ECEN455 Lab1

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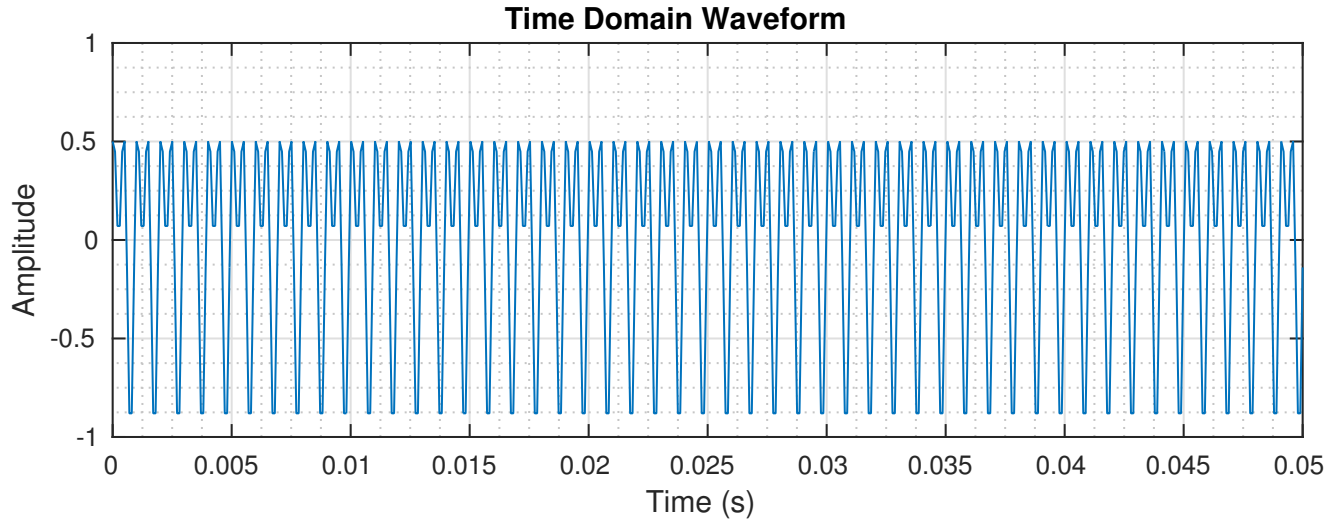
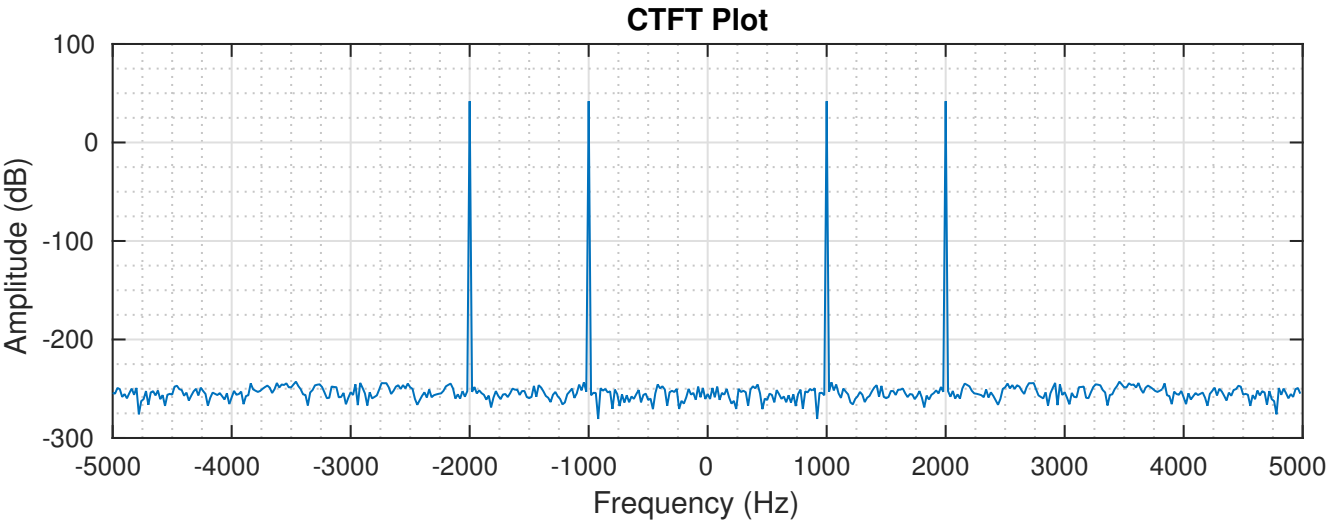
Task 1

