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1. load handel;
2. t = (0:length(y)-1) / Fs;
3. figure;
4. subplot(3,2,1);
5. plot(t,y);
6. xlabel('Time (s)');
7. ylabel('Amplitude');
8. title('Original Audio Signal');
9. N = length(y);
10. frequencies = linspace(-Fs/2, Fs/2, N);
11. y_fft = fft(y);
12. y_fft2=fftshift(y_fft);
13. subplot(3,2,2);
14. plot(frequencies,abs(y_fft2));
15. xlabel('Frequency (Hz)');
16. ylabel('Magnitude');
17. title('Frequency Spectrum of Original Signal');
18. sound(y,Fs);
19. pause(9);
20. D=2;
21. y_downsampled = downsample(y, D);
22. Fs_downsampled = Fs / D;
23. t_downsampled = (0:length(y_downsampled)-1) / Fs_downsampled;
24. subplot(3, 2, 3);
25. plot(t_downsampled, y_downsampled);
26. xlabel('Time (s)');
27. ylabel('Amplitude');
28. title('Downsampled Audio (No Anti-aliasing)');
29. N_downsampled = length(y_downsampled);
30. frequencies_downsampled = linspace(-Fs_downsampled/2, Fs_downsampled/2,
    N_downsampled);
31. y_downsampled_fft = fft(y_downsampled);
32. y_downsampled_fft2=fftshift(y_downsampled_fft);
33. subplot(3, 2, 4);
34. plot(frequencies_downsampled,abs(y_downsampled_fft2));
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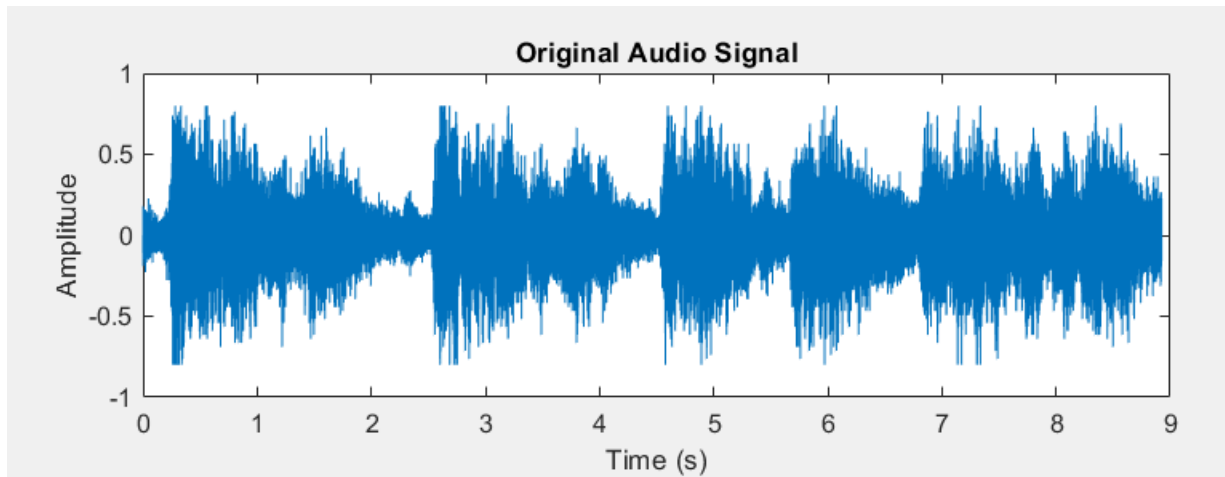
35.xlabel('Frequency (Hz)');
36.ylabel('Magnitude');
37.title('Frequency Spectrum of Downsampled Signal (No Anti-aliasing)');
38.sound(y_downsampled,Fs_downsampled)
39.pause(9);
40.subplot(3, 2, 5);

