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Skylar Tamke, Homework 2 -Cepstrum

Feeding in the waveform to managable variables

```
clc
clear


%file that says 'Help peter pick a peck of potatos.'
filename = 'SX29.WAV';
phntable = readtable("SX29phoneam.txt");

%code provided on handout by Snider
fid = fopen(filename,'r');
status = fseek(fid, 1024, -1);
[wave,count] = fread(fid,inf,'int16');
fclose(fid);
Fs = 16000;
N = 14;



%to change the wave length into a nice number to divide into
count = length(wave)-3;




% This section is plotting the formants of the vowels in the speech
 sample
% in a scatterplot.  Each of the plots are color coded to match the
 vowel
% that they represent.

%vowels
% 3310,4493,'eh'      vowel   1
% 9140,11320,'ey';    vowel   2
% 13230,13720,'ix';   vowel   3
% 15620,17080,'ih';   vowel   4
% 31360,34270,'ow';     vowel 5
% 20690,22440,'eh';     vowel 6
% 23630,24320,'ix';     vowel 7
% 26690,27160,'ix';     vowel 8
% 28757,30880,'ey';     vowel 9
% 18140,19000,'ix';     vowel 10
```

```
% creating a vector for scatter plotting the formants later
vowel_index = [ 3310 4493;
                9140 11320;
                13230 13720;
                15620 17080;
                31360 34270;
                18140 19000;
                20690 22440;
                23630 24320;
                26690 27160;
                28757 30880];

vowel = [1 2 3 4 5 3 1 3 3 2];
```

Homomorphic filtering process, based on lecture notes

The lecture notes showed the method for filtering a waveform using the concept of cepstrums

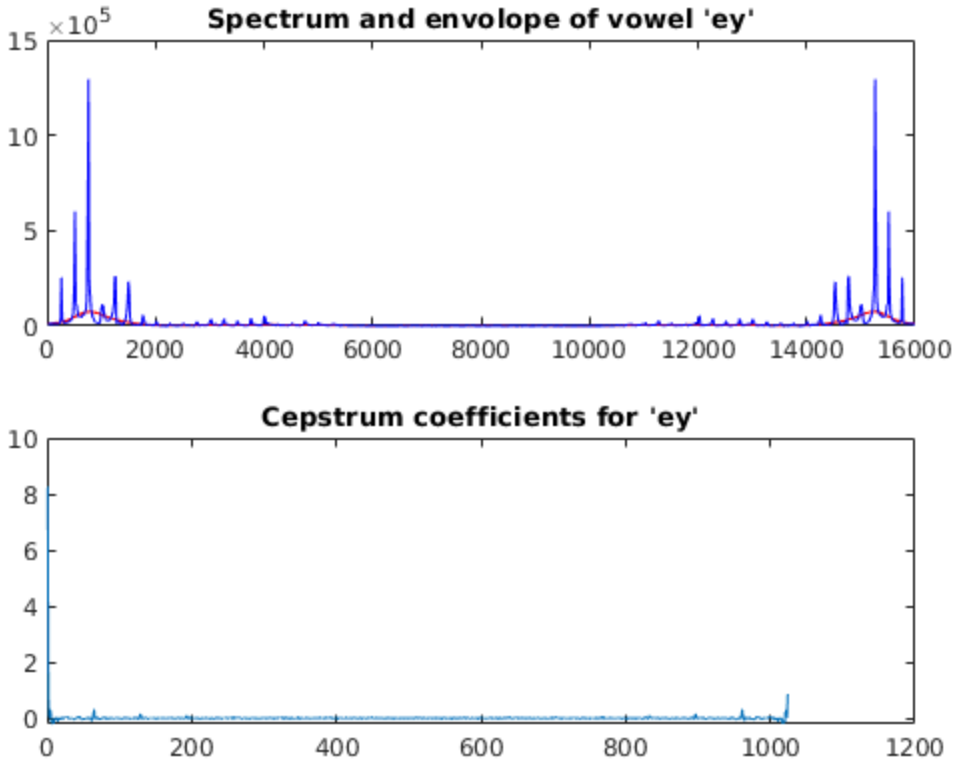
```
vowel_windows = {10};
% seperating the vowels
for i = 1:10
    vowel_windows{i,:}  = wave(vowel_index(i,1):vowel_index(i,2));
end

%number of fft points to take
L = 1024;

% for freq. scaling at the end
f = Fs/(L)*(1:L);

% taking the fft
fft_vowel = {10};
for i = 1:10
    fft_vowel{i,:} = fft(vowel_windows{i,:},L);
end

% putting vowels into the log domain
ln_vowel = {10};
for i = 1:10
    ln_vowel{i,:} = log(abs(fft_vowel{i,:}));
end

% putting the log vowels into the cepstrum domain
cept_vowel = {10};
for i = 1:10
   cept_vowel{i,:} = ifft(ln_vowel{i,:},L);
end

% liftering the parts we want
liftering_vowels = cept_vowel;
```