Input Signal: $0.5 * sin(2\pi(1000)t) + 0.5 * cos(2\pi(2000)t)$
Sampling Rate: 10 kHz





Matlab code:

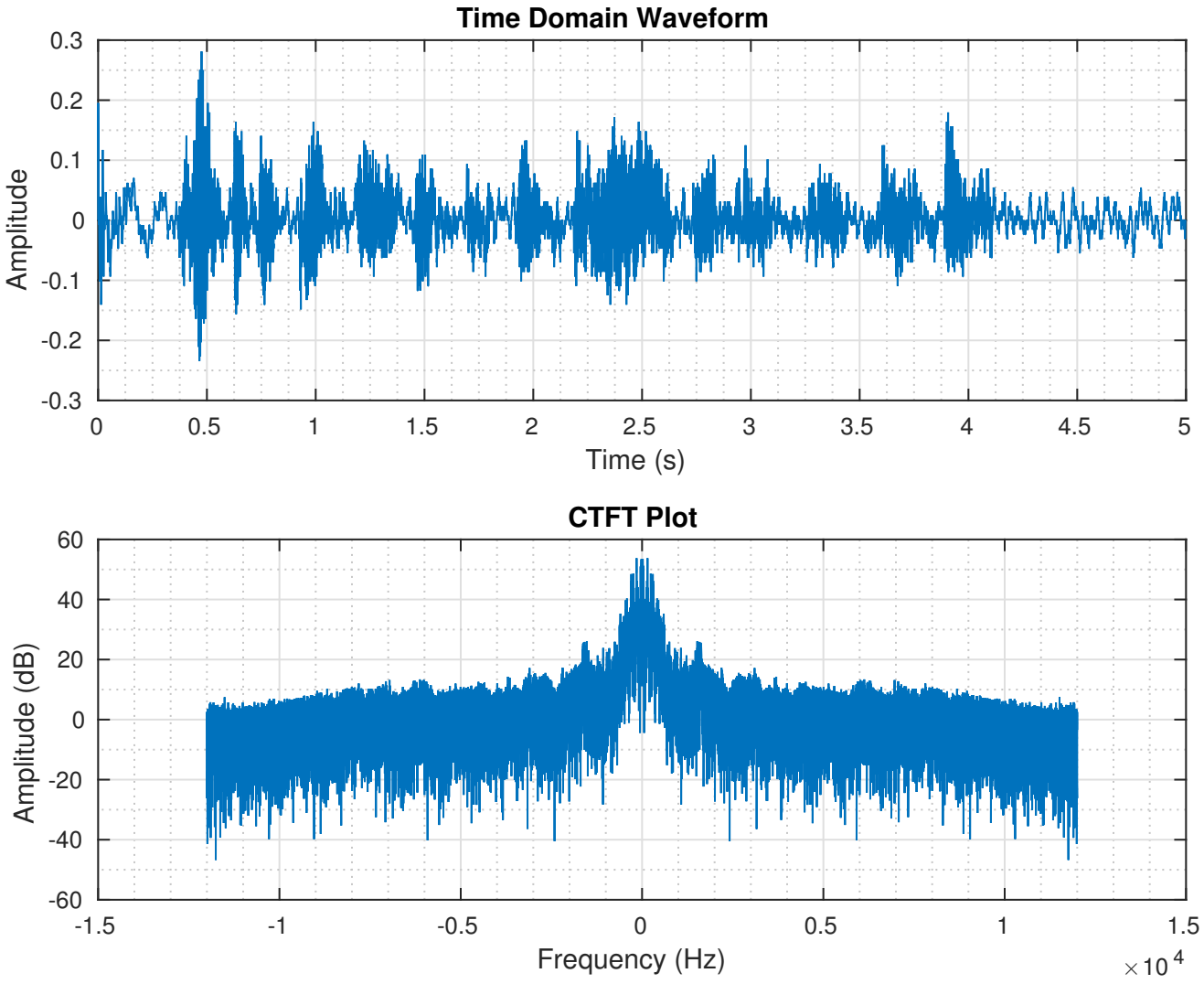
```
clc; clear; close all;
f_sig = 1000; % Tone frequency
fs = 10000; % Sampling frequency
Ts = 1/fs;
samp_time = 0.05; % sample 50ms of the waveform
for k = 1:samp_time/Ts
    x(k) = 0.5*sin(2*pi*(k-1)*f_sig*Ts) + 0.5*cos(2*pi*(k-1)*(2*f_sig)*Ts);
end
[Xf,f] = CTFT(x,fs);
subplot(2,1,1)
plot(linspace(0,samp_time,samp_time*fs),x)
title('Time Domain Waveform')
xlabel('Time (s)')
ylabel('Amplitude')
grid on
grid minor
subplot(2,1,2)
plot (f,20*log10(abs(Xf)))
title('CTFT Plot')
xlabel('Frequency (Hz)')
ylabel('Amplitude (dB)')
grid on
grid minor
print('Task1','-depsc')
```