41.y_downsampled_filtered = filter(cheby1(5, 1, 0.45), 1, downsample(y, D));
42.Fs_downsampled_filtered = Fs / D;
43.t_downsampled_filtered = (0:length(y_downsampled_filtered)-1) /
    Fs_downsampled_filtered;
44.plot(t_downsampled_filtered, y_downsampled_filtered);
45.xlabel('Time (s)');
46.ylabel('Amplitude');
47.title('Downsampled Audio (Anti-aliasing)');
48.sound(y_downsampled_filtered,Fs_downsampled_filtered);
49.subplot(3, 2, 6);
50.N_downsampled_filtered = length(y_downsampled_filtered);
51.frequencies_downsampled_filtered = linspace(-Fs_downsampled/2, Fs_downsampled,
    N_downsampled_filtered);
52.y_downsampled_filtered_fft = fft(y_downsampled_filtered);
53.y_downsampled_filtered_fft2=fftshift(y_downsampled_filtered_fft);

54.plot(frequencies_downsampled_filtered, abs(y_downsampled_filtered_fft2));
55.xlabel('Frequency (Hz)');
56.ylabel('Magnitude');
57.title('Frequency Spectrum of Downsampled Signal (Anti-aliasing)');

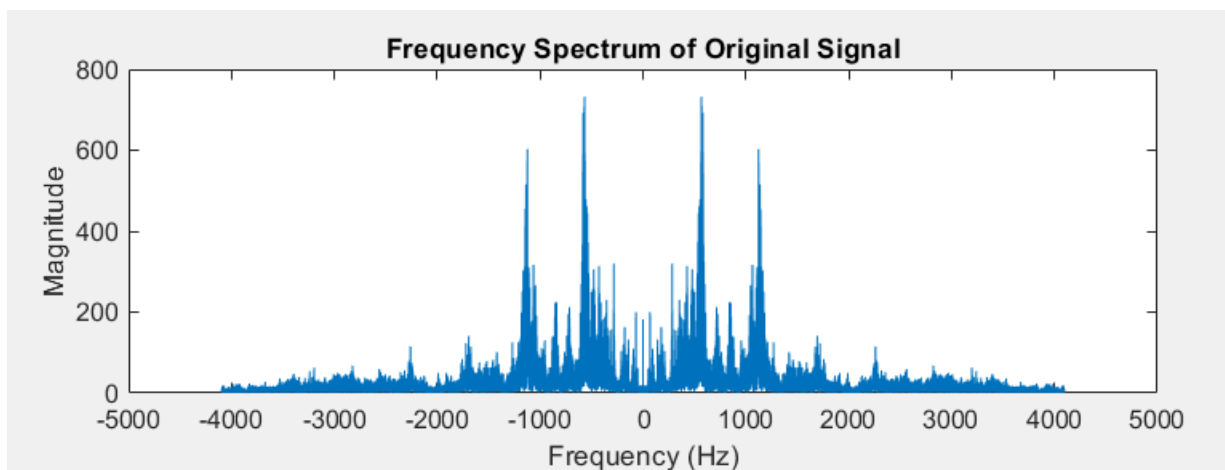
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## Plots



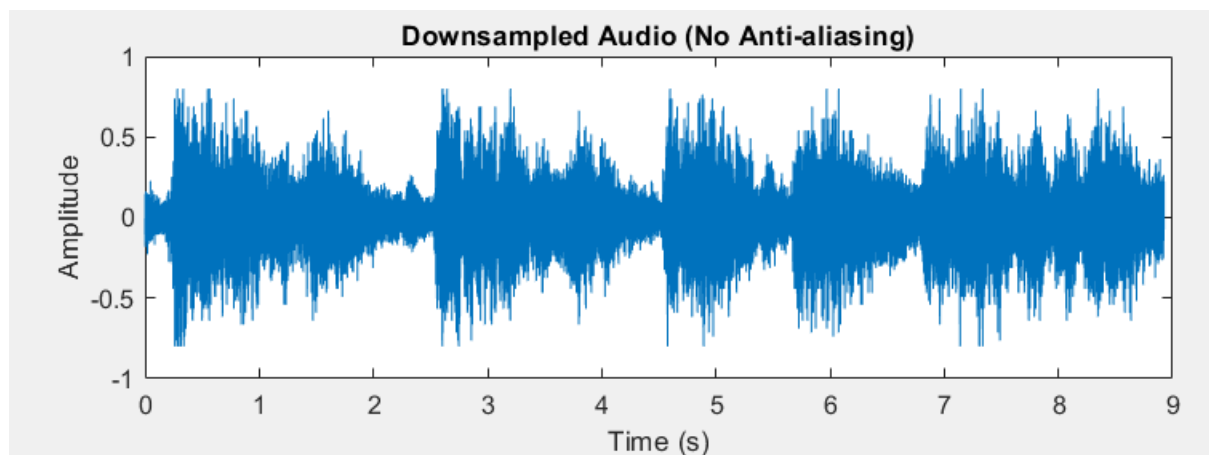
### Plot 1 - Original Audio Signal:

