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DIGITAL SIGNAL PROCESSING

22EC602

A Report on

"Digital Echo Generation in Audio Signals using Scilab"

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Topic:

Digital Echo Generation in Audio Signals using Scilab.

Introduction:

Digital echo generation in audio signals is a technique used to simulate the natural reflection of sound in a digital environment. Unlike traditional analog methods, digital echo is created by processing audio signals through algorithms that introduce time-delayed repetitions of the original sound. This delay creates the perception of space and depth, enhancing the listening experience. Digital echo effects are widely used in music production, film, gaming, and communication systems to add ambience, simulate acoustic spaces, or improve audio clarity. By adjusting parameters such as delay time, feedback, and attenuation, different echo patterns and environments can be recreated with high precision. This digital approach not only provides flexibility and control but also enables real-time audio processing in various multimedia applications.

Objective:

To simulate an echo effect by delaying and attenuating an audio signal using digital signal processing techniques in Scilab.

Tools Used:

- Software: Scilab with Signal Processing Toolbox

- Input: Audio signal (synthetic or recorded)

Theory:

An echo can be digitally simulated by delaying the original signal and attenuating the delayed version before summing it back with the original.

Mathematical Representation:

$$y[n] = x[n] + \alpha * x[n - D]$$

Where:

- x[n] = Input signal

- D = Delay in samples

- α = Attenuation factor (0 < α < 1)

- y[n] = Output signal with echo

Scilab Code:

```
// === Parameters ===
// Path to your recorded audio file (update as needed)
audioFile = "C:\Users\Virupakshayya\Downloads\audio.wav";

// Echo parameters
delay_sec = 0.3;  // Echo delay in seconds
alpha = 0.6;      // Echo attenuation factor

// === Load audio ===
[x, fs] = wavread(audioFile);

// Convert stereo to mono if necessary
if size(x, 2) == 2 then
    x = mean(x, "c"); // average the two channels
end

// Ensure x is a row vector for processing
x = x(:)';

// Calculate delay in samples
D = round(delay_sec * fs);

// === Create echoed signal ===
x_echo = zeros(1, length(x) + D);
x_echo(1:length(x)) = x;
x_echo(D+1:D+length(x)) = x_echo(D+1:D+length(x)) + alpha * x;

// Normalize to avoid clipping
x_echo = x_echo / max(abs(x_echo));

// === Save output files ===
wavwrite(x', fs, 16, "original.wav");
wavwrite(x_echo', fs, 16, "voice_with_echo.wav");

// === Playback (Windows only) ===
disp("Playing original audio...");
host("start original.wav");
sleep(9000); // wait 3 seconds before playing echoed audio
disp("Playing audio with echo...");
host("start voice_with_echo.wav");

// === Plot signals ===
clf;
t = 0:1/fs:(length(x)-1)/fs;
```

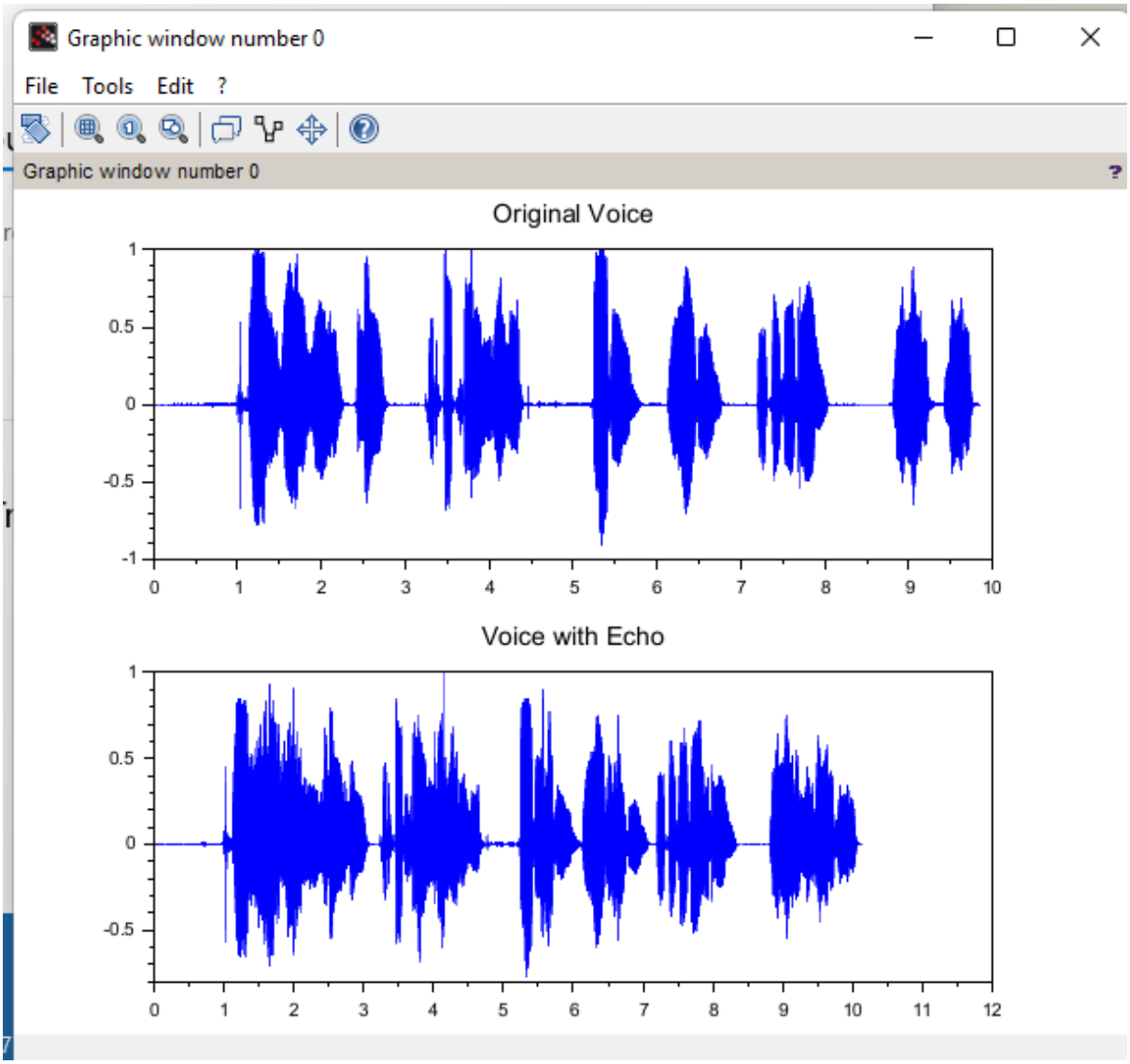
```
subplot(2,1,1);
plot(t, x);
xtitle("Original Voice");

t_echo = 0:1/fs:(length(x_echo)-1)/fs;
subplot(2,1,2);
plot(t_echo, x_echo);
xtitle("Voice with Echo");
```

Output:

```
wavread: The file 'C:\Users\Virupakshayya\Downloads\birds-chirping-75156.wav' d
--> exec('C:\Users\Virupakshayya\Desktop\Echo abhi.sci', -1)
  "Playing original audio..."
  "Playing audio with echo..."

-->
```



Results:

The original and echo-added signals are both played.

Plots illustrate how the echo appears after a delay.

Applications:

- Audio effects in music and sound design

- Acoustic simulation in VR environments

- Speech enhancement systems.

Conclusion:

This project demonstrates how digital signal processing techniques can be used to simulate real-world audio effects like echo using simple mathematical operations and Scilab programming.