

Lab Experiment 4 Frequency domain analysis of audio and speech Signals

```
clear; clc; close all;

%% Load the Audio Signal
[audioSignal, fs] = audioread('Conference.wav'); % Replace with your file
audioSignal = audioSignal(:, 1); % Use only the first channel if stereo

% Time vector
t = (0:length(audioSignal)-1) / fs;

%% Plot Time-Domain Representation
figure;
subplot(2,1,1);
plot(t, audioSignal);
xlabel('Time (seconds)');
ylabel('Amplitude');
title('Time-Domain Representation of the Audio Signal');
grid on;

%% Compute and Plot Fourier Transform (FFT)
n = length(audioSignal);
f = (0:n-1)*(fs/n); % Frequency axis
Y = fft(audioSignal); % Compute FFT

% Plot single-sided amplitude spectrum
subplot(2,1,2);
plot(f(1:n/2), abs(Y(1:n/2)));
xlabel('Frequency (Hz)');
ylabel('Magnitude');
title('Frequency Spectrum of the Audio Signal (FFT)');
grid on;

%% Power Spectral Density (PSD) Analysis
[pxx, f_psd] = pwelch(audioSignal, hamming(1024), 512, 1024, fs);

figure;
plot(f_psd, 10*log10(pxx));
xlabel('Frequency (Hz)');
ylabel('Power/Frequency (dB/Hz)');
title('Power Spectral Density (PSD)');
grid on;

%% Spectrogram Visualization
windowSize = 512; % Define window size
overlap = 256; % Define overlap samples
nfft = 1024; % Number of FFT points

figure;
spectrogram(audioSignal, windowSize, overlap, nfft, fs, 'yaxis');
title('Spectrogram of the Audio Signal');
```

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% Feature Extraction: Mel-Frequency Cepstral Coefficients (MFCC)
coeffs = mfcc(audioSignal, fs, 'NumCoeffs', 13); % Compute 13 MFCCs

figure;
imagesc(coeffs');
colorbar;
xlabel('Frame Index');
ylabel('MFCC Coefficients');
title('MFCC Feature Extraction');
set(gca, 'YDir', 'normal'); % Ensure correct orientation
```