- This plot showcases the waveform of the original audio signal against time.
- This graph depicts how the amplitude of the audio signal varies over time. The x-axis represents time in seconds (t), while the y-axis represents signal amplitude (y).



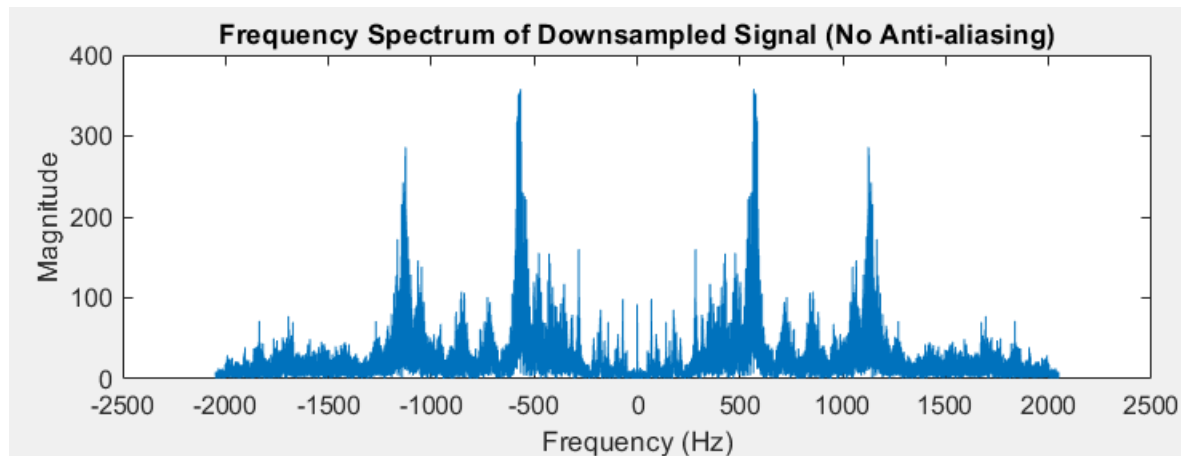
## Plot 2 - Frequency Spectrum of the Original Signal:

- Represents the frequency components present in the original signal.
- Indicates which frequencies and their magnitudes exist in the original audio.
- High peaks in an audio signal represent dominant frequencies.
- This plot depicts the frequency spectrum obtained from the original signal's Fast Fourier Transform (FFT). The x-axis is frequency in Hertz (frequencies), and the y-axis is the magnitude of each frequency component in the signal ( $\text{abs}(y_{\text{fft2}})$ ).



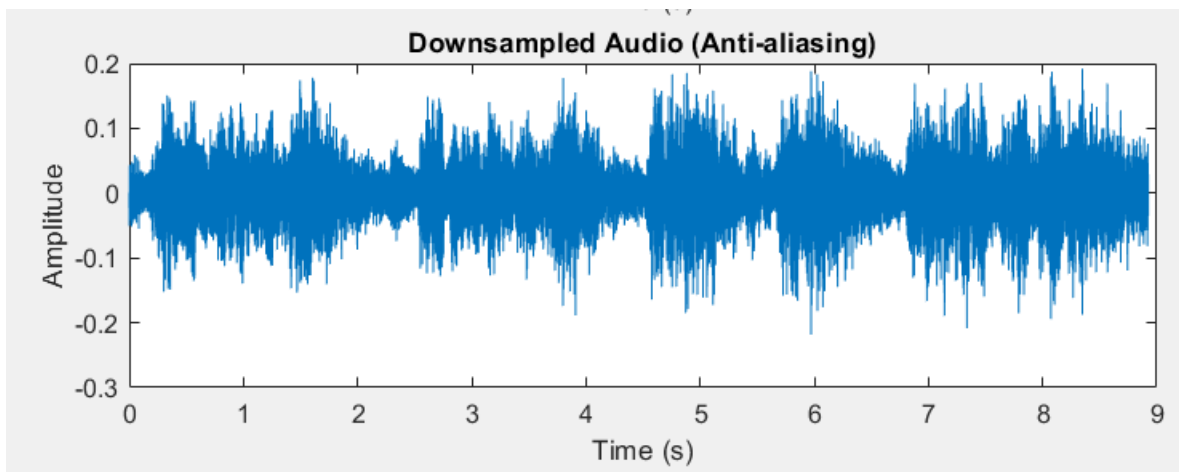
### Plot 3 - Downsampled Audio (No Anti-aliasing):

