Digital Signal Processing Lab

Experiment 6

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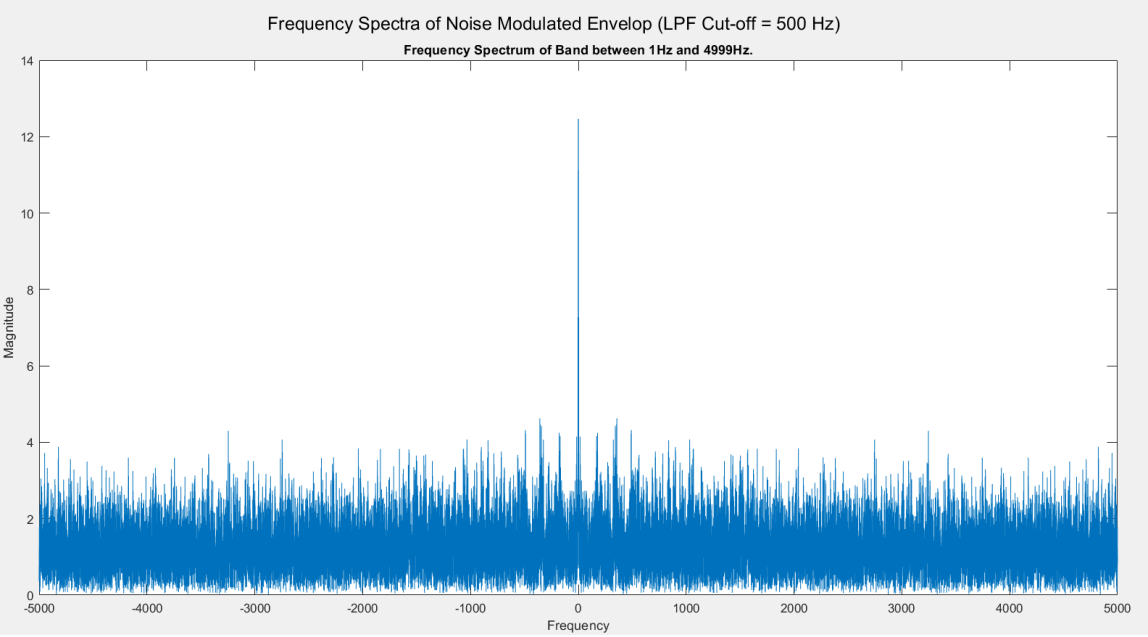
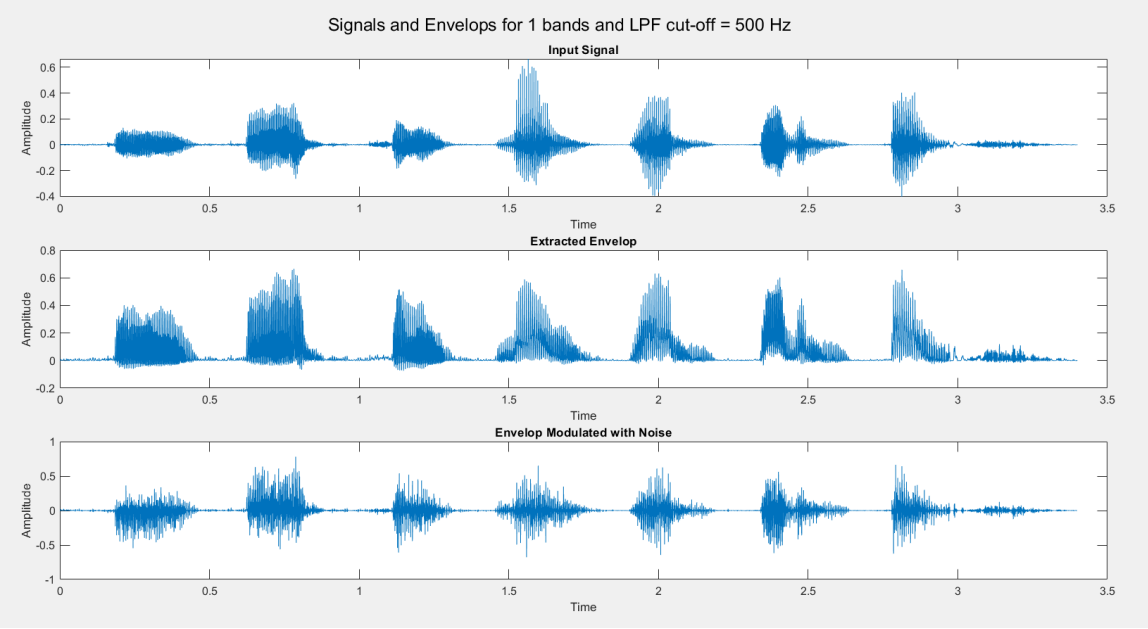
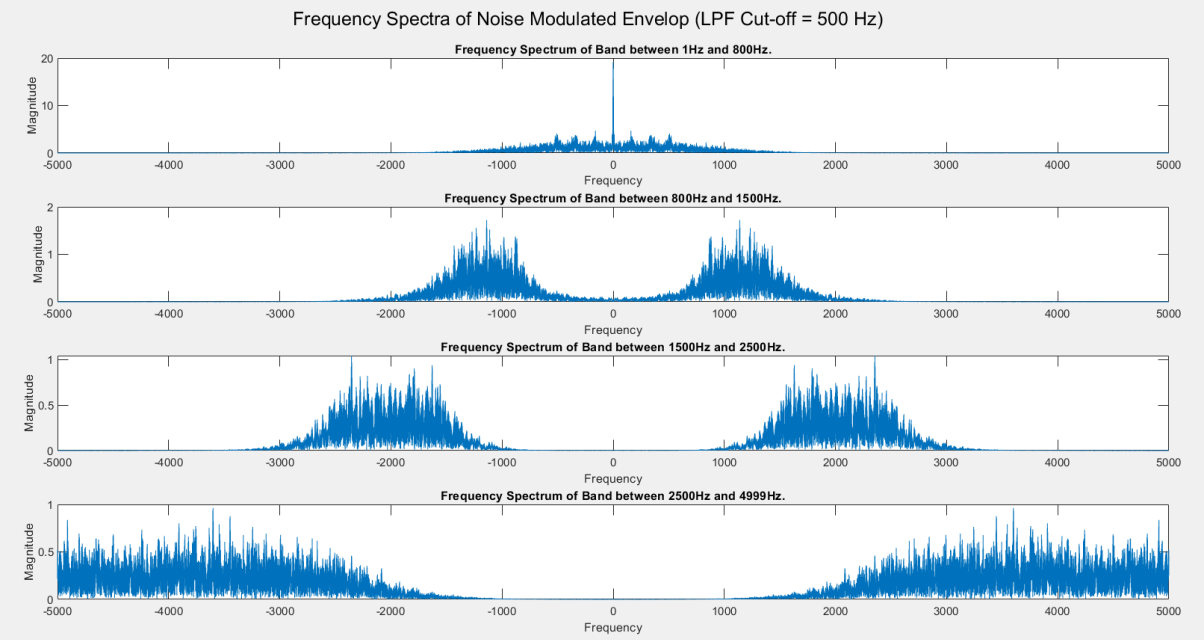
Aim:

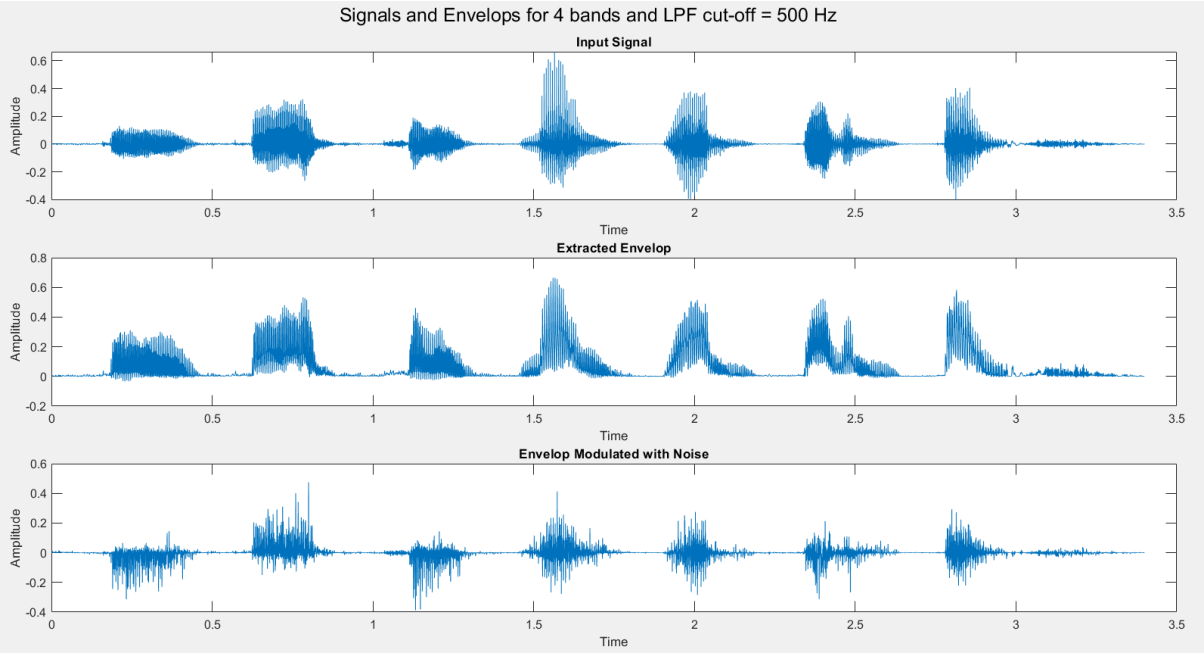
Speech Recognition with Primarily Temporal Cues

