



Final Project for Signals and Systems

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Code

First we define Function to do the plot instead of put it inside the main code

```
Editor - C:\Users\Anindya\Desktop\Final Matlab Project\plotwave.m
ain.m x plotwave.m x +
function [] = plotwave(t, audio, fs, maintitle)
    fvec = linspace(-fs/2, fs/2, length(audio));
    audio_ft = fftshift(fft(audio));

    figure;
    subplot(2, 1, 1);
    plot(t, audio);
    xlabel('Time (s)');

    subplot(2, 1, 2);
    plot(fvec/1000, abs(audio_ft));
    xlabel('Frequency (kHz)');

    % add a main title to the whole subplot
    axes('Visible', 'off');
    title(maintitle, 'Visible', 'on', 'fontsize', 15);
end
```

The main Code

Is divided into Six parts (input from user, Channel , noise and Filter , Plotting, Save Files , Play each Audio)

1-Take the Audio from the User and if the User entered stereo change it To Mono to deal with it easily

```
in.m x plotwave.m x +
filename = input('Enter audio file name: ', 's');%Take The Audio from the user ( Mono or Stereo )

[audio, fs] = audioread(filename);
audio = audio'; % transpose to make it a row vector for easier analysis

% if the input file is stereo, convert it to mono by taking the average of both channels
audiosize = size(audio);
if audiosize(1) == 2
    audio = (audio(1, :) + audio(2, :)) / 2;
end

t_end = length(audio) / fs;
t = linspace(0, t_end, t_end * fs);
```

2-Channel

-Allow the User to choose the System

```
main.m x plotwave.m x +
% ===== channel ===== %

channel = input('Choose the channel impulse response (1->4): ');
sigma = input('Enter the noise sigma: ');
h = [];
switch channel
    case 1
        h = 1;

    case 2
        h = exp(-2*pi*5000*t);

    case 3
        h = exp(-2*pi*1000*t);

    case 4
        h = zeros(1, 1*fs);
        h(1) = 2;
        h(end) = 0.5;

    otherwise
        error('Invalid input.')
end
```

3-Add Noise and Filter to the original Signal

```
in.m x plotwave.m x +
output = conv(audio, h);
output = output(1:t_end*fs); % cut the output to be the length of the input bec it's mostly zeros

% ===== noise ===== %
output_noise = output + sigma * randn(1, length(output));

% ===== filter ===== %
samples_per_hertz = length(output_noise) / fs;
zeroed = samples_per_hertz * (fs/2 - 3400);

filter = fftshift(fft(output_noise));
filter([1:zeroed ceil(end-zeroed+1):end]) = 0;

output_filter = real(ifft(ifftshift(filter)));
```

4-Plotting Each case individually

```
% ===== plotting ===== %
plotwave(t, audio, fs, 'Input Audio');
plotwave(t, output, fs, 'Output Audio');
plotwave(t, output_noise, fs, 'Output Audio With Noise');
plotwave(t, output_filter , fs, 'Output Audio After Applying Filter');
```

5-Saving Each File After Modification

```
% ===== output files ===== %
audiowrite('out.wav', output, fs);
audiowrite('out_noise.wav', output_noise, fs);
audiowrite('out_filter.wav', output_filter, fs);
```

6-Play each Sound individually to notice the Difference in each case

```
% ===== play sound ===== %  
fprintf('\nNow playing the channel input...\n');  
sound(audio, fs);  
pause(t_end);  
fprintf('\nNow playing the channel output...\n');  
sound(output, fs);  
pause(t_end);  
fprintf('\nNow playing the channel output after adding noise...\n');  
sound(output_noise, fs);  
pause(t_end);  
fprintf('\nNow playing the channel output after applying filter...\n');  
sound(output_filter, fs);  
pause(t_end);  
waitfor(gcf);
```