- Displays the downsampled audio signal without using anti-aliasing techniques.
- This plot depicts the time domain of a downsampled audio signal. It shows how the signal changes when it is sampled at a lower rate ( $y_{\text{downsampled}}$ ) than the original signal.



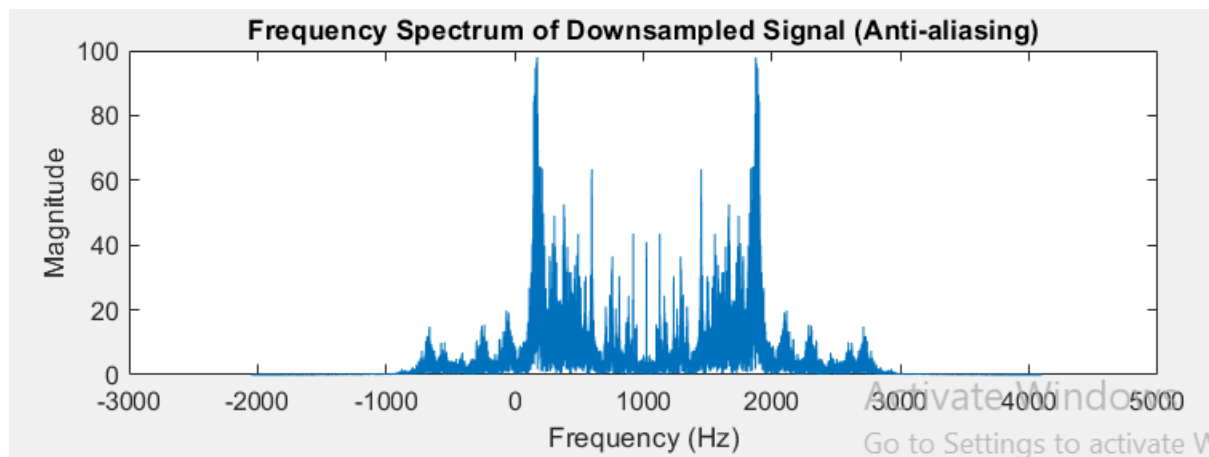
## Plot 4 - Frequency Spectrum of Downsampled Signal (No Anti-aliasing):

- Depicts the frequency components of the downsampled signal without anti-aliasing.
- This plot, like Plot 2, depicts the frequency spectrum derived from the FFT of the downsampled signal (`y_downsampled_fft2`). It depicts the frequency components present in the downsampled signal after no anti-aliasing.



## Plot 5 - Downsampled Audio (Anti-aliasing):

- Displays the downsampled audio signal after applying an anti-aliasing filter.
- This plot depicts the downsampled audio signal after an anti-aliasing filter has been applied (`y_downsampled_filtered`). It demonstrates the time domain effect of filtering on a downsampled signal.



## Plot 6 - Frequency Spectrum of Downsampled Signal (Anti-aliasing):

- Shows the frequency content of the filtered downsampled signal.
- Similar to Plot 2 and Plot 4, this plot shows the frequency spectrum obtained from the FFT of the filtered downsampled signal (`y_downsampled_filtered_fft2`). It illustrates the frequency components present in the filtered downsampled signal after anti-aliasing