EXPT NO : 1 Discrete Convolution

Aim : The aim of this experiment is to study mathematical operation such as :

Linear Convolution,

Circular Convolution, and

Linear Convolution using Circular Convolution

Objective

- Develop a function to find Linear Convolution and Circular Convolution
- Calculate Linear convolution, Circular convolution, Linear Convolution using Circular Convolution and verify the results using mathematical formulation.
- Conclude on aliasing effect in Circular convolution

Input Specifications :

1. Length of first Signal L and signal values.
2. Length of second Signal M and signal values.

Problem Definition

- Find Linear Convolution and Circular Convolution of L point sequence x[n] and M point sequence h[n].
- Find Linear Convolution of L point sequence x[n] and M point sequence h[n] using Circular convolution.
- Give your conclusion about No of values in Linearly Convolved signal, Aliasing effect in Circular Convolution.

Experimentation and Result Analysis

Case-1 : To find y[n] = x[n] * h[n]

Input x[n] = { 1,2,3,4 } Length L= 4

h[n] = { 5, 6, 7 } Length M= 3

Output y[n] = { 5, 16, 34, 52, 45, 28 } Length N =6

- Length of Linear Convolution output signal is

  N = 4+3-1 == 6

  That means, Length of Linear Convolution output signal is N = L + M -1

Case-2 : To find y[n] = x[n] ⊛ h[n]

Input x[n] = { 1, 2, 3, 4 } Length L= 4

h[n] = { 5, 6, 7 } Length M= 3

Output

y[n] = { 50, 44, 34, 52} Length N = 4

The first few values of Circular Convolution output signal are aliased with the values beyond N.

For ex. Let x[n] = { 1, 2, 3, 4 } Length L = 4

h[n] = { 5, 6, 7 } Length M = 3

Then linear convolution output :

y[n] = { 5, 16, 34, 52, 45, 28 } Length N = 6

The circular convolution output :

y[n] = { 50, 44, 34, 52} Length N = 4

- In this example last two values are aliased with first two values of y[n]

y[n] = { 5 + 45, 16+28, 34,52}

The output of circular convolution :

y[n] = { 50, 44, 34, 52}

Circular convolution gives aliased output.