Screen Shots for the Output

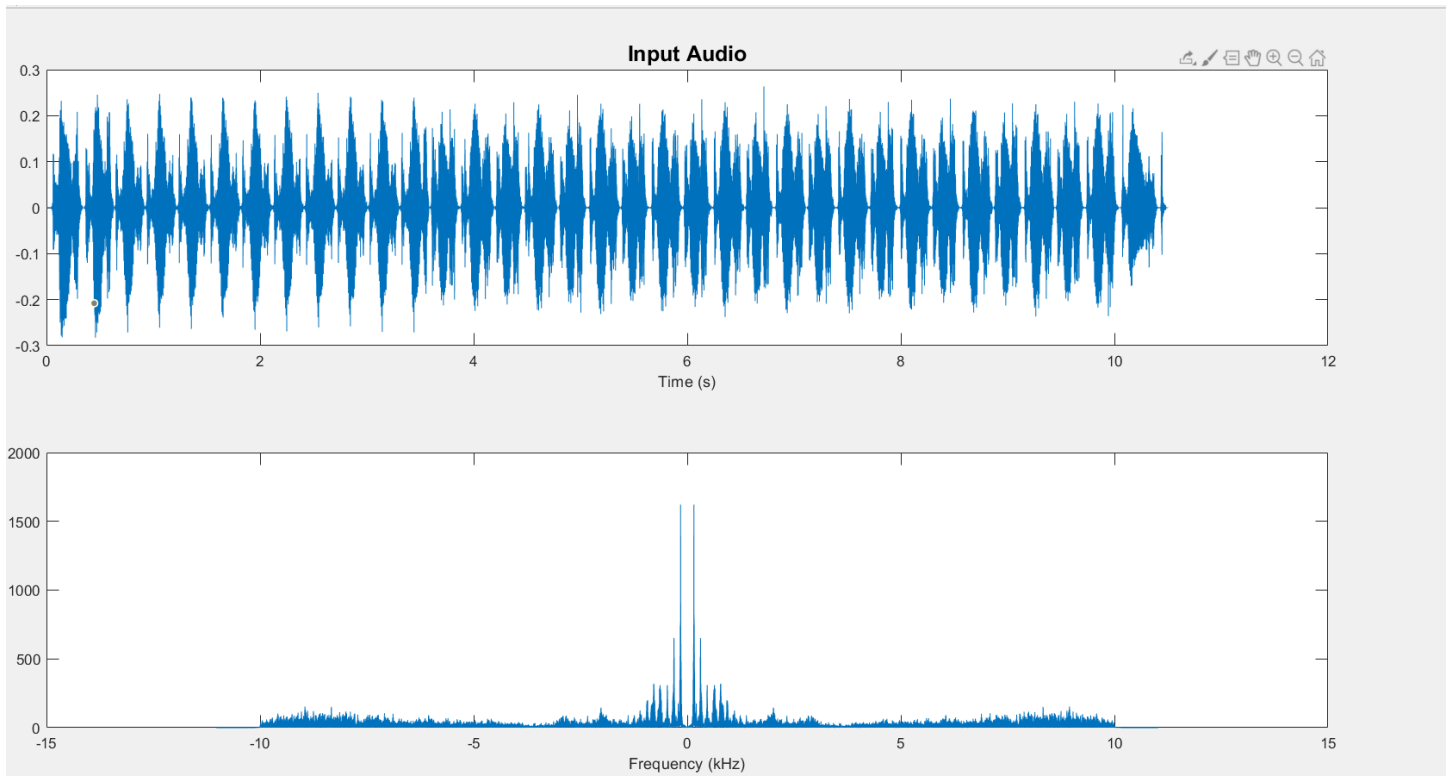
```
>> clear all
>> main
Enter audio file name: test.wav
Choose the channel impulse response (1->4): 1
Enter the noise sigma: 0.05

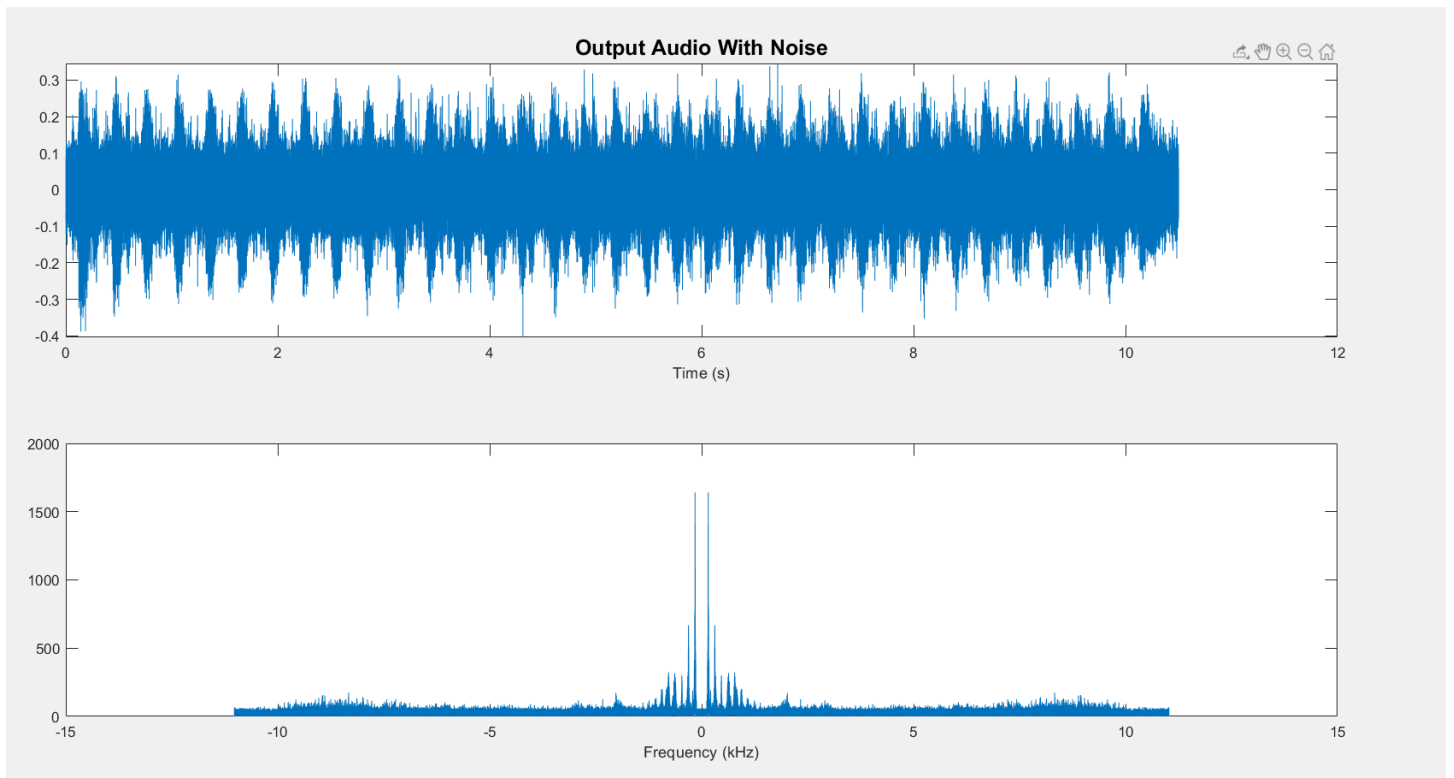