CTFT.m:

```
function [ Xf, f ] = CTFT( x,fs )
% Takes the time domain signal x sampled at fs and returns the CTFT(approximation/sampled ...
    version) signal.
Xf = fftshift(fft(x));
N = length(Xf);
f = linspace(-N/2,N/2 - 1, N) *fs/N;
end
```

Task 2

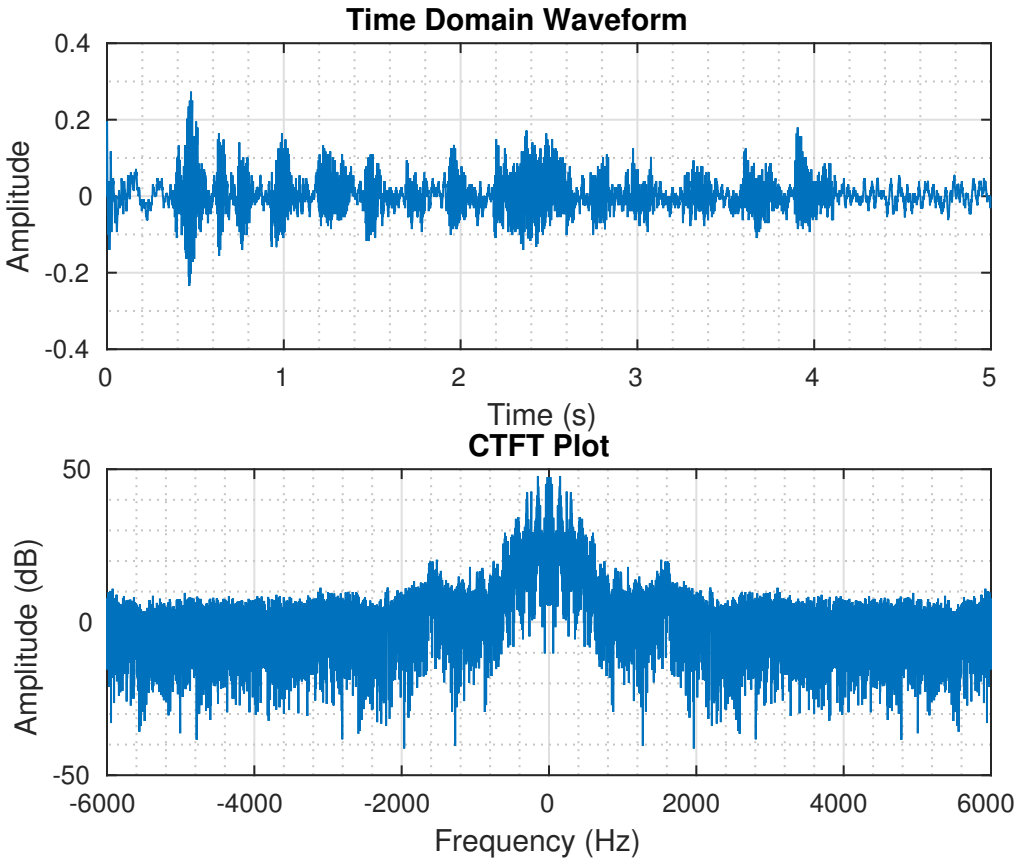
Following is the time and frequency domain plot of the raw recording.



