Heaven’s Light is Our Guide

Rajshahi University of Engineering & Technology

Sessional Course Code: ECE 4124

Course name: Digital Signal Processing Sessional

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Experiment No: 01

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Experiment Name: Convolution of 2 signals using conv function and without using conv function.

Objective:
- Familiar with the conv function
- Problem solving without using conv function
- Realtime implementation and visualization of 2 outputs

Theory: A convolution is an integral that expresses the amount of overlap of one function as it is shifted over another function . It therefore "blends" one function with another.

Let x be the input signal to a linear system L and let the output be y=Lx. We can write x as an integration (summation) of shifted pulses:

$$x(t)=\int_{-\infty}^{\infty} x(u)\delta(u-t)\, du$$

Because $\delta(x)=\delta(-x)$, we can also write:

$$x(t)=\int_{-\infty}^{\infty} x(u)\delta(t-u)\, du=\int_{-\infty}^{\infty} x(u)\delta_u(t)du$$

where $\delta_u(t)$ is the function δ shifted to the left-over u. Now look at Lx. Because of the linearity of L, it can be written:

$$(Lx)(t) =\int_{-\infty}^{\infty} x(u)(L\delta_u) (t)du$$

Shift invariance of the operator implies that $(L\delta_u) =(L\delta)_u$, i.e. first shifting and then applying the operator is the same as first applying the operator and then shift.

Obviously $L\delta$ is the pulse response of the linear system, let's call it the function h, then we get:

$$(Lx)(t) =y(t)=\int_{-\infty}^{\infty} x(u)h(t-u)du$$

or equivalently: $y=x*h$

the output of a shift invariant system is given by the convolution of the input signal with the impulse response function of the system. In the signal processing literature it is common to write:

$$y(t)=x(t)*h(t)$$

Required Tools: MATLAB 2015a.

Code & Output:

1. Convolution using conv function.

```
clear all;
close all;
n1 = 0 : 1 : 7;
y1 = [ 1 2 3 1 2 3 4 5 ];
h1 = [ 1 1 1 2 1 -1 1 1 ];
X = conv (y1, h1);
n2 = 0 : length(X)-1;
figure(1)
subplot(3,1,1)
stem(y1)
title('INPUT SIGNAL, X')
subplot(3,1,2)
stem(h1)
title('IMPULSE SIGNAL, H)');
subplot(3,1,3)
stem(X)
title('CONVOLUTION');
```

