DIGITAL SIGNAL PROCESSING LAB

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Aim of The Experiment :-

To perform sectional convolution using overlap add and overlap save method.

Software Required :-

- MATLAB R2018a

Theory :-

Linear convolution is the basic operation to calculate the output for any linear time invariant system given its input and its impulse response. Circular convolution is the same thing but considering that the support of the signal is periodic (as in a circle, hence the name).

Two methods that make linear convolution look like circular convolution are overlap-save and overlap -add.

Overlap-Add Method

The overlap-add method is used to break long signals into smaller segments for easier processing. FFT convolution uses the overlap-add method together with the Fast Fourier Transform, allowing signals to be convolved by multiplying their frequency spectra.

a) The overlap-add method allows us to calculate the convolution of very long sequences.
b) The overlap-add method breaks a long sequence, x(n) , into signals of shorter length and calculates the convolution of each block independently.

Overlap-Save Method

a) If the input frame size is and the filter length is , then a length FFT and IFFT are used.
b) As a result, samples of the output are invalid due to time aliasing.
c) The overlap-save method writes out the good samples and uses a hop size of , thus recomputing the time-aliased output samples in the previous frame.

Code :-

```
%Overlapadd.m
%Written by Debagnik Kar 1804373
clc
clear all
close all
x=input('enter The sequence x')
h=input('enter the sequence h')
lx=length(x)
M=length(h)
N=2*M-1
L=N-M+1
x=[x,zeros(1,N-1)]
h=[h,zeros(1,N-M)]
k=floor(lx/M)+1
p=zeros(k,N)
for i=1:k
    p(i,1:L)=x((i-1)*L+1:(i-1)*L+L)
end
y=zeros(k,N)
for i=1:k
    y(i,:)=cconv(p(i,:),h,N)
end
for i=2:k
    y(i,1:M-1)= y(i,1:M-1)+y(i-1,L+1:N)
end
z=y(:,1:L)
a=z'
subplot(311)
stem(x)
title('x')
subplot(312)
stem(h)
title('h')
subplot(313)
stem(a(:))
title('overlap add')

%Overlapsave.m
%Written by Debagnik Kar 1804373
clc
close all
clear all
x = input('Enter sequence')
h = input('Enter an impulse response')
lx = length(x)
M = length(h)
N = 2*M-1
L = N-M+1
x = [x,zeros(1,N)]
h = [h,zeros(1,N-M)]
```

```
k = floor(lx/M)+1
p = zeros(k,N)
for i=1:k
    p(i,L:N)=x((i-1)*L+1:(i-1)*L+L)
end
for i=2:k
    p(i,1:M-1)=p(i-1,L+1:N)
end
y=zeros(k,N)
for i=1:k
    y(i,:)=cconv(p(i,:),h,N)
end
z = y(:,L:N)
u = z'
subplot(311)
stem(x)
title('x')
subplot(312)
stem(h)
title('h')
subplot(313)
stem(u(:))
title('Overlap Save')
```

Graph/Output :-

OVERLAP-ADD Method:

```
x =
   1   8   0   4   3   7   3   0   0   0   0
h =
   4  -1   6   0   0
p =
   1   8   0   0   0
   4   3   7   0   0
   3   0   0   0   0
y =
   4.0000  31.0000  -2.0000  48.0000  -0.0000
  64.0000   8.0000  49.0000  11.0000  42.0000
  23.0000  39.0000  18.0000   0.0000        0
z =
   4.0000  31.0000  -2.0000
  64.0000   8.0000  49.0000
  23.0000  39.0000  18.0000
a =
   4.0000  64.0000  23.0000
  31.0000   8.0000  39.0000
  -2.0000  49.0000  18.0000
```