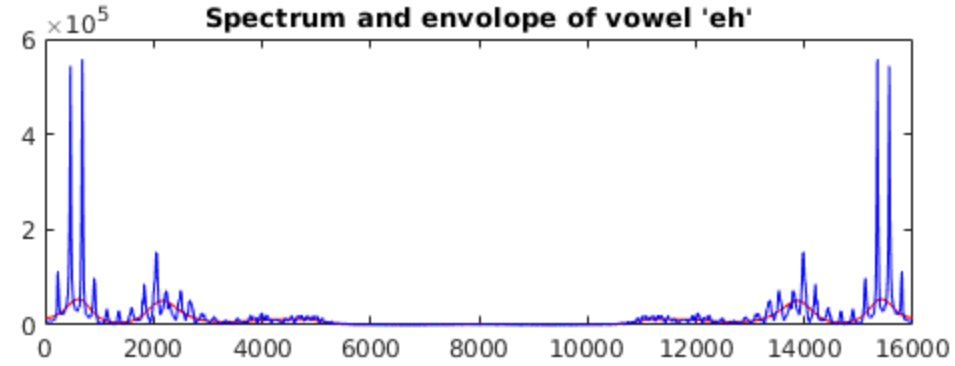
```
for i = 1:10
    temp = liftering_vowels{i,:};
    temp(N+1:end-N) = 0;
    liftering_vowels{i,:} = temp;
end

% taking a fft to get back into the log domain
decept = {10};
for i = 1:10
   decept{i,:} = abs(fft(liftering_vowels{i,:},L));
end

% Taking the exponential to get back into the frequency domain
delog = {10};
for i = 1:10
   delog{i,:} = exp(decept{i,:});
end
```

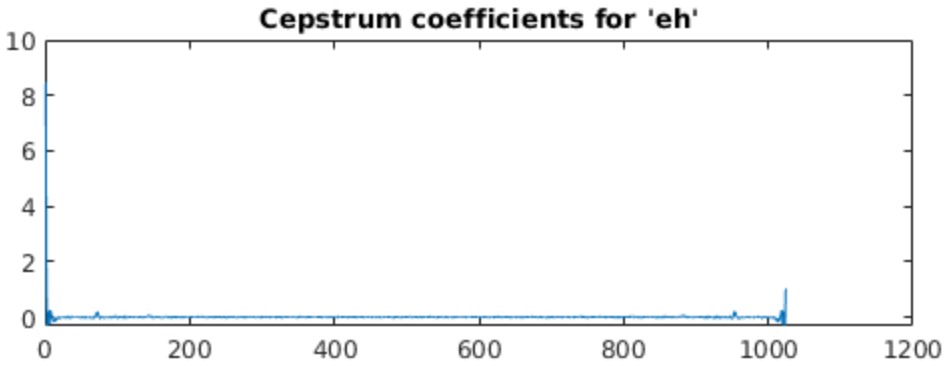
Plotting all of the vowels ceptstrum coefficients and spectrum with envelope overlap