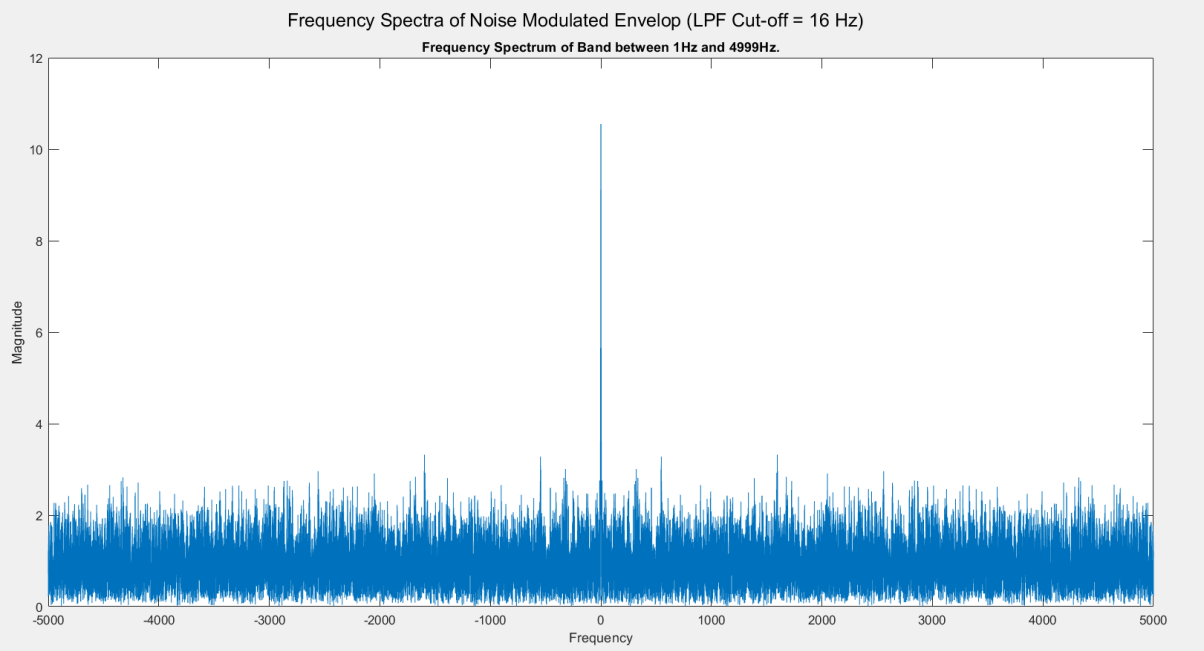
Plots: (Not all plots are shown, since total number of plots for the experiment is 32 (16 conditions, 2 plots for each). They will be included in the report. Extreme cases are shown here)