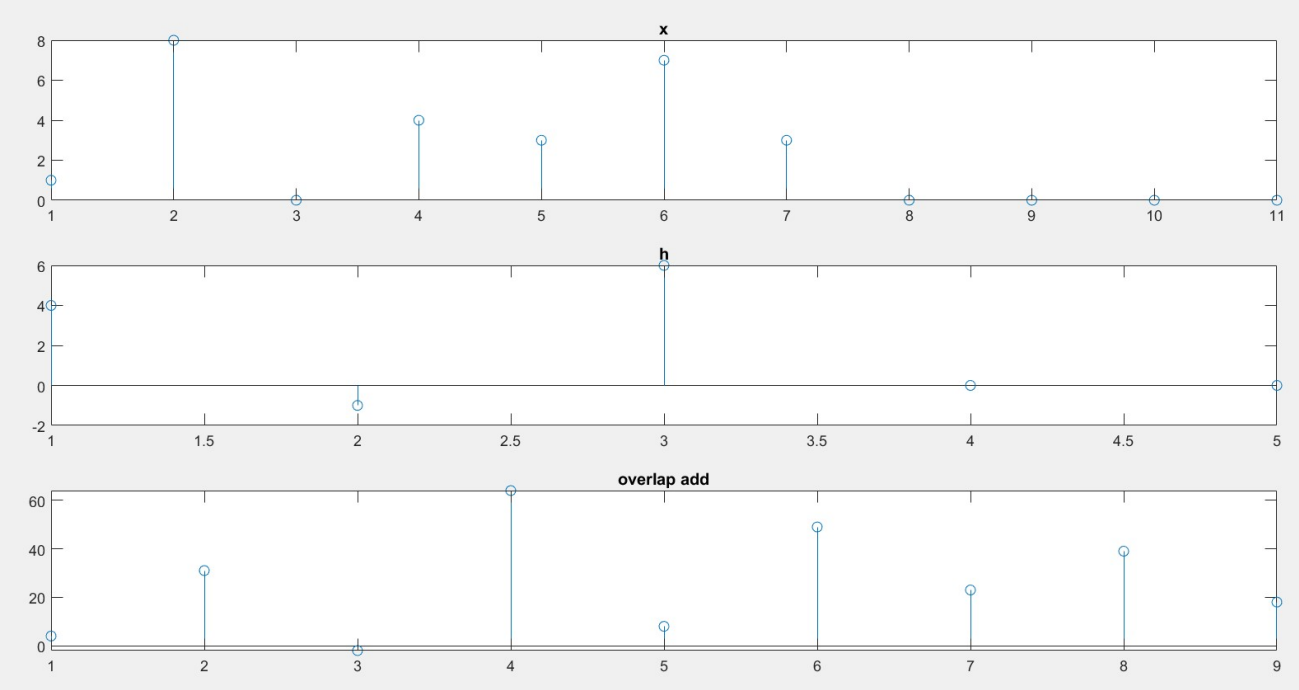

Fig 5.1: Linear convolution using Overlap-add method

OVERLAP-SAVE Method:

```
x =
    1    8    0    4    3    7    3    0    0    0    0    0
h =
    4   -1    6    0    0
k =
    3
p =
    0    0    1    8    0
    8    0    4    3    7
    3    7    3    0    0
y =
   48.0000   -0.0000    4.0000   31.0000   -2.0000
   43.0000   34.0000   64.0000    8.0000   49.0000
   12.0000   25.0000   23.0000   39.0000   18.0000
z =
    4.0000   31.0000   -2.0000
   64.0000    8.0000   49.0000
   23.0000   39.0000   18.0000
u =
    4.0000   64.0000   23.0000
   31.0000    8.0000   39.0000
   -2.0000   49.0000   18.0000
```