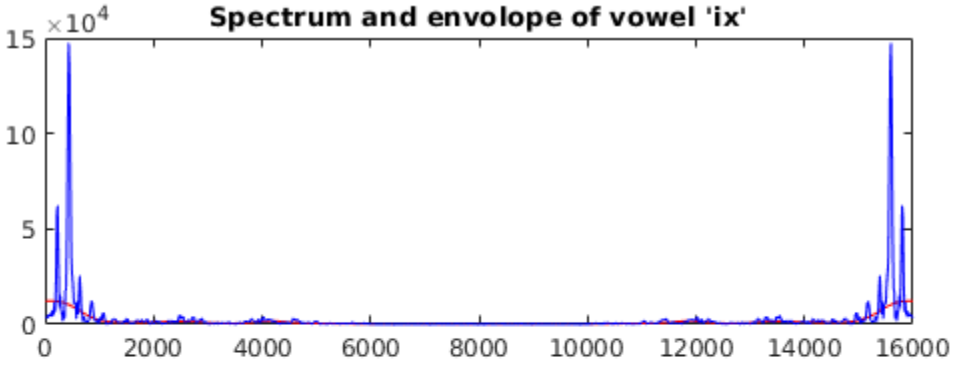
```
% Creating a plot for each of the vowels with their freq spectrum and
 cept
% coefficiets
for i = 1:10

    figure(i)
    subplot(2,1,2)
    plot(cept_vowel{i,:})
    switch vowel(i)
        case 1
            title("Cepstrum coefficients for 'ey'")
        case 2
            title("Cepstrum coefficients for 'eh'")
        case 3
            title("Cepstrum coefficients for 'ix'")
        case 4
            title("Cepstrum coefficients for 'ih'")
        case 5
            title("Cepstrum coefficients for 'ow'")
    end
    % plotting the spectrum with the envelope
    subplot(2,1,1)

    plot(f,(delog{i,:}), 'r')
    switch vowel(i)
        case 1
            title("Spectrum and envolope of vowel 'ey'");
        case 2
            title("Spectrum and envolope of vowel 'eh'");
        case 3
            title("Spectrum and envolope of vowel 'ix'");
```

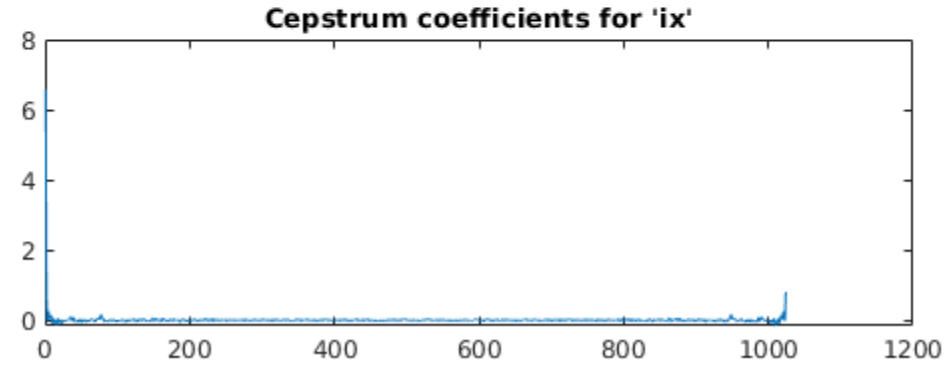
```
            case 4
                title("Spectrum and envolope of vowel 'ih'");
            case 5
                title("Spectrum and envolope of vowel 'ow'");
        end
        hold on
        subplot(2,1,1)
        plot(f,(abs(fft_vowel{i,:})),'b')
end
```

