Date: 27/08/2025
Experiment No: 04
Experiment Name: Performing time scaling Operation on discrete time signal.

Theory:
Time scaling means changing the speed of a discrete-time signal without changing its amplitude. If the signal is written as x[n], then after scaling it becomes: $y[n]=x(\alpha n)$

where α(alpha) is the scaling factor.

1.Time Compression (Fast Playback)

a) Formula: $y[n]= x(Mn)$, where $M>1$.

b) It keeps only every M-th sample of the signal.

c) The signal becomes faster and shorter in duration.

d) Example: If M=2, we keep samples x[0],x[2],x[4],….

e) Risk: Some information is lost (aliasing) if the signal has high frequencies, so a low-pass filter is often used before compression.

2.Time Expansion (Upsampling)

a) Formula (ideal): $y[n] = x(n / L)$, $L>1$

b) In practice, since n/L is not always an integer:

c) We keep original samples at multiples of L.

d) For in-between points, we usually insert zeros and then use a low-pass filter to smooth.

e) The signal looks slower/longer in duration.

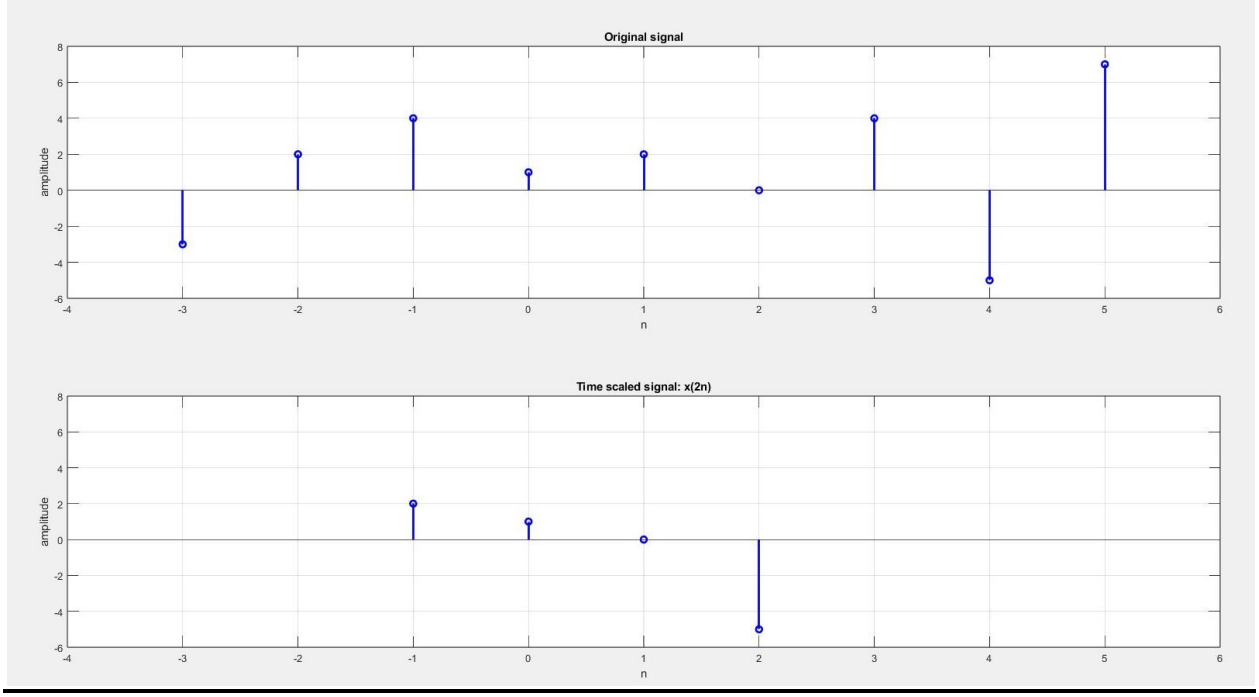
f) Example: If L=2, the sequence becomes x[0],0,x[1],0,x[2],0,….

Codes:

```
clear all;
close all;
clc;

sample = [-3, 2, 4, 1, 2, 0, 4, -5, 7];
n1 = -3:5;
```

```
scaled = [];
n2 = [];

for i = 1:length(n1)
    x = 2 * n1(i);
    selected = find(n1 == x);
    if ~isempty(selected)
        n2 = [n2, x];
        scaled = [scaled, sample(selected)]
    end
end

n2 = n2 / 2;

subplot(2, 1, 1);
stem(n1, sample, 'b', 'linewidth', 2);
title('Original signal');
xlabel('n');
ylabel('amplitude');
grid on;
xlim([-4, 6]);
ylim([-6, 8]);

subplot(2, 1, 2);
stem(n2, scaled, 'b', 'linewidth', 2);
title('Time scaled signal: x(2n)');
xlabel('n');
ylabel('amplitude');
grid on;
xlim([-4, 6]);
ylim([-6, 8]);
```

Output:



Discussion:

This experiment showed that time compression makes the signal faster by keeping fewer samples, but it may lose information if not filtered. On the other hand, time expansion makes the signal slower by inserting zeros, which creates extra unwanted frequencies that need smoothing. Overall, time scaling changes the speed of a signal without changing its amplitude.

Conclusion:

The experiment proved that time scaling changes the speed of a discrete-time signal. Compression makes the signal faster but may cause information loss, while expansion makes it slower but adds extra frequencies. Proper filtering is important to preserve the signal quality.