Case-3 : **To find y[n] = x[n] * h[n] using Circular Convolution**

Input x[n] = { 1,2,3,4 } Length L= 4

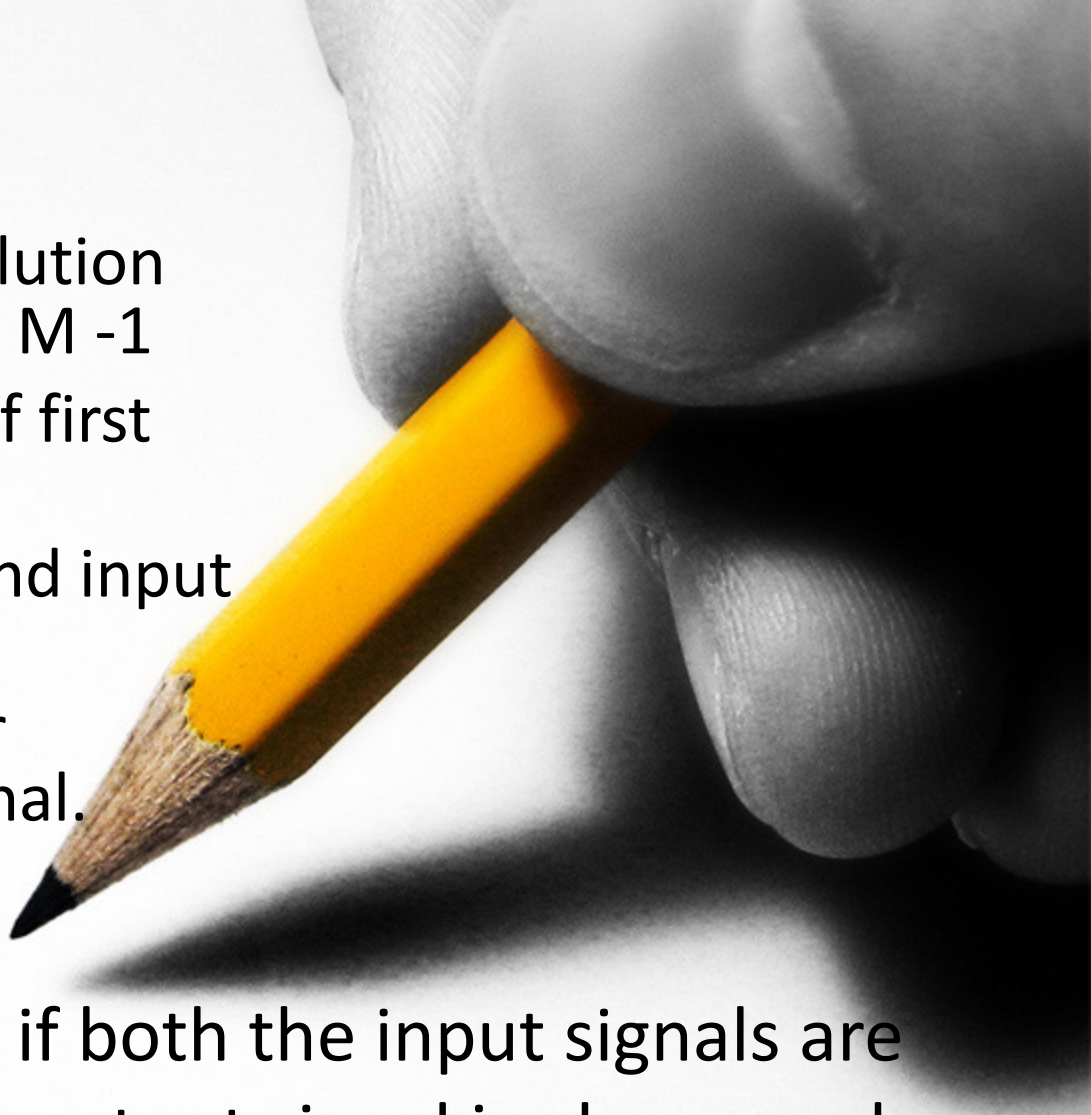
h[n] = { 5, 6, 7 } Length M= 3

Output y[n] = { 5, 16, 34, 52, 45, 28 }

Length of y[n] is N =6

Conclusion

1. Length of Linear Convolution output signal is $N = L + M - 1$
   - Where L is the length of first input signal
   - M is the length of second input signal
   - N is the length of linear convolution output signal.



2. In Linear convolution if both the input signals are causal, then resultant output signal is also causal.

3. To find Circular Convolution

Select N = MAX(L,M)

Where L is the length of first input signal

M is the length of second input signal

4. To find Linear Convolution using Circular Convolution

Select N >= L + M -1

Where L is the length of first input signal and

M is the length of second input signal.

5. Circular Convolution gives aliased output

Audio Signal Filtering

Audio Signal Filtering

- **Problem Statement :**
  Filter the Audio Signal Captured in the presence of noise and improve the quality of sound

- **Algorithm :**

  1. Record Audio Signal in the presence of noise ➔ x[n].
  2. Play the recorded signal x[n] and observe the quality of sound.
  3. Design FIR Low Pass Filter using MATLAB filter design Tool.
     Take Fpass= 3000Hz, Fstop=7000Hz Fs = 44000 Hz ➔ h[n]
  4. Filter the audio signal x[n]
     i.e. Perform Linear Convolution of x[n] and h[n] ➔ y[n]
  5. Play the filtered signal y[n] and observe the quality of sound

- **Platform :** C/C++/Java/Python/MATLAB