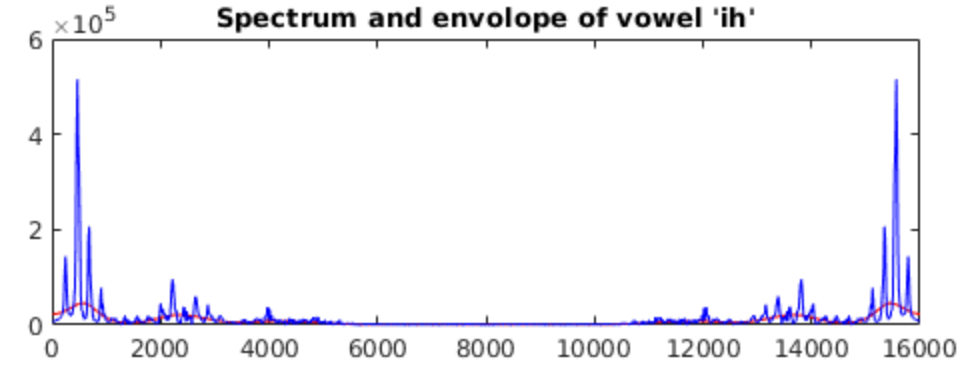


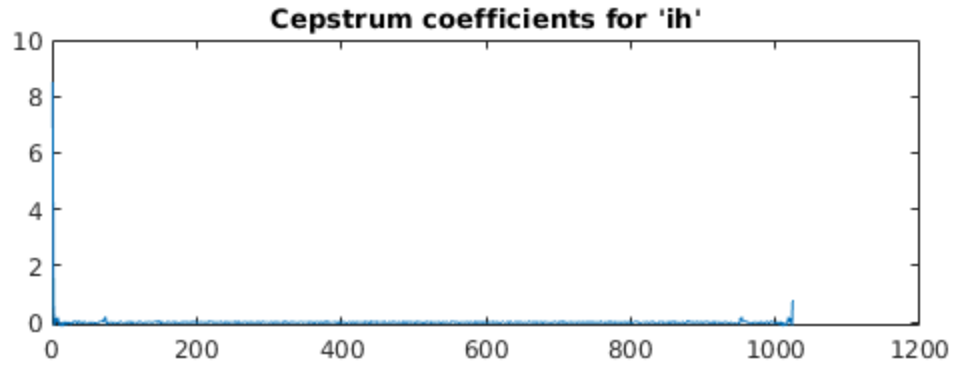

Spectrum and envolope of vowel 'eh'
×10^5
6
4
2
0
0
2000
4000
6000
8000
10000
12000
14000
16000

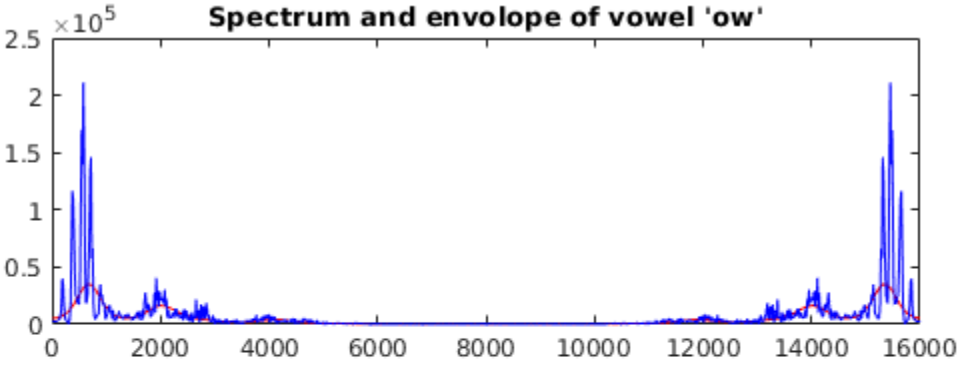

Cepstrum coefficients for 'eh'
10
8
6
4
2
0
0
200
400
600
800
1000
1200

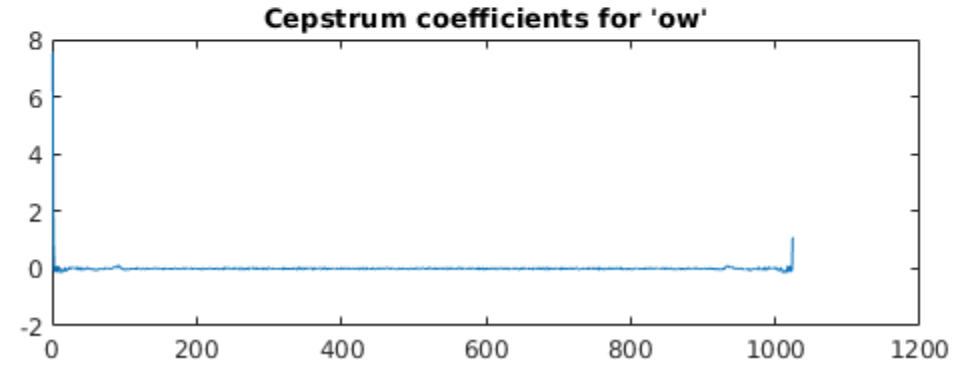

Spectrum and envolope of vowel 'ix'
×10^4
15
10
5
0
0
2000
4000
6000
8000
10000
12000
14000
16000