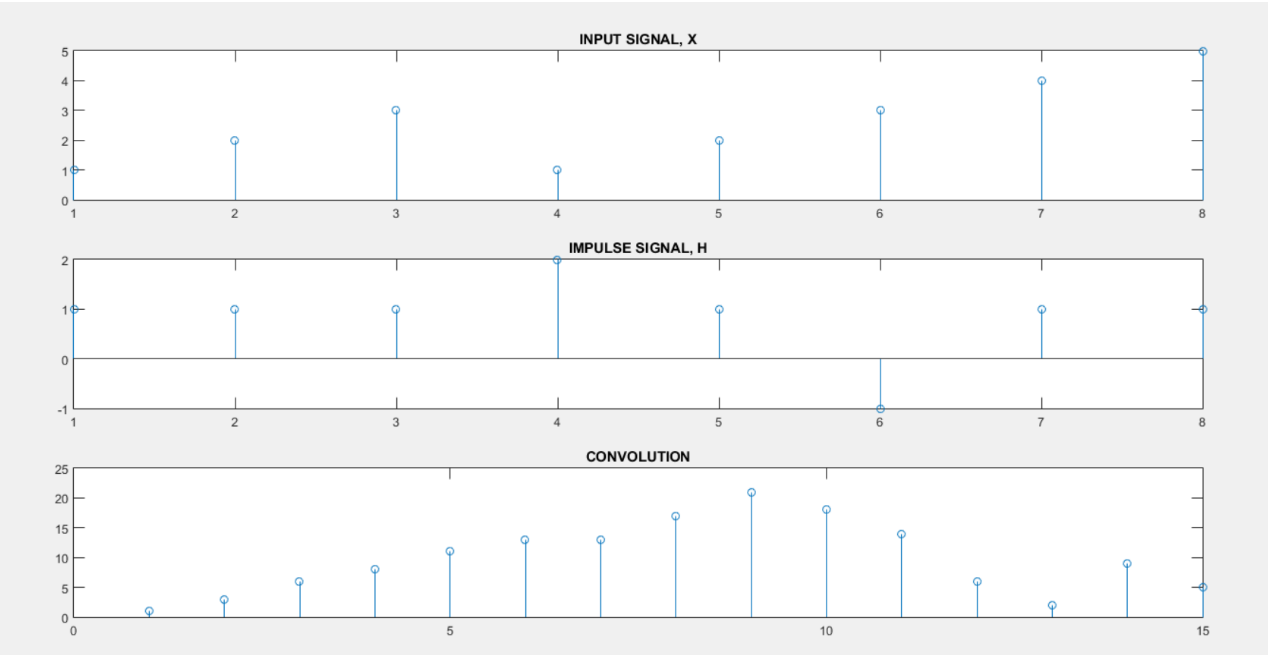

Figure1: Convolution of 2 numbers using conv

2. Convolution without using conv function.

```
clear all;
close all;
x=[ 1 2 3 1 2 3 4 5 ];
h=[ 1 1 1 2 1 -1 1 1 ];
n=length(x) + length(h)-1
k = max(length(x) , length(h))
x=[x,zeros(1,k-length(x))]
h=[h,zeros(1,k-length(x))]
for i =1:1:n
  y(i)=0;

  for j=1:1:k
    if(i-j<0)
      y(i)=y(i)+0

    elseif(i>k)
    if (j+(i-k)<=k)
     y(i) = y(i)+ x(j+(i-k))*h((i-j)-(i-(k+1)));

      endif

    else
      y(i) = y(i)+x(j)*h(i-j+1);

     endif
  endfor
endfor

subplot(3,1,1)
stem(x)
title('INPUT SIGNAL, X')
subplot(3,1,2)
stem(h)
title('IMPULSE SIGNAL, H');
subplot(3,1,3)
title('CONVOLUTION');
stem(y)
```

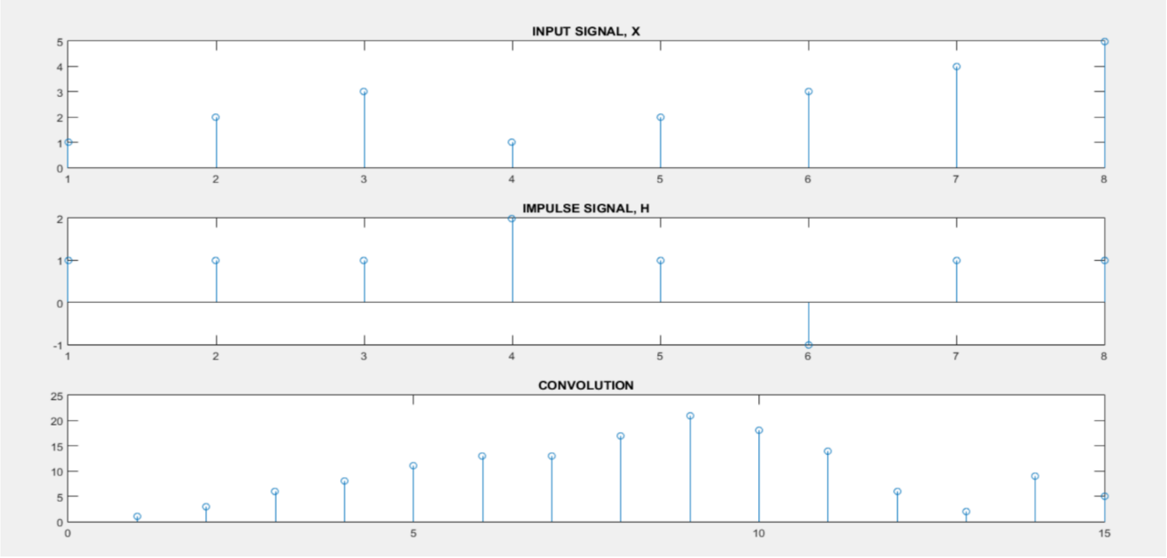

Figure2: Convolution of 2 numbers without using conv

Discussion: This experiment is mainly focused on the convolution of 2 signals. The code is done in 2 different ways. Both of them give the same output.

Conclusion: We tried to find out the convolution of 2 signals. The output resembles to our theory.

References:

1. DSP - Operations on Signals Convolution
https://www.tutorialspoint.com/digital_signal_processing/dsp_operations_on_signals_convolution.htm/ [Online]. [Accessed May1, 2023]

2. Convolution
https://www.analog.com/media/en/technical-documentation/dsp-book/dsp_book_ch6.pdf [Online]. [Accessed May1, 2023]