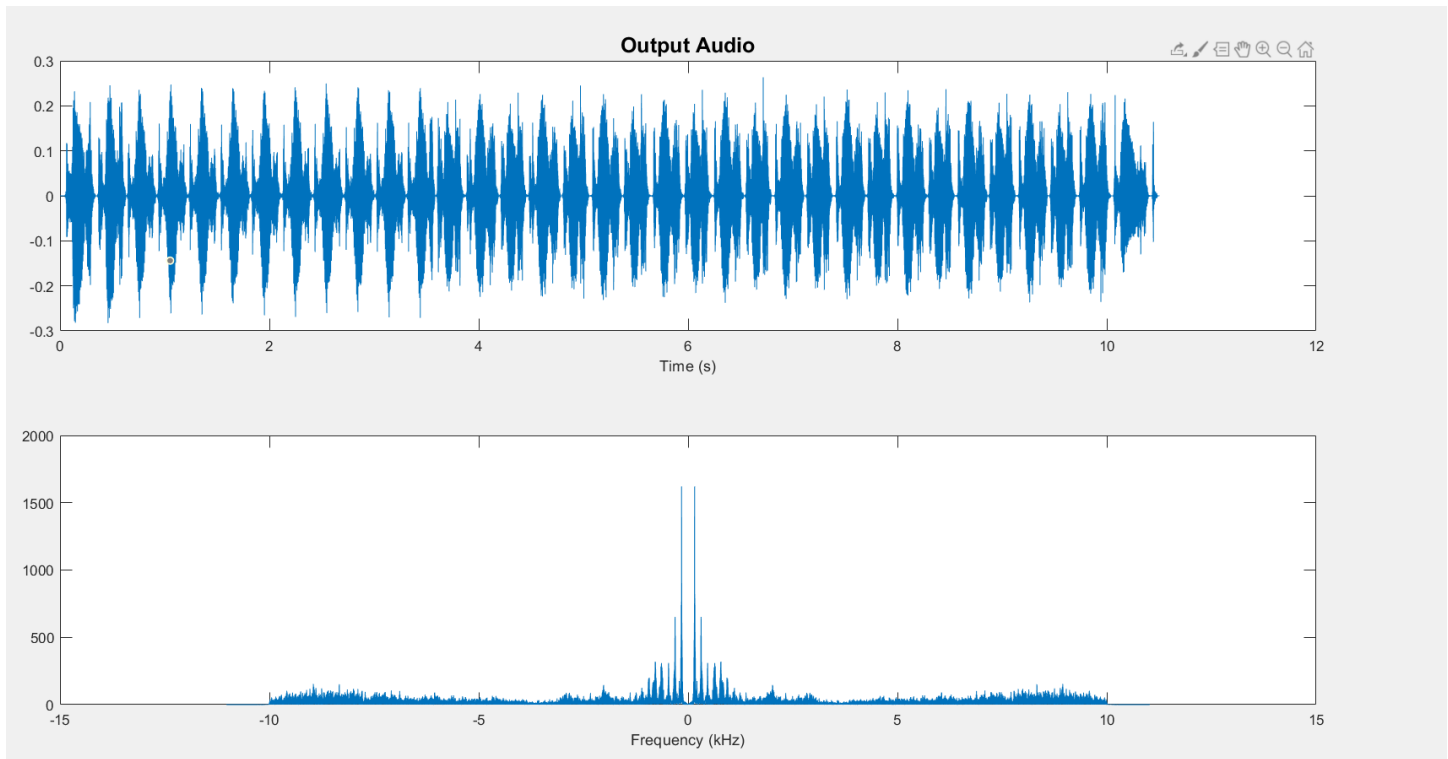
Now playing the channel input...

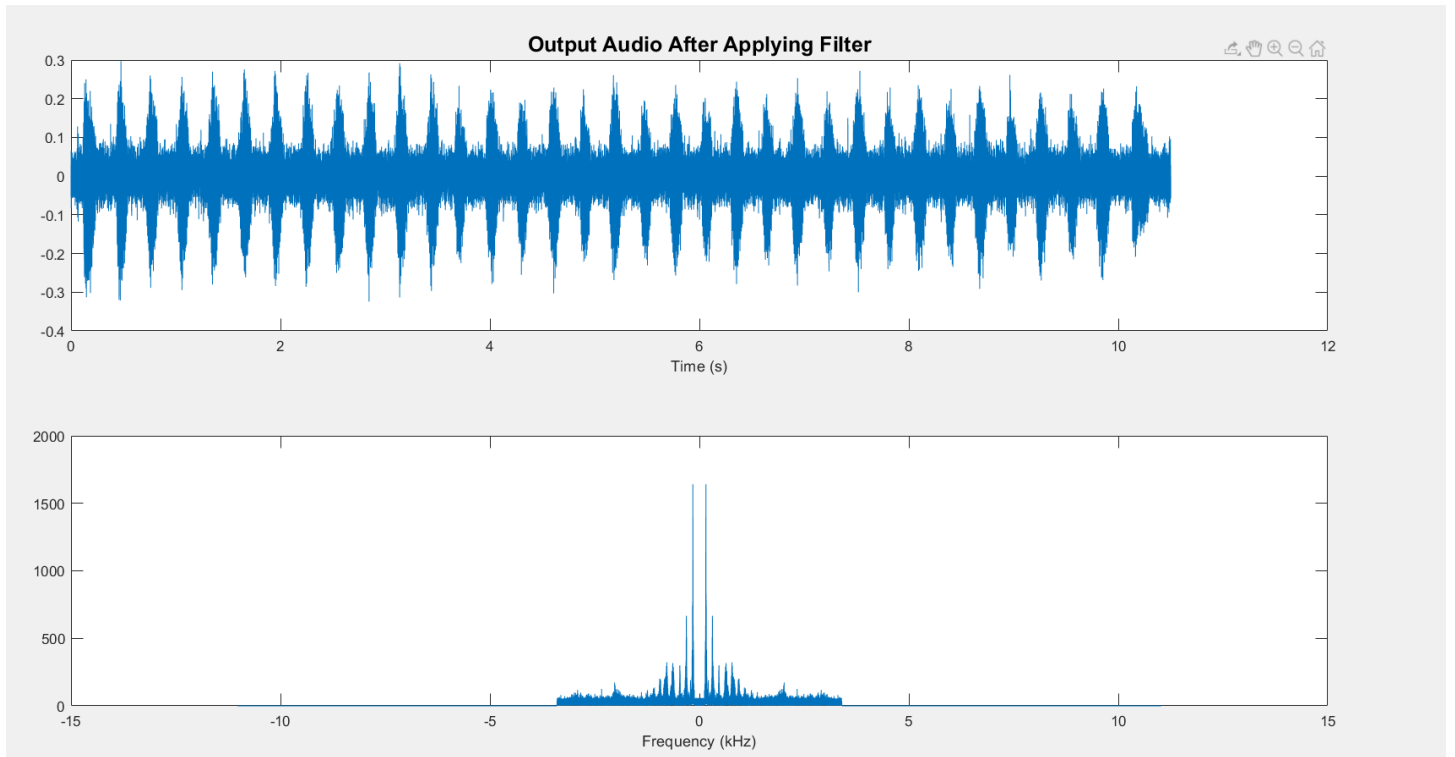
Now playing the channel output...

Now playing the channel output after adding noise...

Now playing the channel output after applying filter...
```







