EE 679 Speech Processing bonus assignment 1

Swrangsar Basumatary 09d07040

We produce the notes individually and then gather them in a cell array. We then run a loop which plays already loaded notes from the cell array.

The function which generates the impulse for vowel /a/ :

```
function [impulseResponse] = vowelResonatorA(samples)
%VOWELRESONATORA(SAMPLES) Creates a new filter WITH 3 formant
frequencies.
%  VOWELRESONATORA creates a new transfer function H(z)
%  for a digital filter with three formants. It uses the input
%  string 'VOWEL' to do
%  this. SAMPLES is the no of samples of impulse response
required within 1 second of time.

vowel = 'a';
F1 = 730; F2 =1090; F3 = 2440;

Bw = 100;
Fs = 16000; % 16 kHz
poleRadius = exp(-(pi*Bw/Fs));
poleTheta = 2*pi*F1/Fs;
pole1 = poleRadius*exp(1i*poleTheta);
pole2 = poleRadius*exp(-1i*poleTheta);

M = 16000;
% step = Fs/M;
f = 0:1:M-1;
% f = f*step;
r = 1;
z = r*exp(1i*2*pi*f/Fs);
H1 = (z.*z)./((z-pole1+eps).*(z-pole2+eps));
poleTheta = 2*pi*F2/Fs;
pole1 = poleRadius*exp(1i*poleTheta);
pole2 = poleRadius*exp(-1i*poleTheta);
H2 = (z.*z)./((z-pole1+eps).*(z-pole2+eps));
poleTheta = 2*pi*F3/Fs;
pole1 = poleRadius*exp(1i*poleTheta);
pole2 = poleRadius*exp(-1i*poleTheta);
H3 = (z.*z)./((z-pole1+eps).*(z-pole2+eps));
H = H1.*H2.*H3;
```

```
% mag = 20*log10(abs(H));
% figure, plot(f, mag);
% title(['Magnitude plot for vowel /', vowel, '/']);
% xlabel('Frequency (Hz)');
% ylabel('Magnitude (dB)');
% length(H)

impulseResponse = real(ifft(H, samples)); % do ifft on centered
Fourier transform

% M = length(impulseResponse)
% n = 0:1:M-1;
% t = n/M;
% figure, plot(t, impulseResponse);
% title(['Impulse response for vowel /', vowel, '/']);
% xlabel('Time (sec)');
% ylabel('Impulse response h(t)');
```

The function for making an individual note:

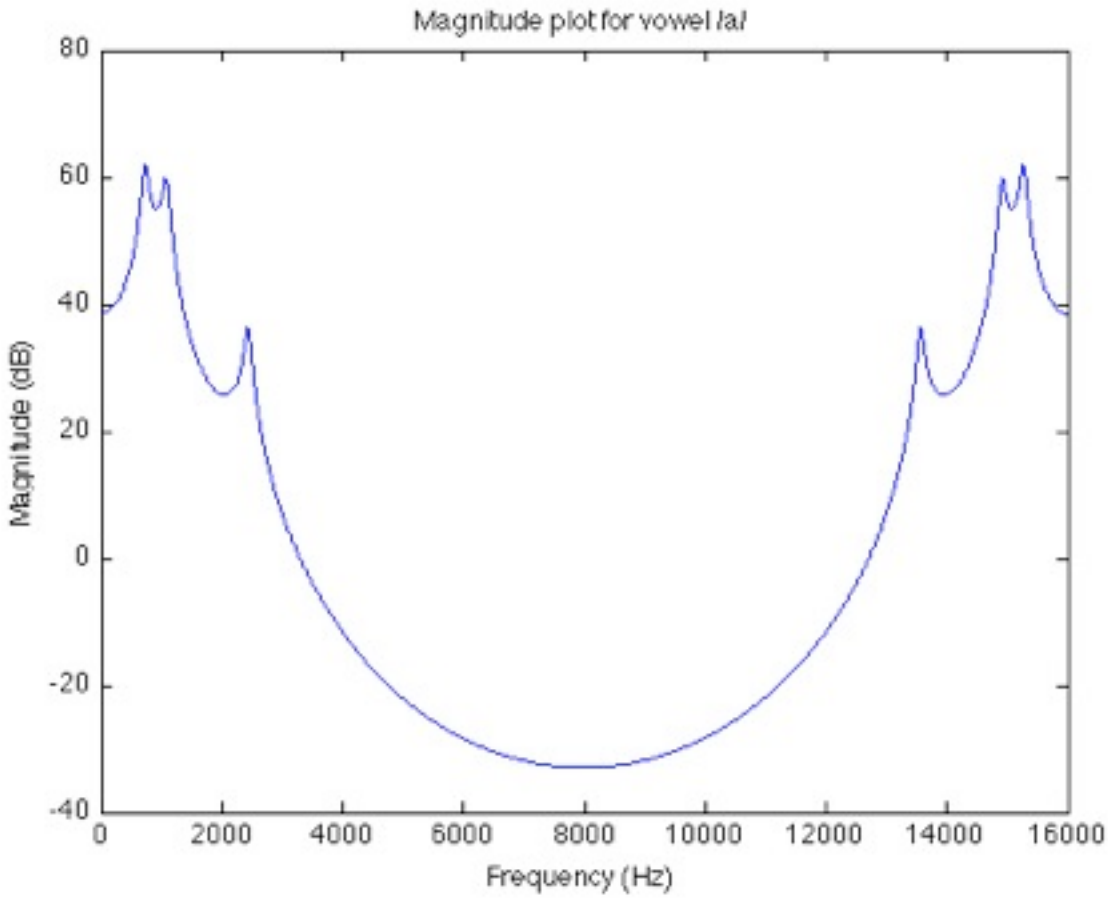
```
function note = noteWithVowelA(F0, duration)
%NOTEWITHVOWELA produces a note of vowel /a/ with pitch F0 and
duration
%'duration' ms
Fs = 16000;
samples = 16000;
impulseResponse = vowelResonatorA(samples);

step = round(samples/F0);
impulseTrain = zeros(1, samples);
for k = 1:step:samples
    impulseTrain(k) = 1;
end
y = conv(impulseResponse, impulseTrain);
requiredLength = round(duration*(samples/1000));
note = y(1:requiredLength);
% n = 0:length(note)-1;
% t = n/samples;
% figure, plot(t, note);
% title(['Time domain waveform for vowel /a/ and F0 = ',
num2str(F0), ' and duration = ', num2str(duration), ' ms']);
% xlabel('Time (sec)');
% ylabel('Output y(t)');
```