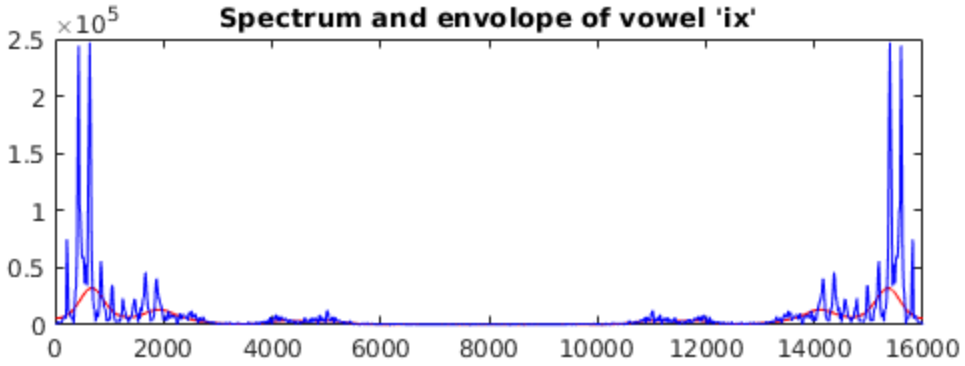

Cepstrum coefficients for 'ix'
8
6
4
2
0
0
200
400
600
800
1000
1200

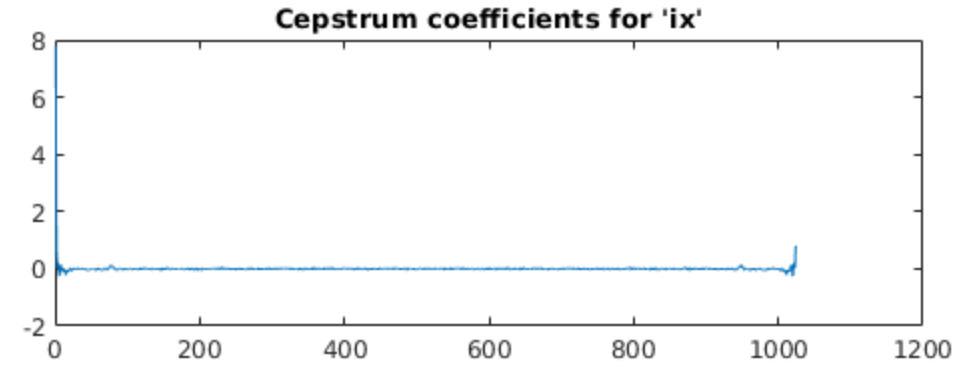

Spectrum and envolope of vowel 'ih'
×10^5
6
4
2
0
0
2000
4000
6000
8000
10000
12000
14000
16000