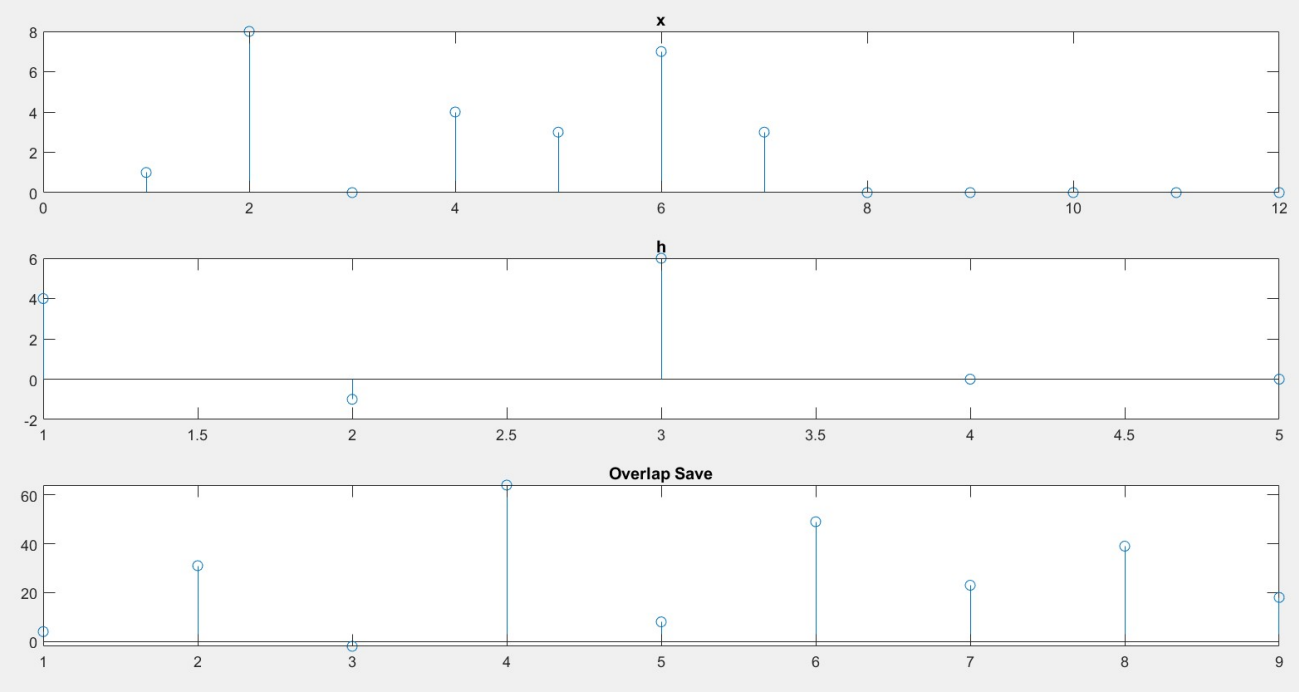

Fig 5.2: Linear convolution using overlap-save method

Discussion/Inference of the experiment :-

In this experiment for the overlap add method we followed these steps to write the code

4.Broke the long sequence(n) , into signals of length L .

5.Used the DFT-based method to calculate the convolution of each xm(n) x m (n) with h(n) .

6.Shifted each ym(n) y m (n) by mL samples and added the results together.

For the sequences

the first sequence [1 8 0 4 3 7 3]

the second sequence [4 -1 6]

The result was

[4 31 -2 48 0 64 8 49 11 42 23 39 18 0 0]

In this experiment for the overlap save method we followed these steps to write the code

3.cut the signal up into equal length segments with some overlap.

4.Then take the DFT of the segments and saves the parts of the convolution that correspond to the circular convo

For the sequences

the first sequence [1 8 0 4 3 7 3]

the second sequence [4 -1 6]

The result was

[4 31 -2 64 8 49 23 39 18]

Conclusion :-

In this experiment we learned about sectional convolution methods like overlap add and overlap save method and wrote codes to obtain linear convolution of given sequences using sectional convolution methods such as overlap add and overlap save. After successfully simulating the experiment we generated the required graphs using MATLAB whose behavior was in accordance with the theoretical concept.