Heaven's Light is Our Guide

Rajshahi University of Engineering & Technology

RUET

Course Code: ECE 4124

Course Title: Digital Signal Processing Sessional

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Experiment Name: Study of Circular Convolution, Plotting of Figures, Summation, Subtraction and Particular Shapes of Two Signals Using MATLAB

Theory:

Circular convolution is a mathematical operation used in signal processing to analyze periodic signals. In circular convolution, the signal wraps around at the edges instead of being truncated or zero-padded. This operation is performed by taking the Discrete Fourier Transform (DFT) of two signals, multiplying them pointwise, and taking the Inverse Discrete Fourier Transform (IDFT) of the result. The output is a circular convolution of the two input signals.

The circular convolution of two signals x[n] and h[n] can be expressed mathematically as:

y[n] = (1/N) * sum{k=0 to N-1} x[k] * h[(n-k) mod N]

where N is the length of the input signals, and mod represents the modulo operation. This formula calculates the convolution of two signals in a circular manner by taking the sum of the product of the samples of the two signals, where the sample index of the second signal is shifted by k samples.

Circular convolution is used in various applications, such as in digital signal processing, image processing, and communication systems. In these applications, circular convolution is used to filter, modulate, or demodulate signals. Additionally, circular convolution is used to implement circular convolutional codes, which are used in error correction coding in communication systems.

Code:

Problem-1:

```
% Input signals
x = input('Enter the first signal: ');
subplot(3, 1, 1);
stem(x);

h = input('Enter the second signal: ');
subplot(3, 1, 2);
stem(h);

% Length of the signals
N = length(x);
M = length(h);

% Pad the signals with zeros
if N > M
    h = [h zeros(1,N-M)];
else
    x = [x zeros(1,M-N)];
end

% Circular convolution calculation
y = zeros(1, N);
for n = 1:N
    for m = 1:N
        k = mod(n - m, N) + 1;
        y(n) = y(n) + x(m) * h(k);
    end
end

% Result display
disp('Circular Convolution Output: ');
disp(y);
subplot(3, 1, 3);
stem(y);
```

Problem-2:

```
% 1st signal
n1 = [0, 0, 0, 2, 2, 2, 1, 1, 1, 0, 2]
subplot(4, 1, 1);
stem(n1);
title('1st signal');
xlabel('Index');
ylabel('Value');

% 2nd signal
n2 = [2, 2, 0, 1, 1, 1, 0, 0, 0, 0, 3]
subplot(4, 1, 2);
stem(n2);
title('2nd signal');
xlabel('Index');
ylabel('Value');

% Summation
n3=n1+n2;
subplot(4, 1, 3);
stem(n3);
title('Summation');
xlabel('Index');
ylabel('Value');


% Subtraction
n4=n1-n2;
subplot(4, 1, 4);
stem(n4);
title('Subtraction');
xlabel('Index');
ylabel('Value');
```

Problem-3:

```
% 1st signal
x=[0 0 1 1 1 1 0 0];
t=0:1:7;
subplot(2,1,1);
plot(t,x);

% 2nd signal
y=[0 1 1 2 2 1 1 0];
t=0:1:7;
subplot(2,1,2);
plot(t,y);
```

Output:

Problem-1:

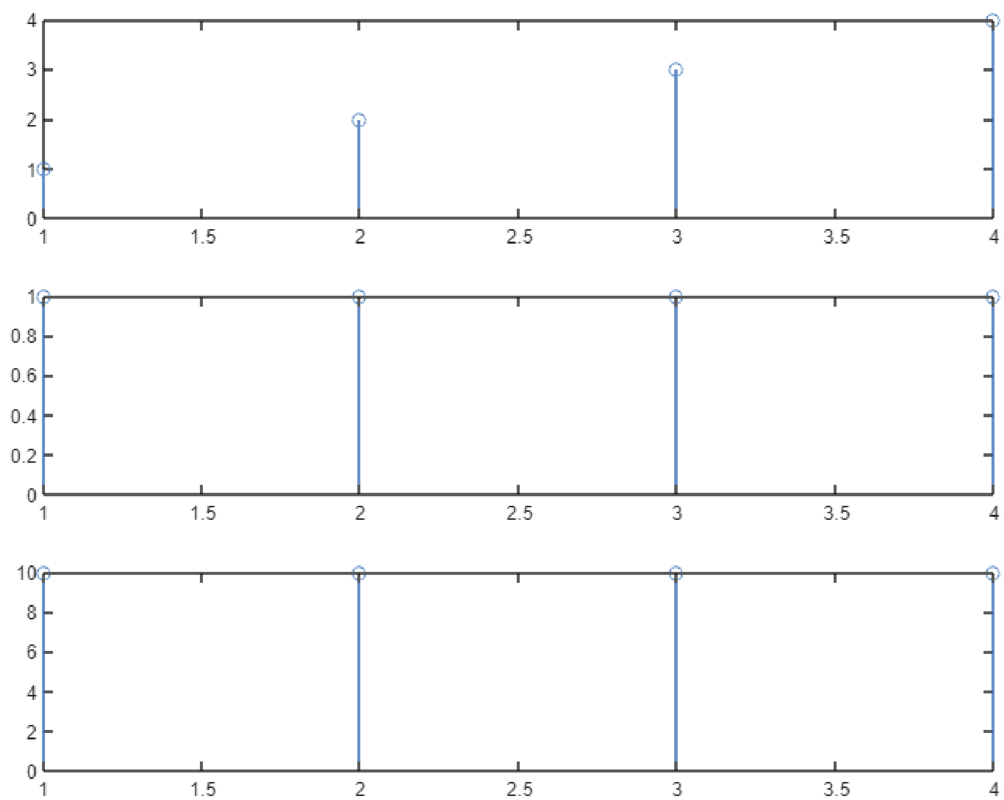

Figure-1: Circular Convolution of Two Signals

```
Enter the first signal:
[1 2 3 4]
Enter the second signal:
[1 1 1 1]
Circular Convolution Output:
    10    10    10    10
```

Figure-2: Result

Problem-2:

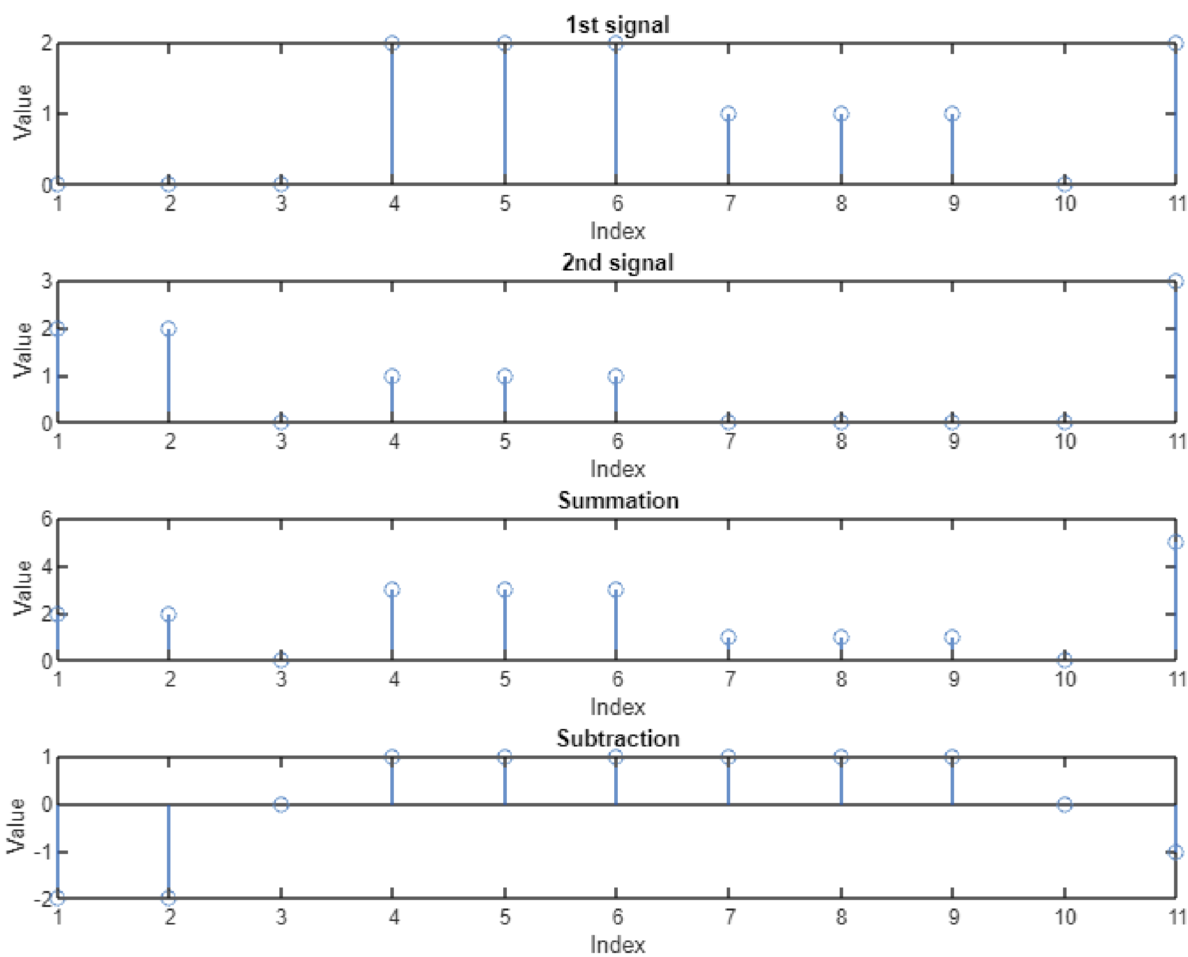

Figure-3: Two Signals, Summation and Subtraction

Problem-3:

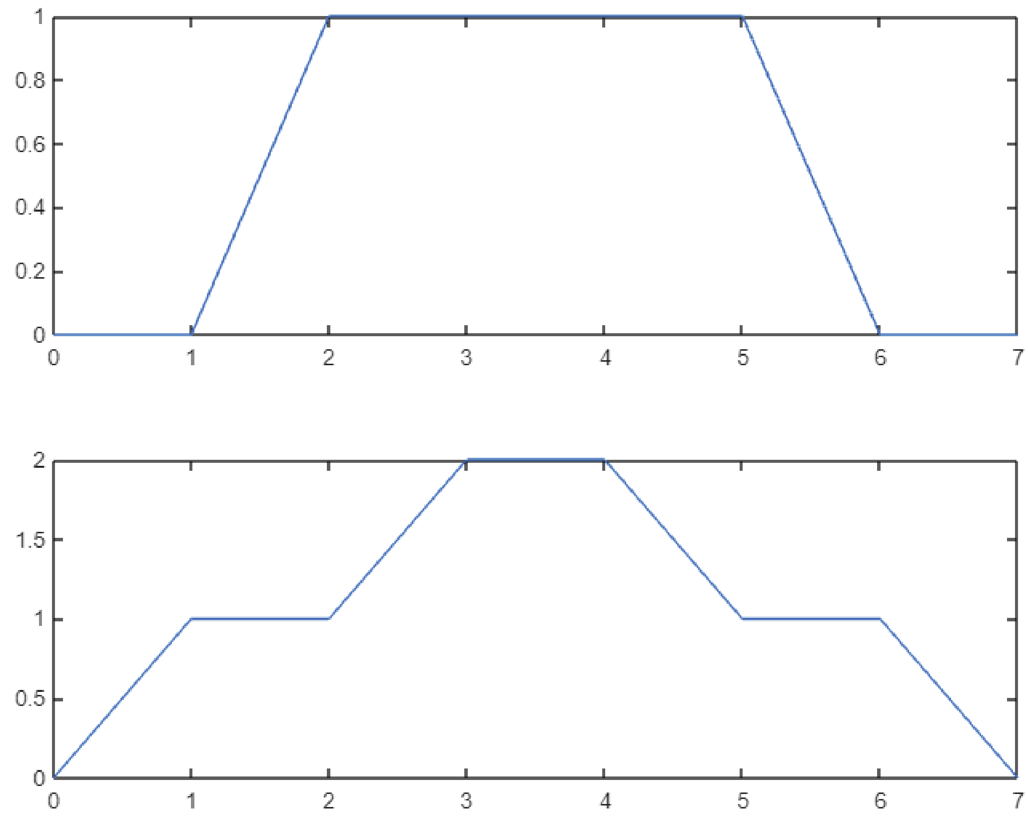

Figure-4: Particular Shape of Two Signals

Discussion:

Circular convolution of two signals was carried out without using any built-in function. The built-in function was also used to check whether the previous output was similar or not. The obtained result was same in both the cases. Then two signals, their summation and subtraction were also plotted as well as particular shape of two signals.

Conclusion: The experiment was carried out successfully.