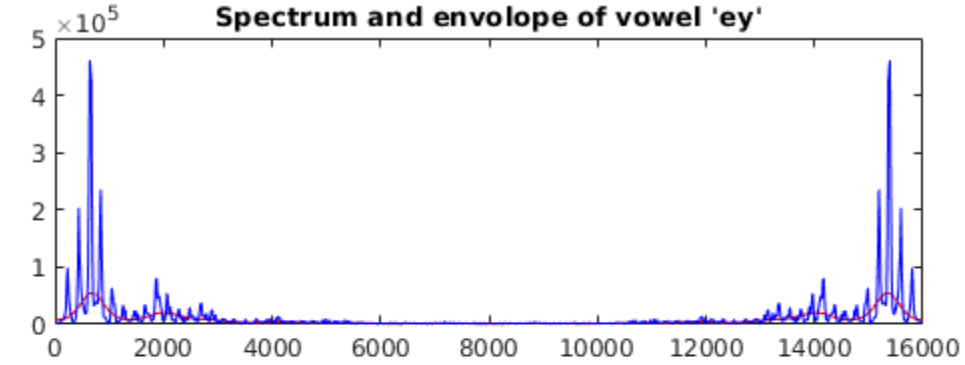

Cepstrum coefficients for 'ih'
10
8
6
4
2
0
0
200
400
600
800
1000
1200

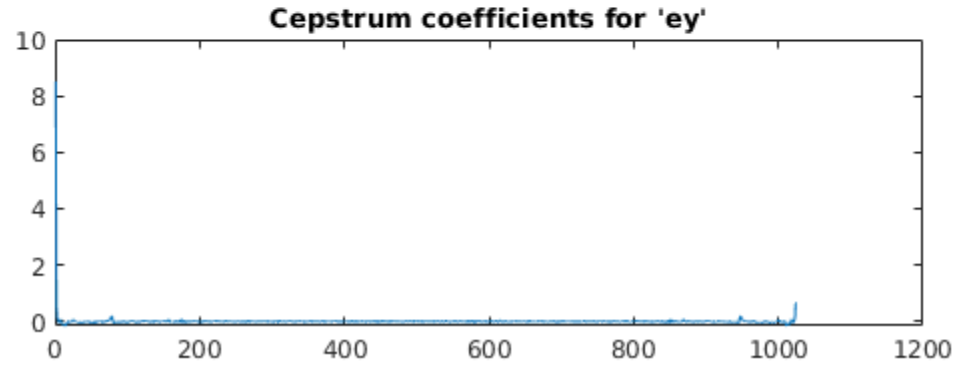

Spectrum and envolope of vowel 'ow'
×10^5
2.5
2
1.5
1
0.5
0
0
2000
4000
6000
8000
10000
12000
14000
16000

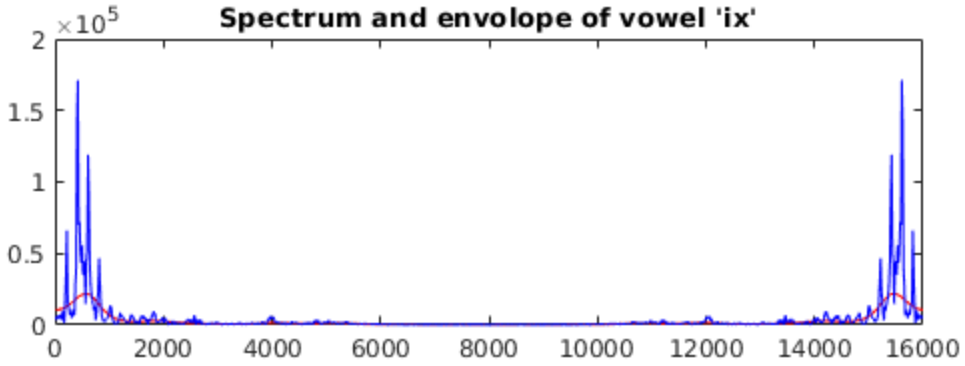

Cepstrum coefficients for 'ow'
8
6
4
2
0
-2
0
200
400
600
800
1000
1200

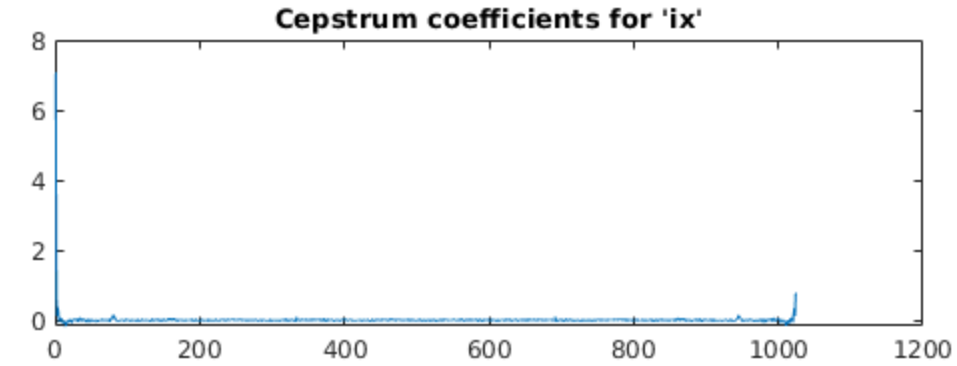

Spectrum and envolope of vowel 'ix'
×10^5
2.5
2
1.5
1
0.5
0
0
2000
4000
6000
8000
10000
12000
14000
16000