The frequency domain plot shows that for frequencies greater than 2500 Hz have very low energy and most of the information is present within 2500 Hz.

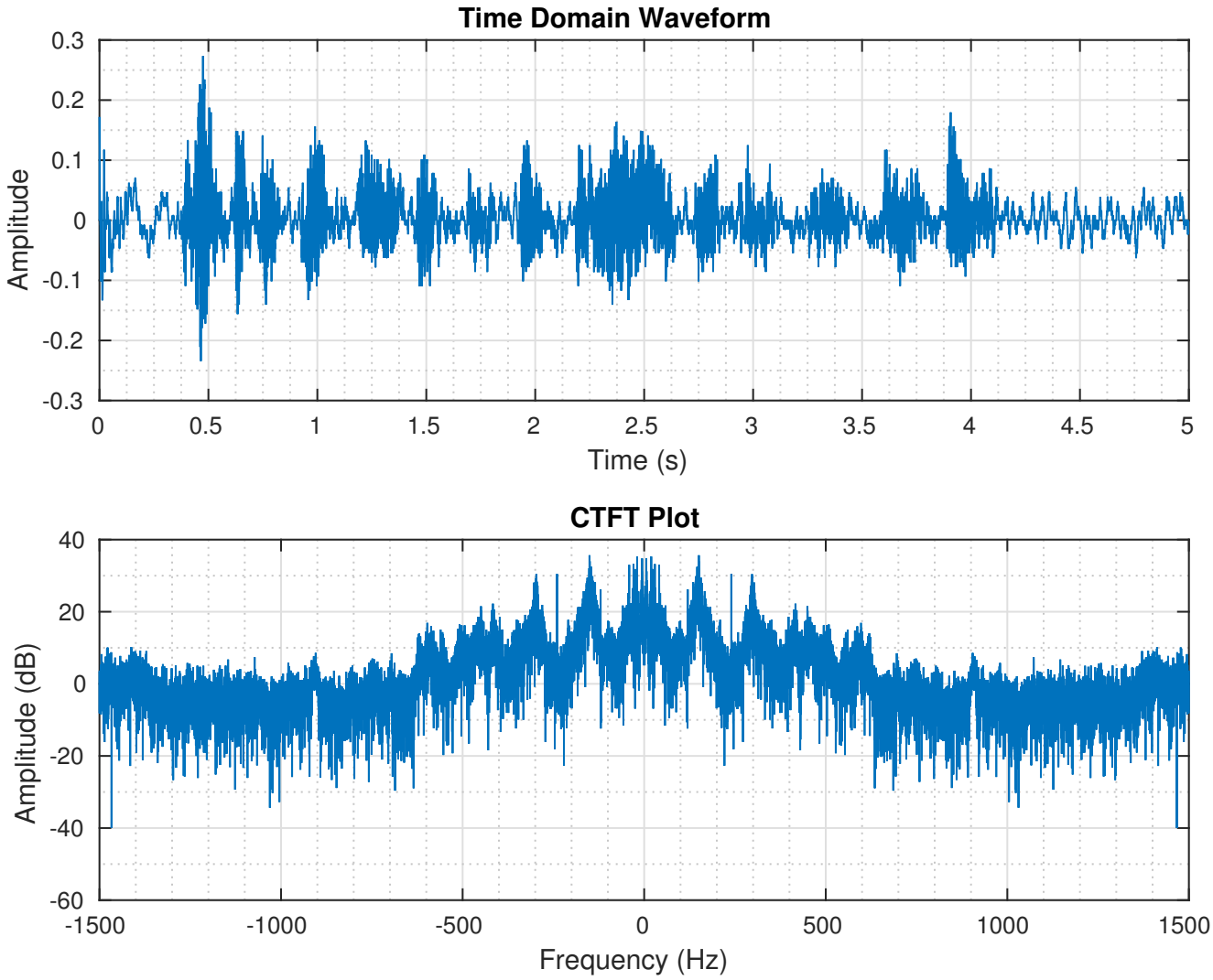
Downsampling the recording by a factor of 2 removes the high frequency components(i.e. $> 6kHz$) and we get a zoomed version of the frequency domain.
The downsampling(by 2) has no significant impact on the voice recording.