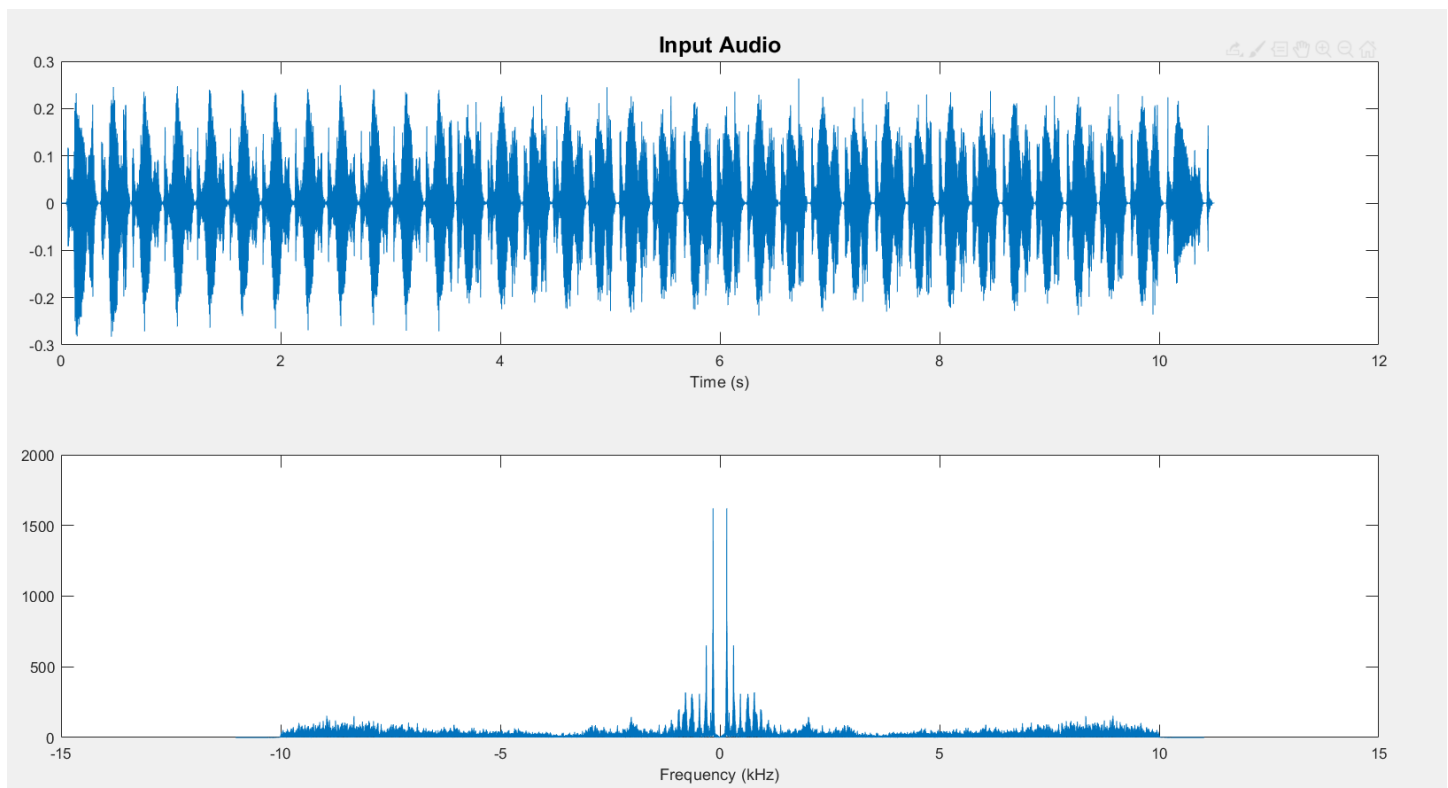

```
>> clear all
>> main
Enter audio file name: test.wav
Choose the channel impulse response (1->4): 2
Enter the noise sigma: 0.05

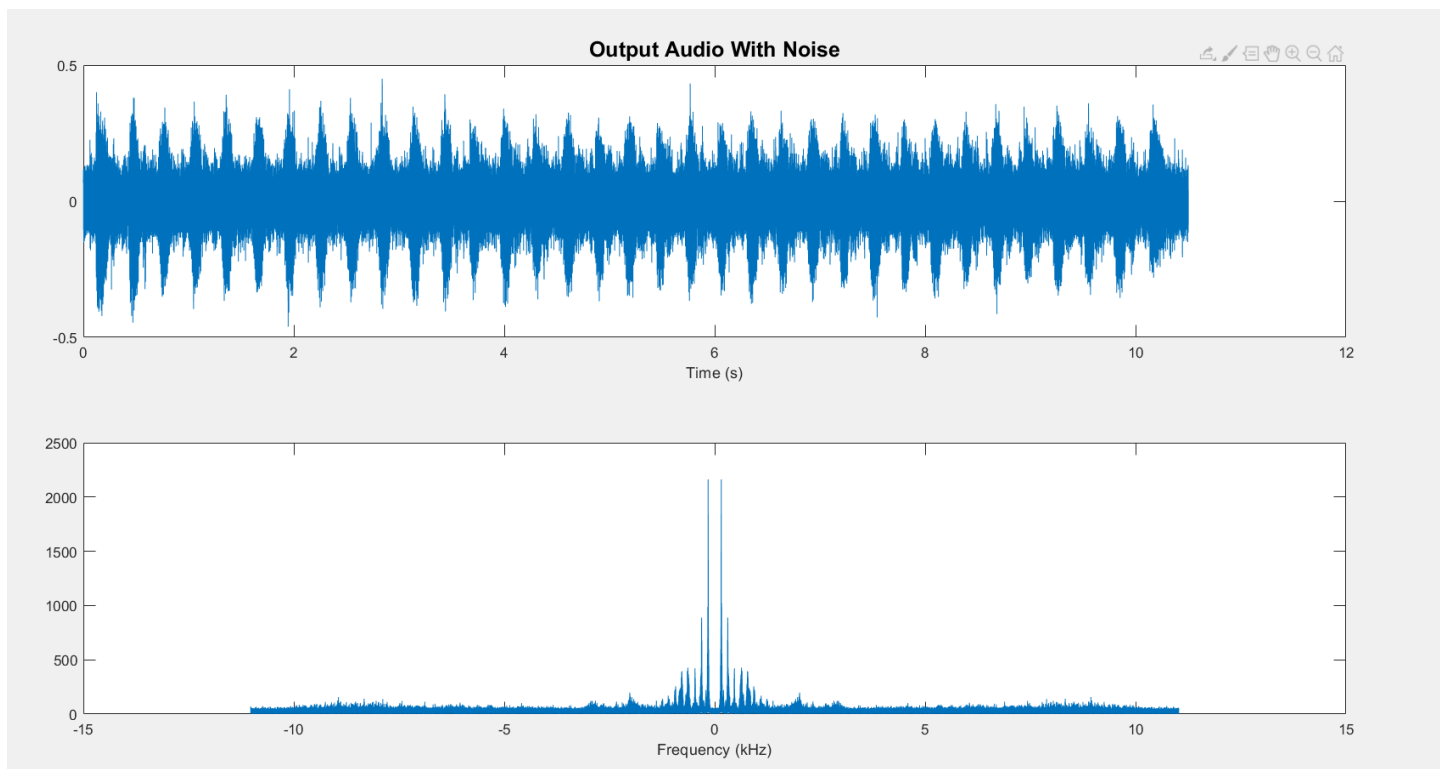
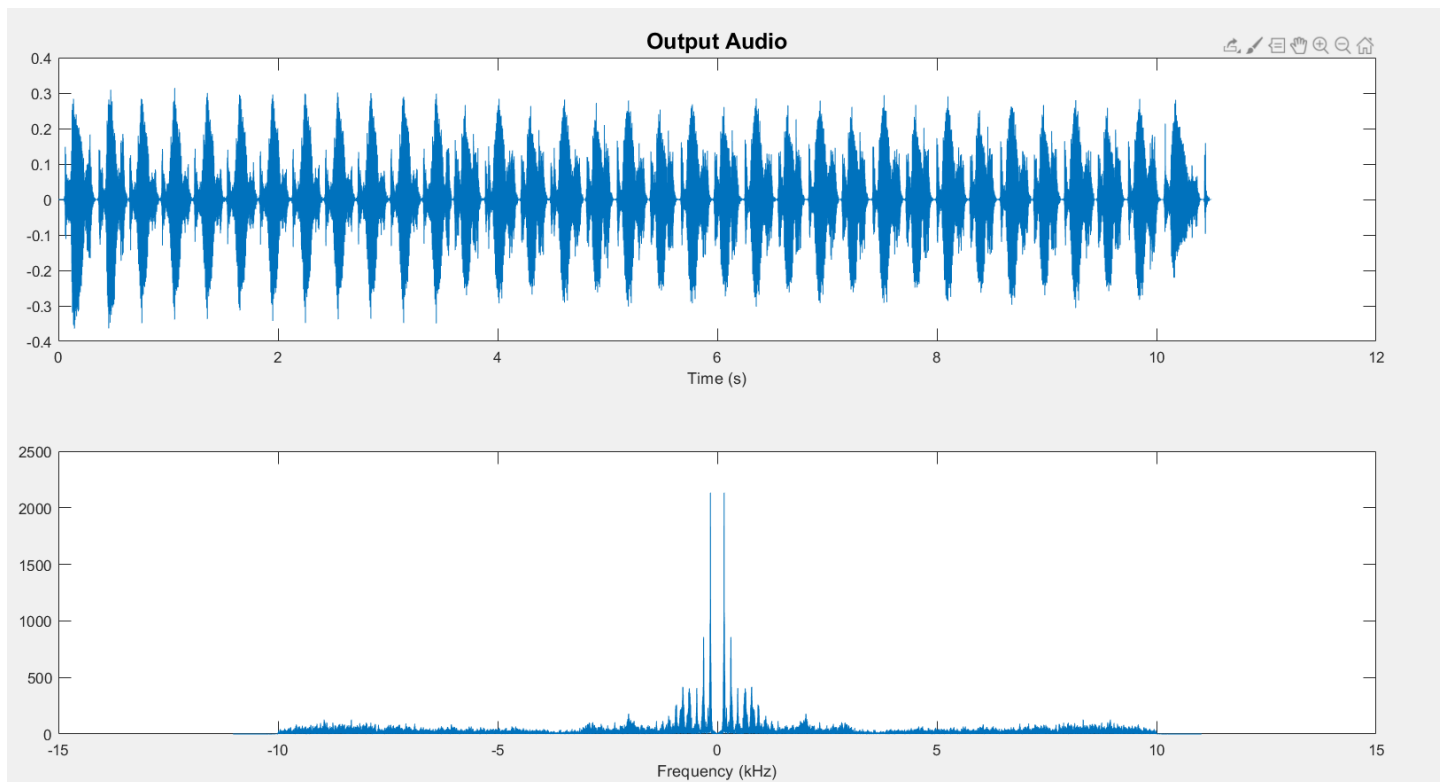
Now playing the channel input...

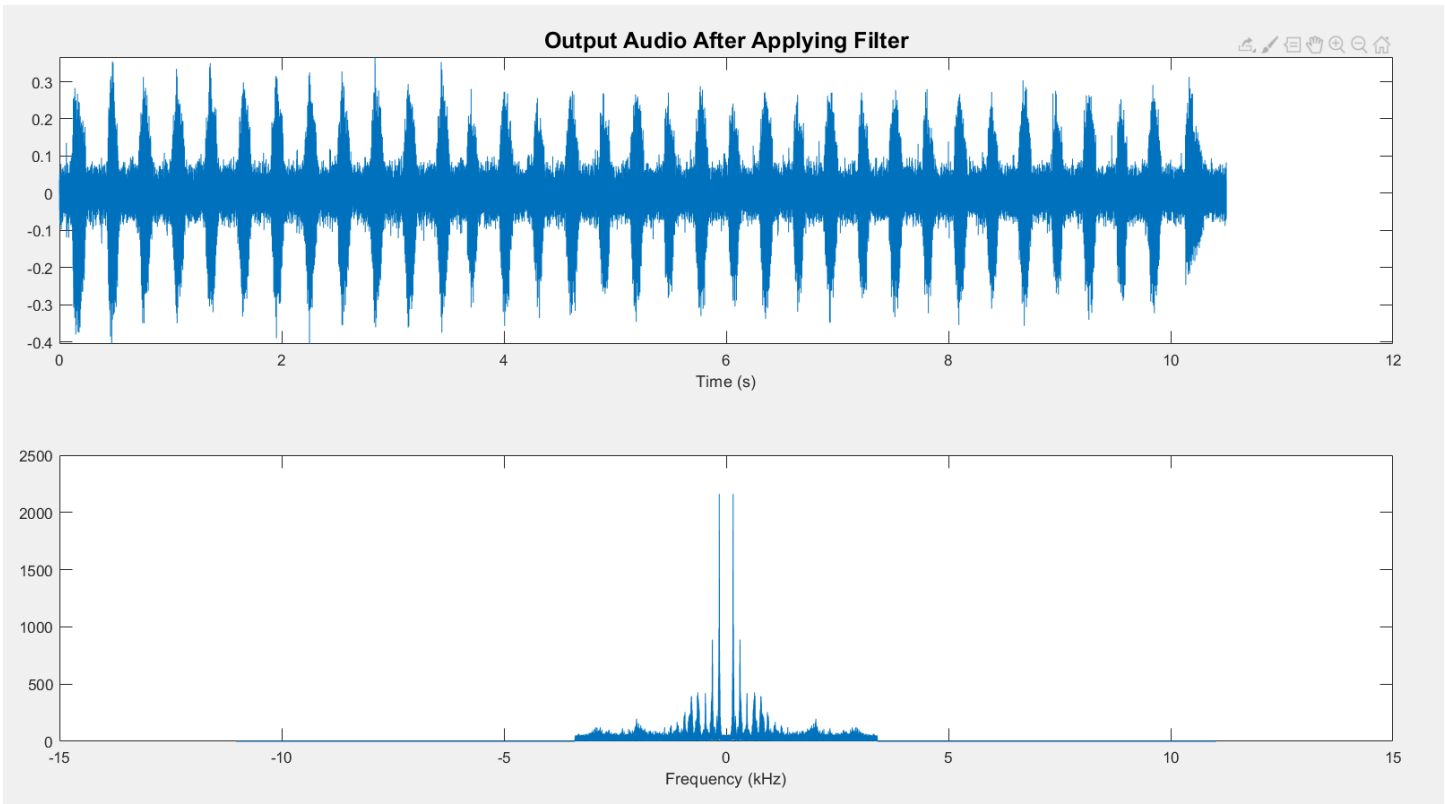