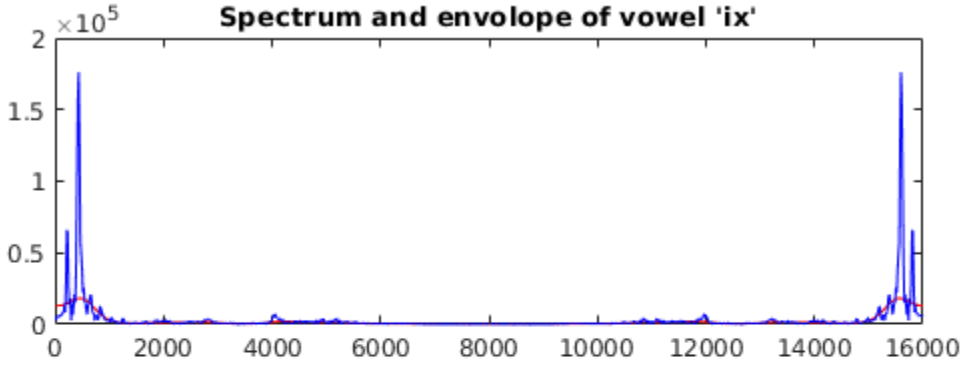

Cepstrum coefficients for 'ix'
8
6
4
2
0
-2
0
200
400
600
800
1000
1200

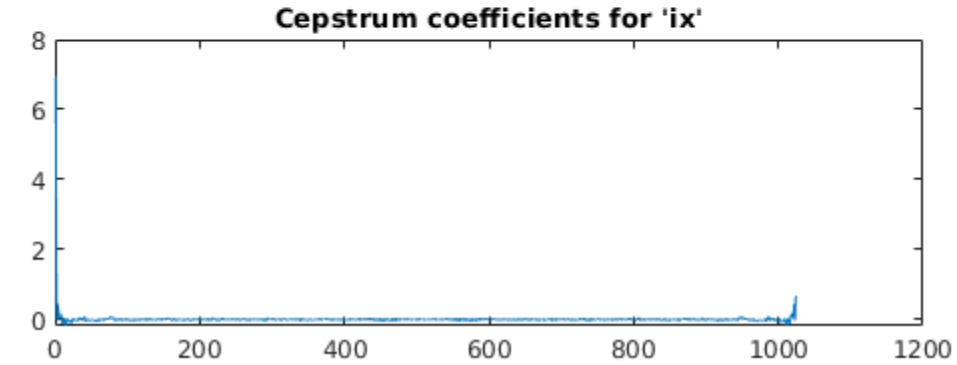

Spectrum and envolope of vowel 'ey'
×10^5
5
4
3
2
1
0
0
2000
4000
6000
8000
10000
12000
14000
16000

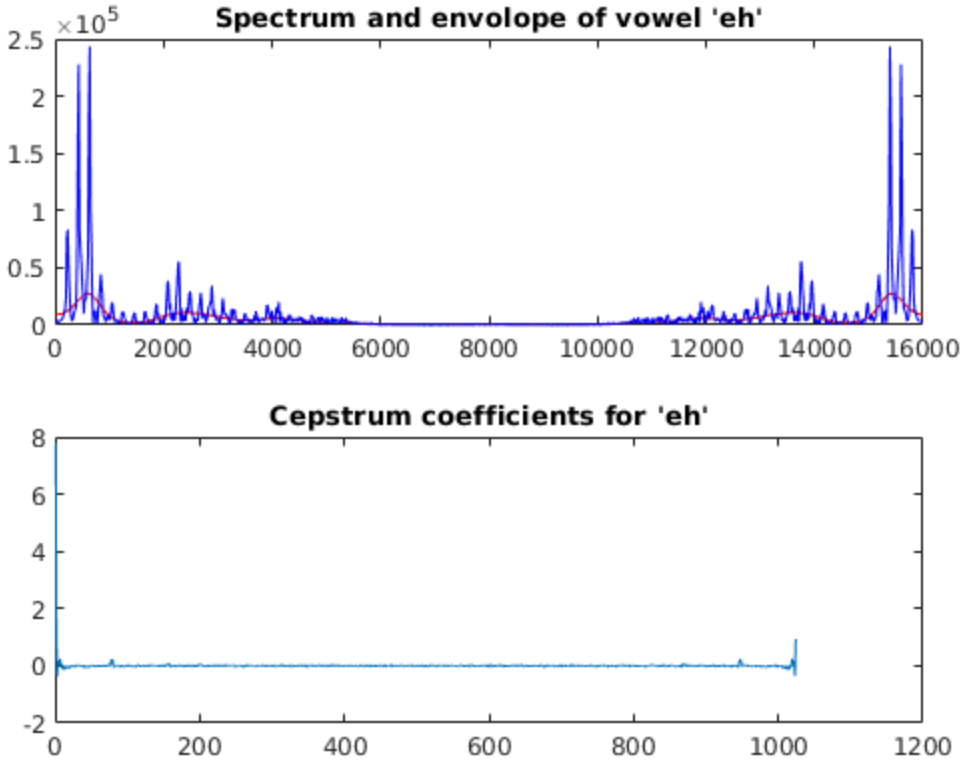

Cepstrum coefficients for 'ey'
10
8
6
4
2
0
0
200
400
600
800
1000
1200


Spectrum and envolope of vowel 'ix'
×10^5
2
1.5
1
0.5
0
0
2000
4000
6000
8000
10000
12000
14000
16000