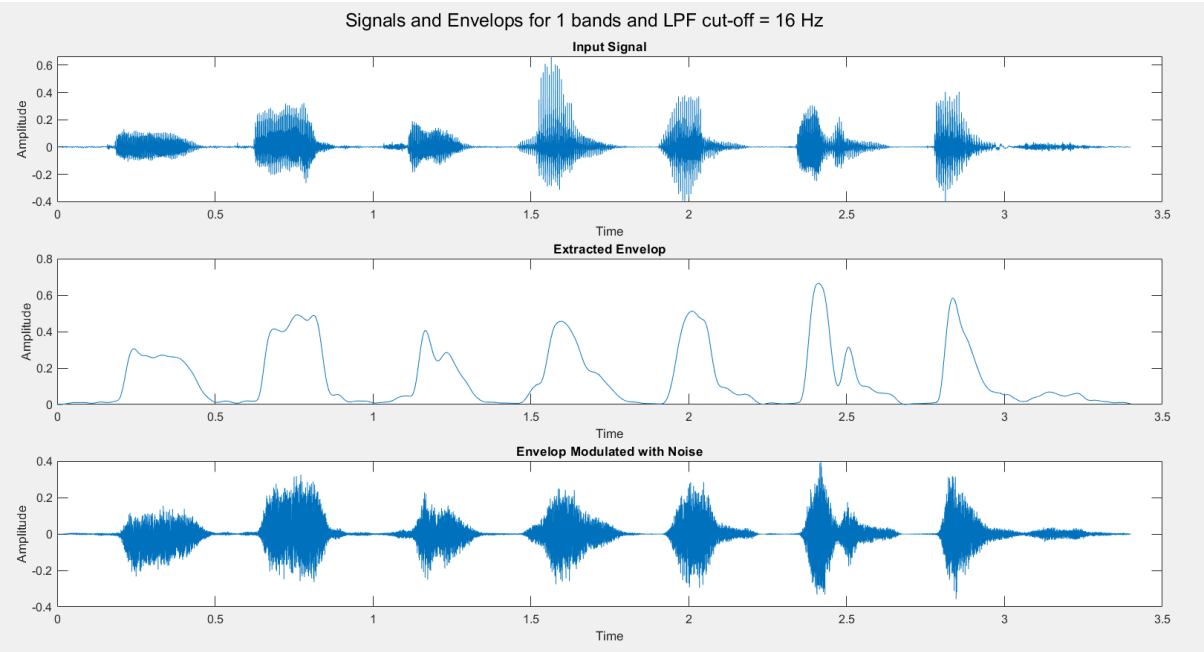


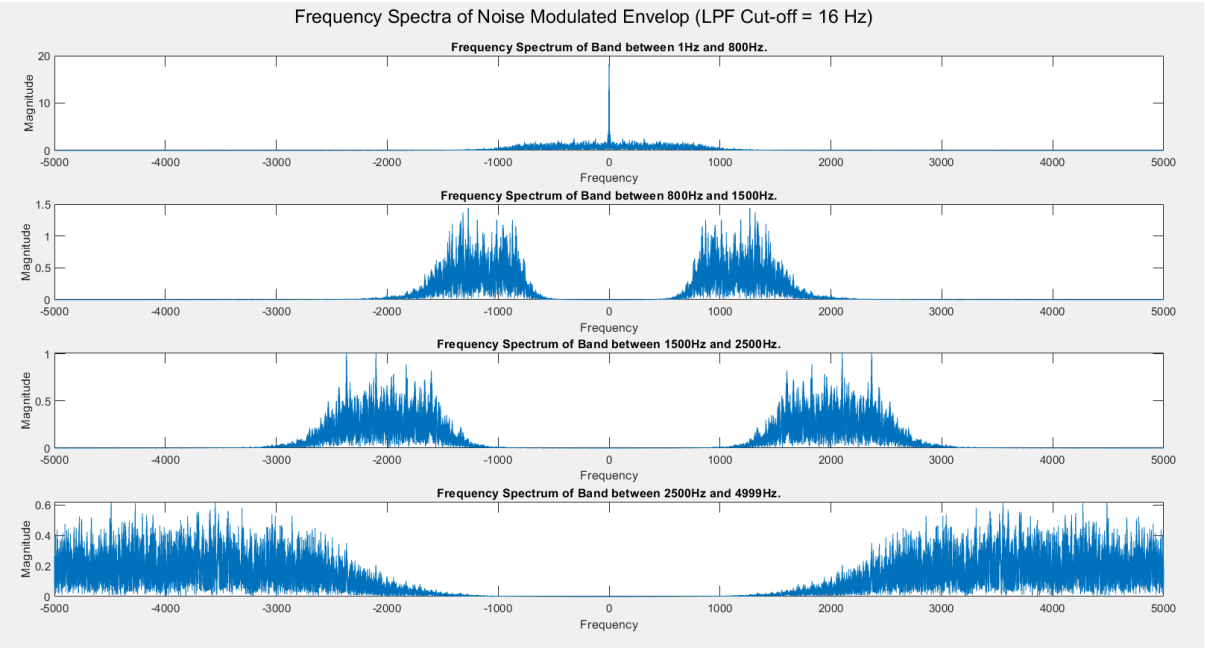


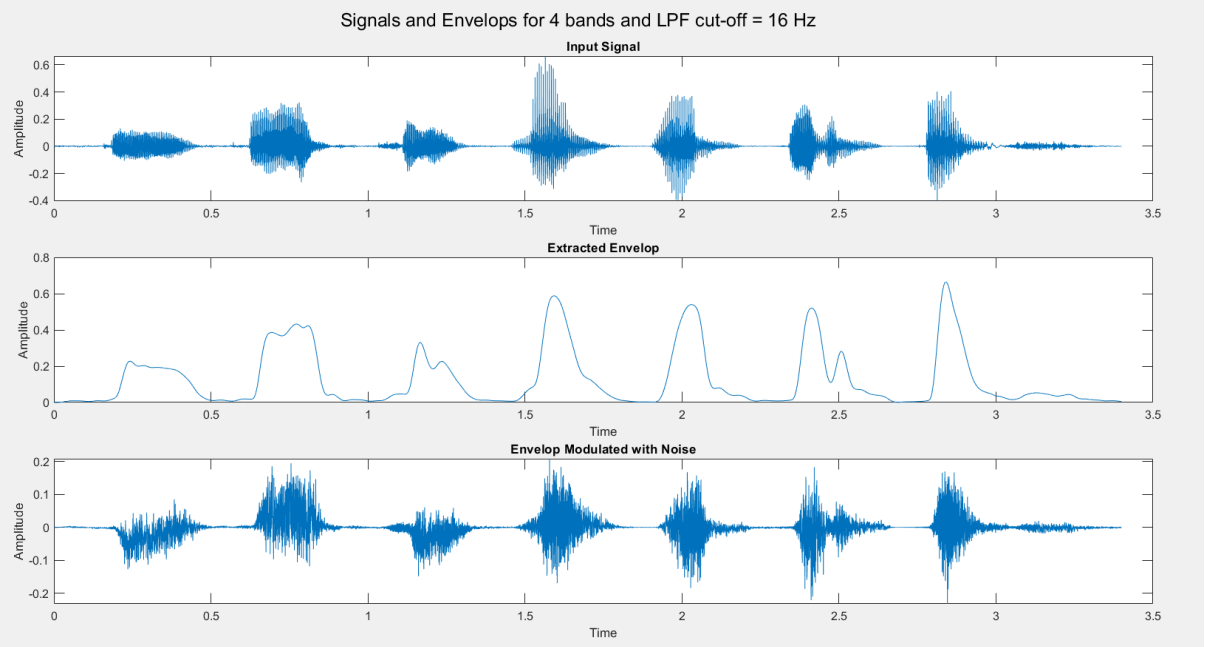

Frequency Spectra of Noise Modulated Envelop (LPF Cut-off = 500 Hz)
Frequency Spectrum of Band between 1Hz and 800Hz.
Frequency Spectrum of Band between 800Hz and 1500Hz.
Frequency Spectrum of Band between 1500Hz and 2500Hz.
Frequency Spectrum of Band between 2500Hz and 4999Hz.
Magnitude
Frequency


