

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 IFFT.

```
clc;
close all;
clear all;
x1 = [1 2 1 2];
x2 = [1 2 3 4];
X1_k = fft(x1);
X2_k = fft(x2);
Y1_k = X1_k.*X2_k;
```

```
y1 = ifft(Y1_k);  
disp("Using FFT and IFFT:")  
disp(y1);
```

b. Using Concentric Circle Method.

```
clc;  
close all;  
clear all;  
x = [1 2 1 2];  
h = [1 2 3 4];  
N = max(length(x),length(h));  
y = zeros(1,N);  
for n=1:N  
    h_s = circshift(h,n-1); %shifting h(n) by 1 unit  
    y(n) = sum(x.*h_s);  
end  
  
disp("Using Concentric Circle Method:")  
disp(y);
```

c. Using Matrix Method.

```
clc;  
close all;  
clear all;  
  
x = [1 2 1 2];  
h = [1 2 3 4];  
N = max(length(x),length(h));  
h_n = zeros(N,N);
```

```

for n=1:N
h_s = circshift(h,n-1);%shifting h(n) by 1 unit
h_n(:,n) = h_s;
end
y = h_n *x';
disp("Using Concentric Circle Method:")
disp(y');

```

Result:

Performed Circular Convolution using a) FFT and IFFT; b) Concentric Circle method; c) Matrix method and verified result.

Observation:

a) USING FFT AND IFFT

Using FFT and IFFT:

16 14 16 14

b) USING Concentric Circle Method

Using Concentric Circle Method:

16 14 16 14

c) USING Matrix Method

Using Matrix Method.:

16 14 16 14