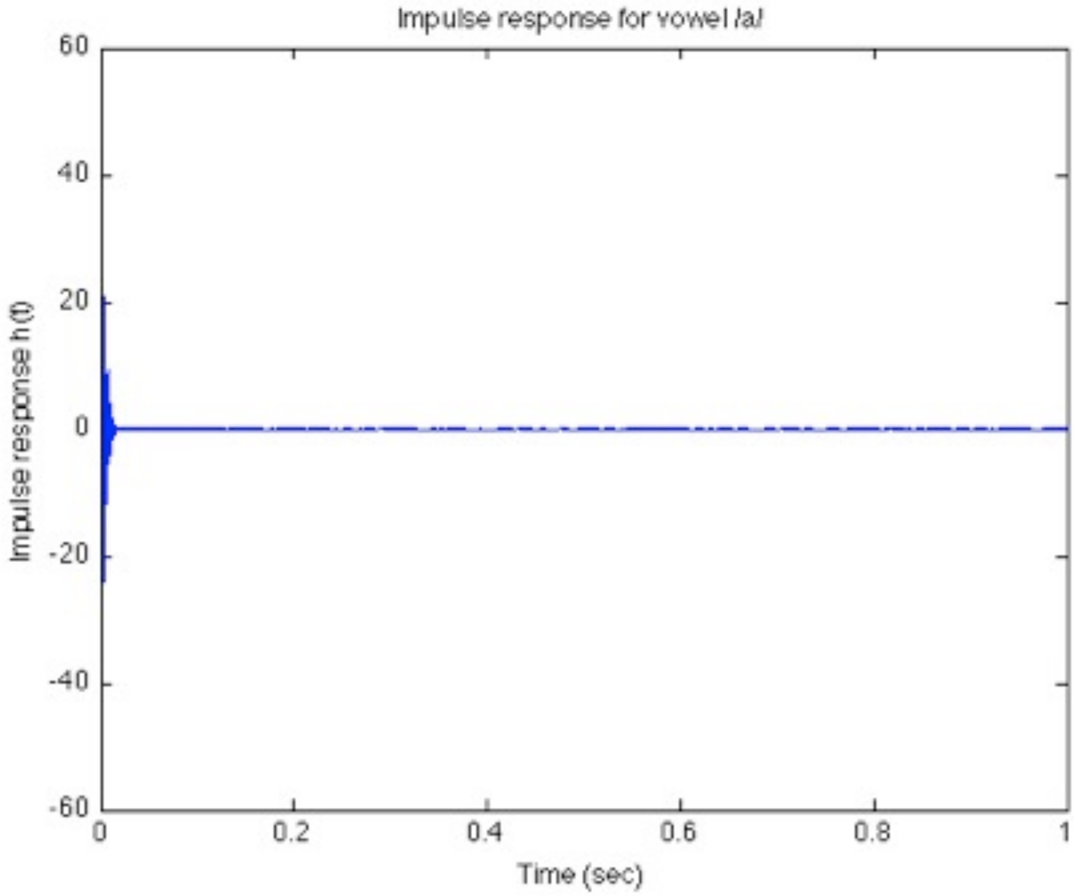
```
% sound(note, Fs);
```

The Matlab script which gathers the notes and plays them:

```
clear all; close all;
Fs = 16000;

note = { noteWithVowelA(220, 100),
noteWithVowelA(220, 100),
noteWithVowelA(247, 100),
noteWithVowelA(247, 100),

noteWithVowelA(220, 150),
noteWithVowelA(196, 50),
noteWithVowelA(185, 200),

noteWithVowelA(220, 100),
noteWithVowelA(220, 100),
noteWithVowelA(247, 100),
noteWithVowelA(247, 100),

noteWithVowelA(220, 150),
noteWithVowelA(196, 50),
noteWithVowelA(185, 200),


noteWithVowelA(220, 100),
noteWithVowelA(220, 100),
noteWithVowelA(247, 100),
noteWithVowelA(277, 100),

noteWithVowelA(294, 350),
noteWithVowelA(330, 50),

noteWithVowelA(262, 200),
noteWithVowelA(247, 200),

noteWithVowelA(220, 400)};


% for k = 1:length(note)
%     sound(note{k}, Fs);
% end

song = cat(2, note{:});
sound(song, Fs);
```

The frequency response and impulse response for the first note in the song:




Impulse response for vowel /a/
Impulse response h (t)
Time (sec)
60
40
20
0
-20
-40
-60
0
0.2
0.4
0.6
0.8
1