Signals and Envelops for 4 bands and LPF cut-off = 500 Hz
Input Signal
Extracted Envelop
Envelop Modulated with Noise
Amplitude
Time


Frequency Spectra of Noise Modulated Envelop (LPF Cut-off = 16 Hz)
Frequency Spectrum of Band between 1Hz and 4999Hz.
Magnitude
Frequency
12
10
8
6
4
2
0
-5000
-4000
-3000
-2000
-1000
0
1000
2000
3000
4000
5000


Signals and Envelops for 1 bands and LPF cut-off = 16 Hz
Input Signal
Extracted Envelop
Envelop Modulated with Noise
Amplitude
Time
0.6
0.4
0.2
0
-0.2
-0.4
0.8
0.5
1
1.5
2
2.5
3
3.5


Frequency Spectra of Noise Modulated Envelop (LPF Cut-off = 16 Hz)
Frequency Spectrum of Band between 1Hz and 800Hz.
Frequency Spectrum of Band between 800Hz and 1500Hz.
Frequency Spectrum of Band between 1500Hz and 2500Hz.
Frequency Spectrum of Band between 2500Hz and 4999Hz.
Magnitude
Frequency


Signals and Envelops for 4 bands and LPF cut-off = 16 Hz
Input Signal
Extracted Envelop
Envelop Modulated with Noise
Amplitude
Time

Code:

```
clc
clear all
close all

order = 4;
[y,F] = audioread("./Samples/B1_A1.wav");
audiowrite("Original.wav",y, 10000);
[y,Fs] = audioread("Original.wav");

norm = Fs/2;
for N = [1,2,3,4]
Fc = 500;
[B_l, A_l] = butter(order, Fc/norm);
noise = rand(size(y));
output = zeros(size(y));
envelop = zeros(size(y));

bands = zeros(4,5);
bands(1,:) = [1, norm-1, 0, 0, 0];
bands(2,:) = [1, 1500, norm-1, 0, 0];
bands(3,:) = [1, 800, 1500, norm-1, 0];
bands(4,:) = [1, 800, 1500, 2500, norm-1];


figure();
sgtitle("Frequency Spectra of Noise Modulated Envelop (LPF Cut-off = "+Fc+" Hz)")
for ii = 1:N
   [B, A] = butter(order, [bands(N,ii)/norm, bands(N,ii+1)/norm]);
   Y = filter(B,A,y);
   Y_e = Y.*(Y>=0);
   Y_el = filter(B_l, A_l, Y_e);
   n = filter(B,A,noise);

   subplot(N,1,ii);
   NUM = length(Y_el);
   f_range = -norm:2*norm/NUM:norm-1/NUM;
   plot(f_range, abs(fftshift(abs(fft(n.*Y_el)))));
   xlabel("Frequency");ylabel("Magnitude");
   title("Frequency Spectrum of Band between "+bands(N,ii)+"Hz and "+bands(N,ii+1)+"Hz.");

   output = output + n.*Y_el;
   envelop = envelop+Y_el;
end
[B_f, A_f] = butter(order, 4000/norm);
output = filter(B_f, A_f, output);
output = output*10;
envelop = filter(B_f, A_f, envelop);
envelop = envelop.*(max(y)/max(envelop));
t = 0:1/Fs:(length(y)-1)/Fs;

figure();
sgtitle("Signals and Envelops for "+N+" bands and LPF cut-off = "+Fc+" Hz");
subplot(311)
plot(t, y);
xlabel("Time");ylabel("Amplitude");
title("Input Signal");

subplot(312)
```

```
plot(t, envelop);
xlabel("Time");ylabel("Amplitude");
title("Extracted Envelop");

subplot(313);
plot(t,output);
xlabel("Time");ylabel("Amplitude");
title('Envelop Modulated with Noise');

out_file = "./Audio_outputs/answer_"+N+"_freq_"+Fc+".wav";
audiowrite(out_file,output,Fs);

out_file = "./Audio_outputs/envelop_"+N+"_freq_"+Fc+".wav";
audiowrite(out_file,envelop,Fs);
end
```