Cepstrum coefficients for 'ix'
8
6
4
2
0
0
200
400
600
800
1000
1200


Spectrum and envolope of vowel 'ix'
×10^5
2
1.5
1
0.5
0
0
2000
4000
6000
8000
10000
12000
14000
16000

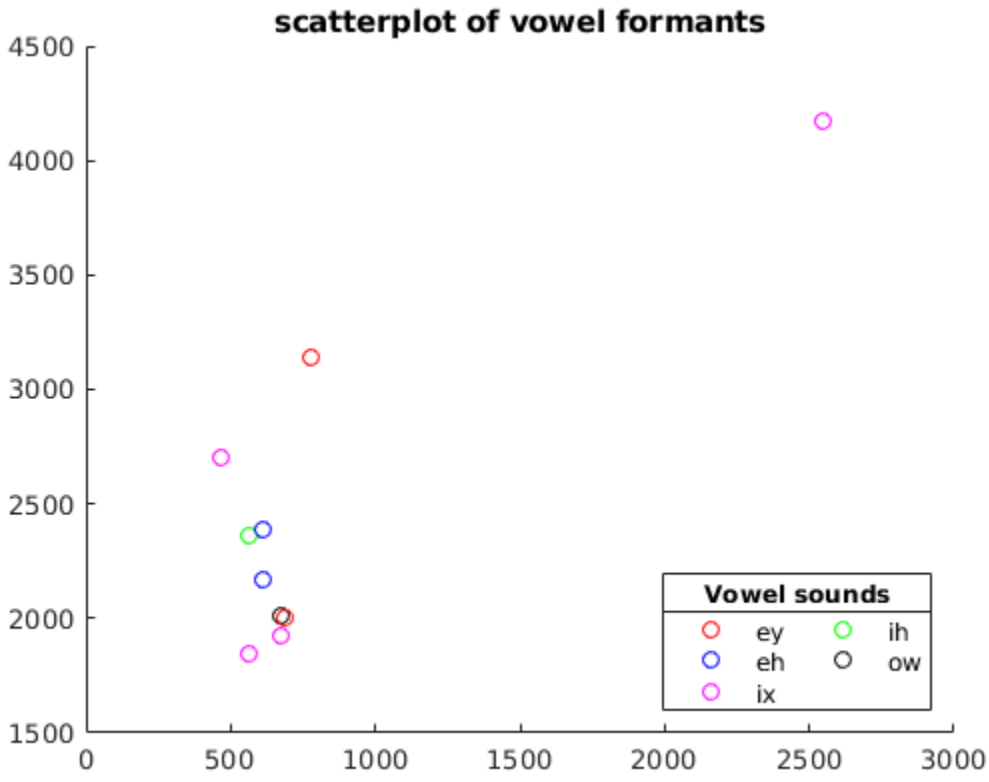

Cepstrum coefficients for 'ix'
8
6
4
2
0
0
200
400
600
800
1000
1200



Formants of the vowels

```
for i = 1:10
    [pks,indc] = findpeaks(delog{i,:},f);

    formant1{i,:} = round(indc(1));
    formant2{i,:} = round(indc(2));
end


figure(11)
hold on

%
% first the vowels from the least squares method sent to the scatter
 plot
% and color coded to the vowels
for i = 1:10
   switch vowel(i)
       case 1
           scatter(formant1{i},formant2{i},'r');
       case 2
           scatter(formant1{i},formant2{i},'b');
       case 3
           scatter(formant1{i},formant2{i},'m');
```

```
        case 4
            scatter(formant1{i},formant2{i},'g');
        case 5
            scatter(formant1{i},formant2{i},'k');
    end
end
title("scatterplot of vowel formants")
% just adding a legend to show which colors correspond to the vowels
 they
% are plotting
lgn  = legend({'ey', 'eh', 'ix', 'ih', 'ow'});
lgn.NumColumns = 2;
lgn.Location = 'southeast';
lgn.Title.String = "Vowel sounds";
```



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