Now playing the channel output...

Now playing the channel output after adding noise...

Now playing the channel output after applying filter...
```







```

>> clear all
>> main
Enter audio file name: test.wav
Choose the channel impulse response (1->4): 3
Enter the noise sigma: 0.05
Warning: Data clipped when writing file.
> In audiowrite>clipInputData (line 407)
  In audiowrite (line 187)
    In main (line 62)
Warning: Data clipped when writing file.
> In audiowrite>clipInputData (line 407)
  In audiowrite (line 187)
    In main (line 63)
Warning: Data clipped when writing file.
> In audiowrite>clipInputData (line 407)
  In audiowrite (line 187)
    In main (line 64)

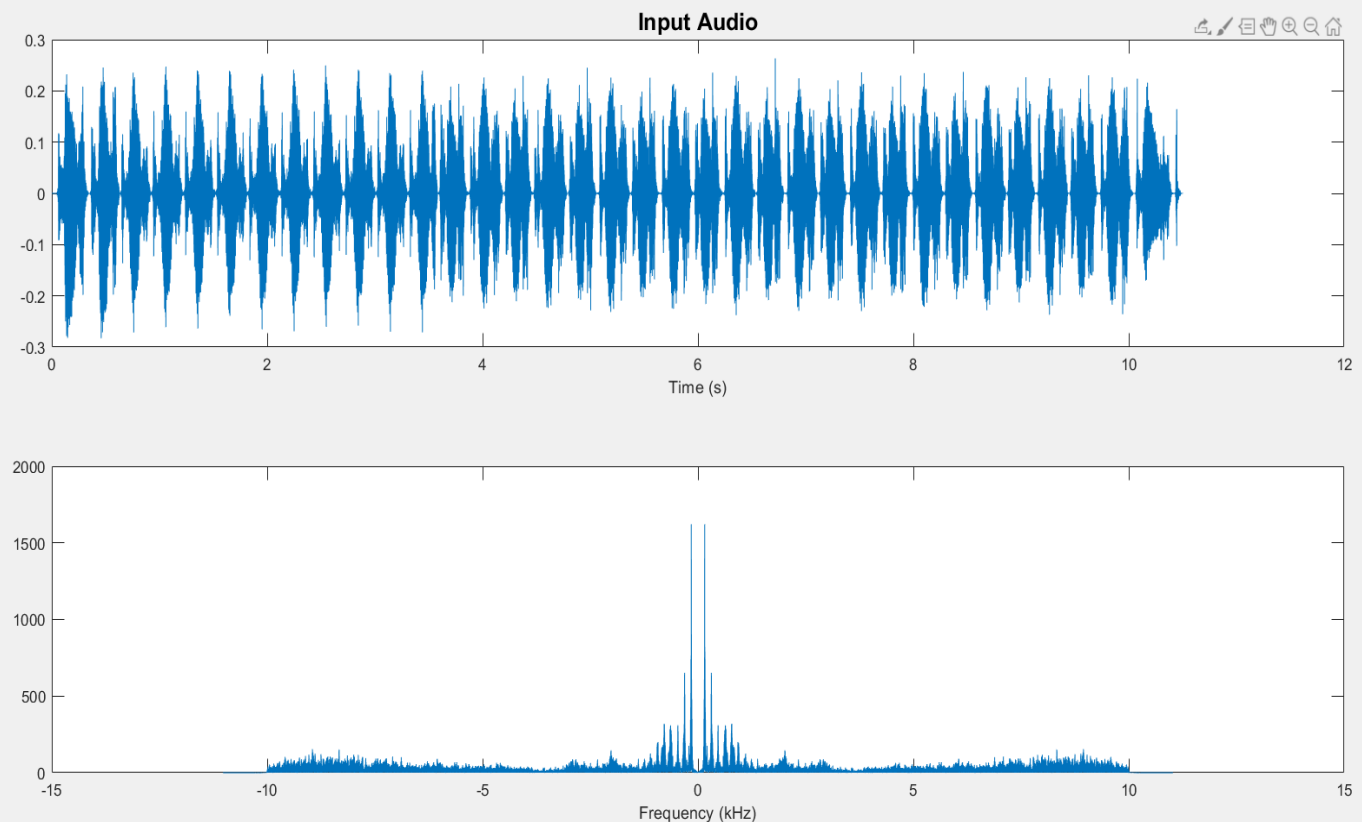
Now playing the channel input...

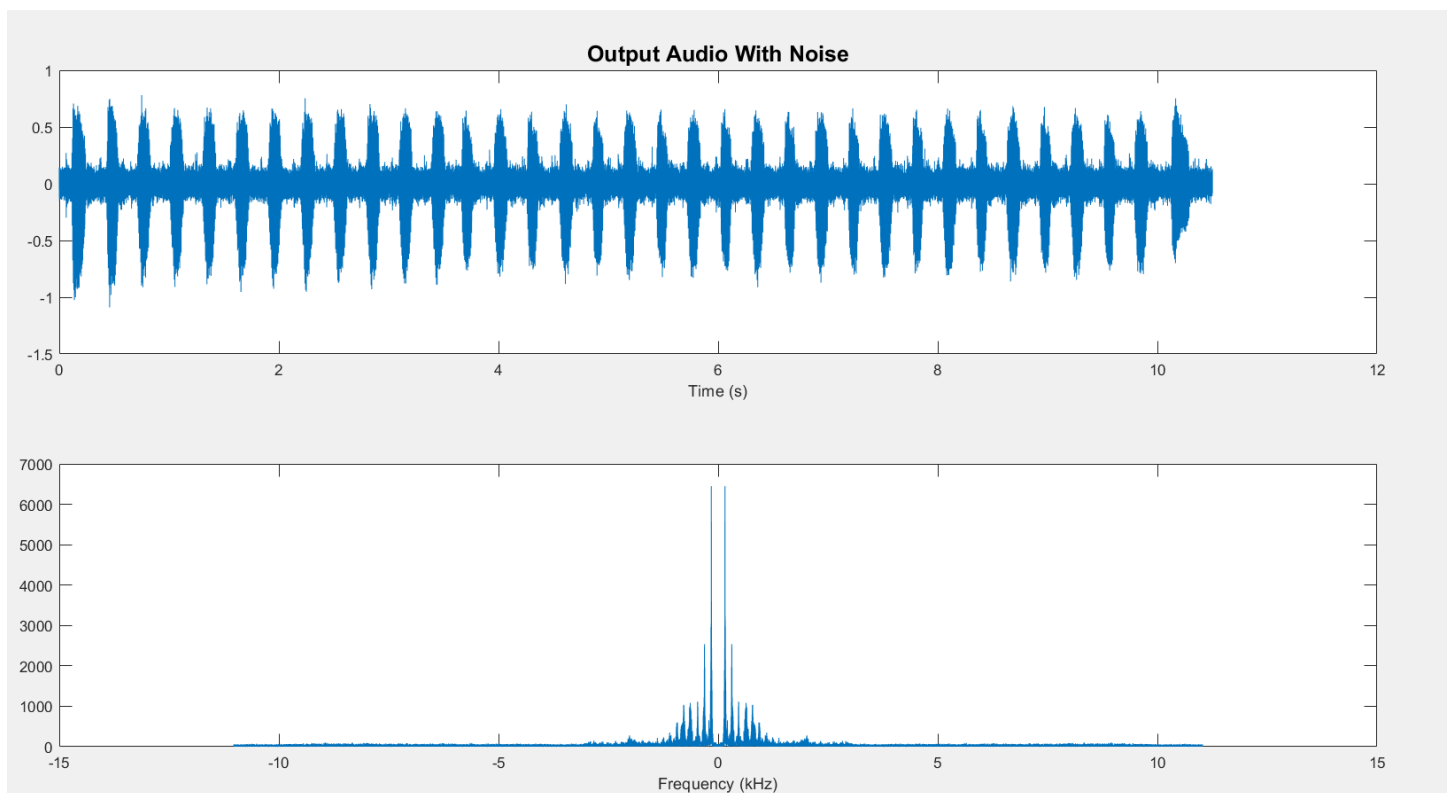
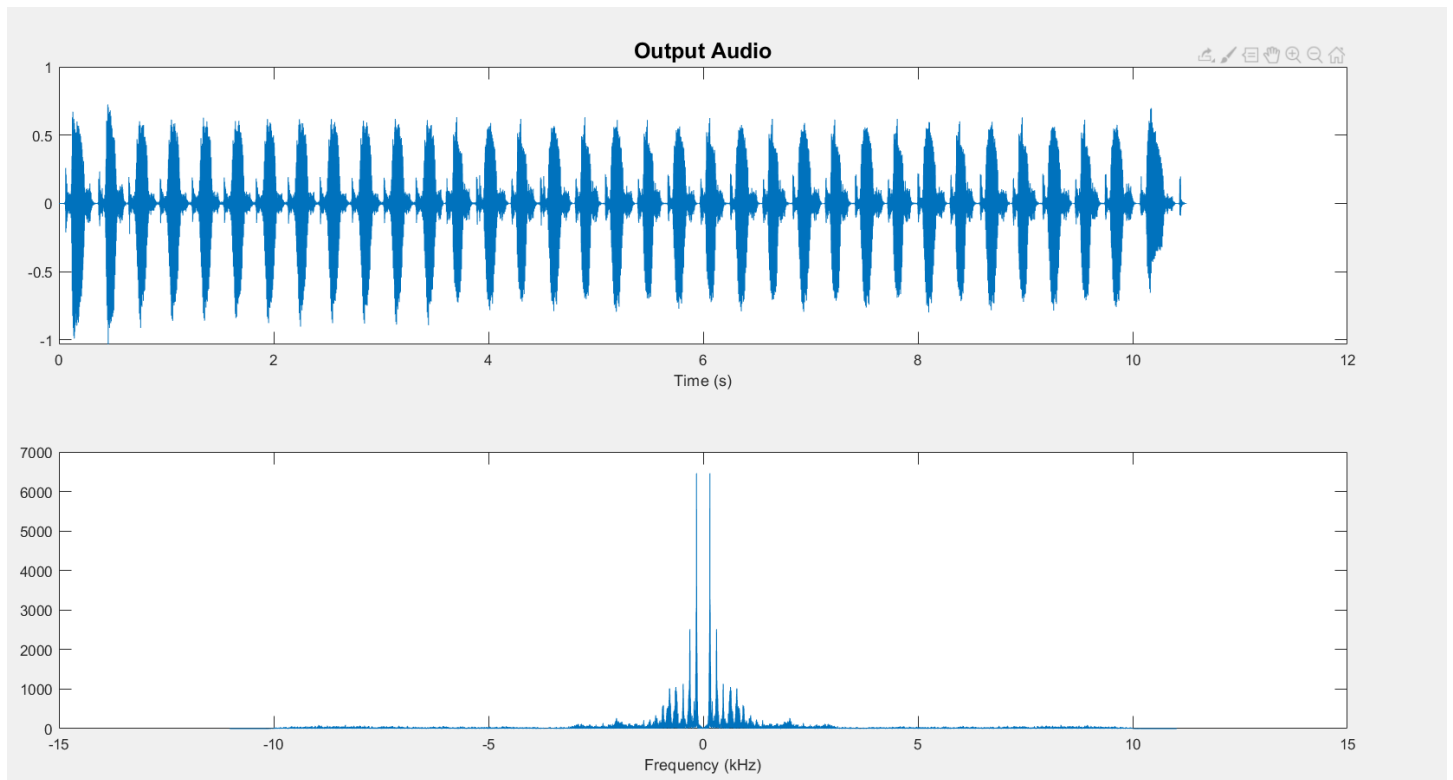
Now playing the channel output...

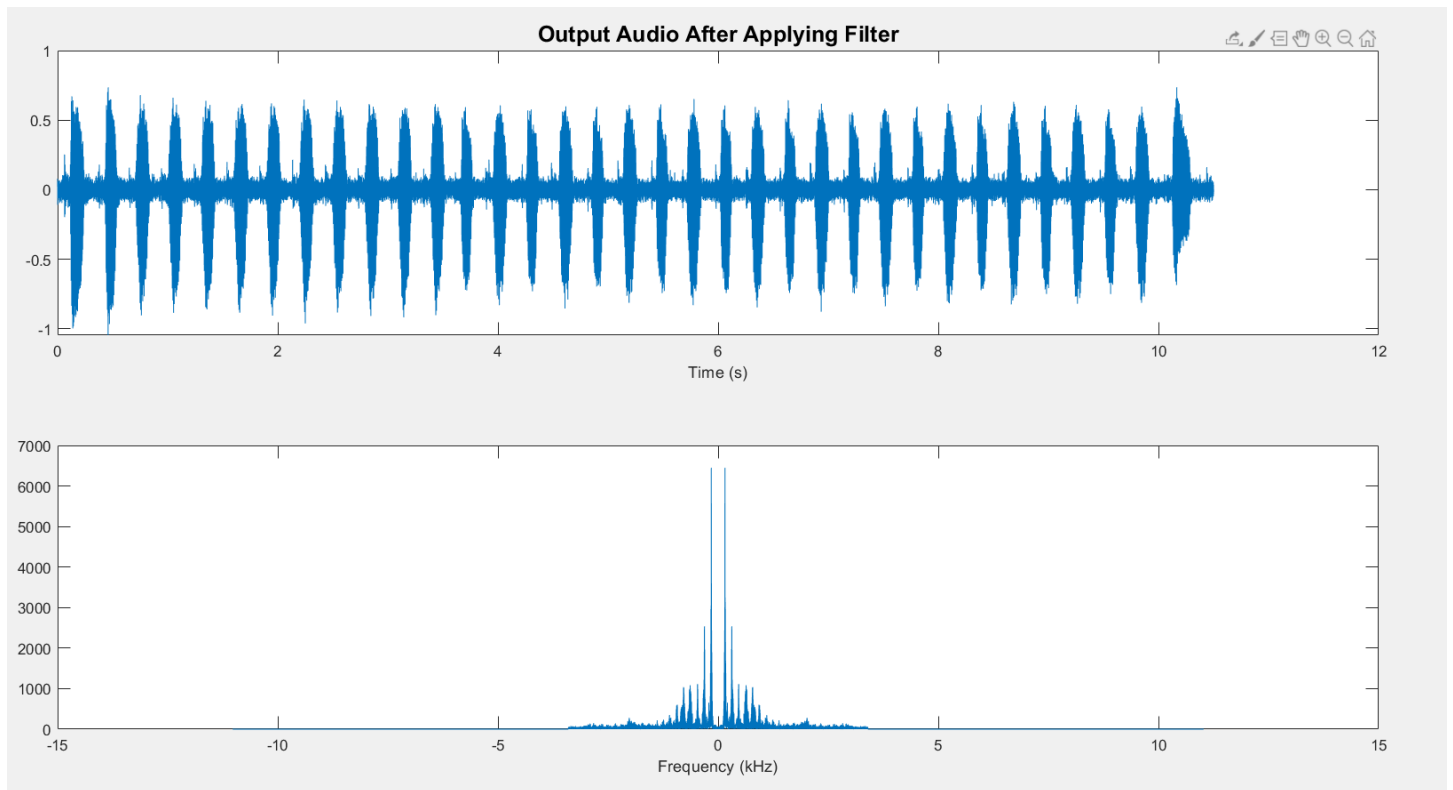
Now playing the channel output after adding noise...

Now playing the channel output after applying filter...

```







```
>> clear all
>> main
Enter audio file name: test.wav
Choose the channel impulse response (1->4): 4
Enter the noise sigma: 0.05

Now playing the channel input...

Now playing the channel output...

Now playing the channel output after adding noise...
|
Now playing the channel output after applying filter...
```

