DFT). This technique ensures that the result maintains periodicity by aligning the endpoints of signals. It is computationally efficient and widely applied in fast algorithms like the Fast Fourier Transform (FFT). It can be performed by 3 methods:

Using FFT (Fast Fourier Transform):

- Circular convolution is performed by transforming the sequences to the frequency domain using FFT, multiplying them element-wise, and transforming them back using the inverse FFT.

$$y[n] = \text{IFFT}(\text{FFT}(x[n]) \cdot \text{FFT}(h[n]))$$

Concentric Circle Method:

- This is a graphical method where one sequence is placed in a circular pattern, and the other sequence is rotated around it. The inner product of corresponding values after each rotation gives the result.

Matrix Method:

- Circular convolution can be represented as matrix multiplication, where one sequence is arranged in a circulant matrix, and the other is a column vector.

  y=C·h

where C is the circulant matrix formed from x, and h is the vector.

PROGRAM

a)Circular convolution using FFT

```
clc;

clear;

 close all;

 x=input('enter the elements in x[n]:');
```

OBSERVATION

INPUT

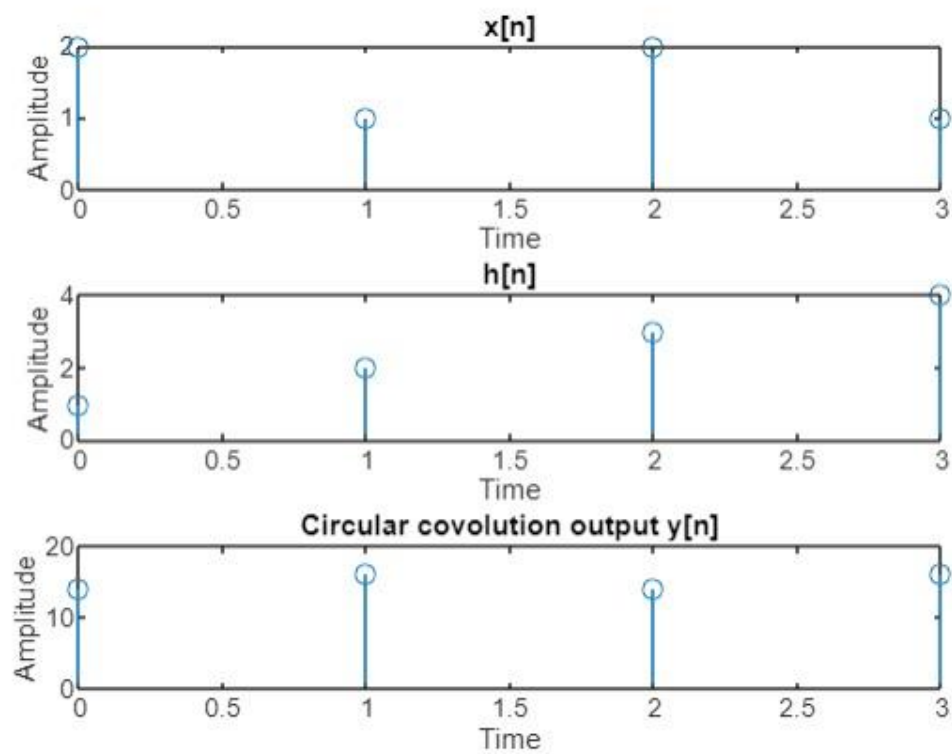enter the elements in x[n] :[2 1 2 1]

enter the index of x[n]:[0:3]

enter the elements in h[n]:[1 2 3 4]

enter the index of h[n]:[0:3]

OUTPUT

```matlab
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');
subplot(3,1,2);
stem(h_ind,h);
title('h[n]');
xlabel('time');
ylabel('amplitude');
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');
```
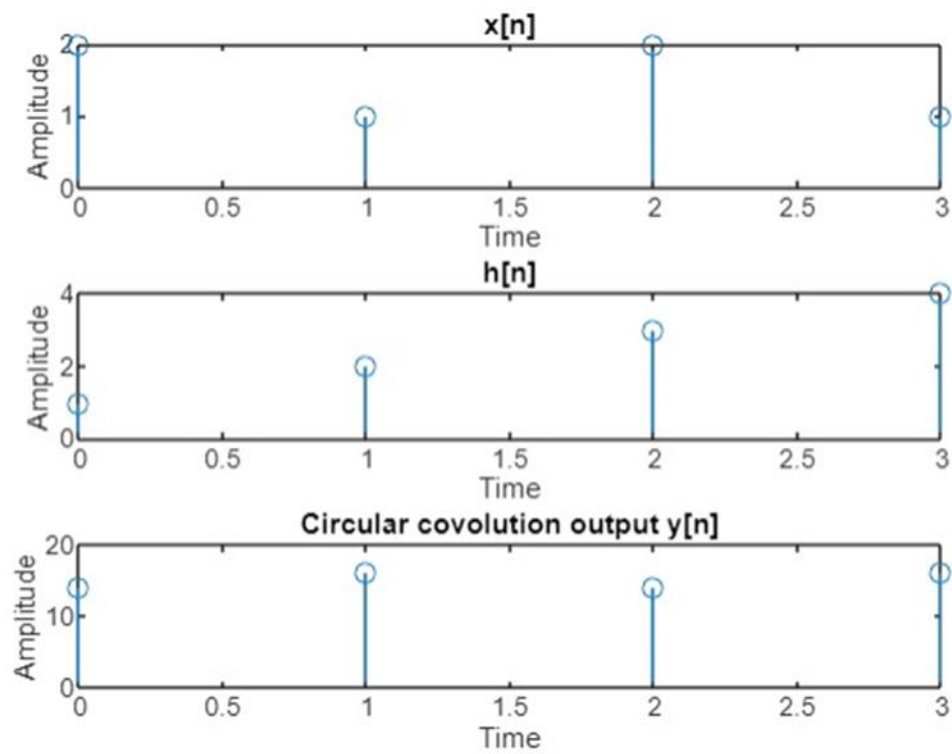
OBSERVATION