This plot shows the downsampled time and frequency domain of the signal:



While downsampling by 8 we loose information in the frequencies $> 1.5kHz$ and we get a further zoomed version of the frequency domain.
This (downsampling by 8) has noticable impact on the recording however, the recording is still perceivable.

The plot shows the downsampled by 8 time and frequency domain of the signal:



Matlab code:

```
clc; clear; close all;
load('recording.mat');
x = getaudiodata(voice_sample);
fs = 24000;
Ts = 1/fs;
samp_time = 5;
[Xf,f] = CTFT(x,fs);
figure;
subplot(2,1,1)
plot(linspace(0,samp_time,samp_time/Ts),x)
title('Time Domain Waveform')
xlabel('Time (s)')
ylabel('Amplitude')
grid on
grid minor
subplot(2,1,2)
plot (f,20*log10(abs(Xf)))
title('CTFT Plot')
```

```
xlabel('Frequency (Hz)')
ylabel('Amplitude (dB)')
grid on
grid minor
print('Task2_original','-depsc')

% Downsample by 2
DS_factor = 2;
N = length(x);
for i = 1:N/DS_factor
    x_ds(i) = x(DS_factor * i);
end
[Xf_ds,f_ds] = CTFT(x_ds,fs/DS_factor);
figure;
subplot(2,1,1)
plot(linspace(0,samp_time,samp_time/(DS_factor*Ts)),x_ds)
title('Time Domain Waveform')
xlabel('Time (s)')
ylabel('Amplitude')
grid on
grid minor
subplot(2,1,2)
plot (f_ds,20*log10(abs(Xf_ds)))
title('CTFT Plot')
xlabel('Frequency (Hz)')
ylabel('Amplitude (dB)')
grid on
grid minor
print('Task2_DS2','-depsc')

% Downsample by 8
DS_factor = 8;
N = length(x);
for i = 1:N/DS_factor
    x_ds8(i) = x(DS_factor * i);
end
[Xf_ds8,f_ds8] = CTFT(x_ds8,fs/DS_factor);
figure;
subplot(2,1,1)
plot(linspace(0,samp_time,samp_time/(DS_factor*Ts)),x_ds8)
title('Time Domain Waveform')
xlabel('Time (s)')
ylabel('Amplitude')
grid on
grid minor
subplot(2,1,2)
plot (f_ds8,20*log10(abs(Xf_ds8)))
title('CTFT Plot')
xlabel('Frequency (Hz)')
ylabel('Amplitude (dB)')
grid on
grid minor
print('Task2_DS8','-depsc')
```