INPUT

enter the elements in x[n] :[2 1 2 1]

enter the index of x[n]:[0:3]

enter the elements in h[n]:[1 2 3 4]

enter the index of h[n]:[0:3]

OUTPUT

```
ylabel('amplitude');
```

b)Circular convolution using Matrix Method

```
clc;
 close all;
 clear;
 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)
figure;
 subplot(3,1,1);
stem(x_ind,x);
 title('x[n]');
 xlabel('time');
 ylabel('amplitude');
 grid;
 subplot(3,1,2);
 stem(h_ind,h1);
```

OSERVATION

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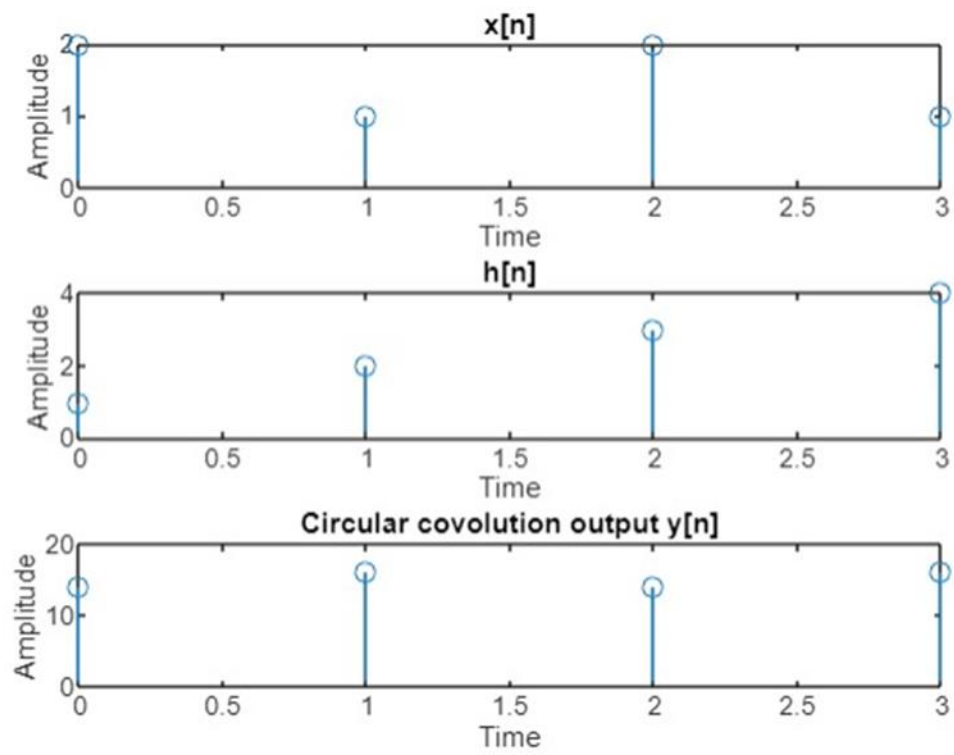
```
 title('h[n]');
 xlabel('time');
 ylabel('amplitude');
subplot(3,1,3);
 Ny=0:3;
 stem(Ny,y);
 title('Circular convolution output y[n]');
 xlabel('time');
 ylabel('amplitude');
```

c)Circular Convolution using concentric circles 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);
figure;
subplot(3,1,1);
stem(x_ind,x);
title('x[n]');
xlabel('time');
```

```
ylabel('amplitude');

subplot(3,1,2);

stem(h_ind,h1);

 title('h[n]');

 xlabel('time');

 ylabel('amplitude');

 subplot(3,1,3);

 Ny=0:3;

 stem(Ny,y);

 title('Circular convolution output y[n]');

 xlabel('time');

 ylabel('amplitude');
```

RESULT

Performed circular convolution using FFT method, matrix method, concentric circle method.