

Southern University of Science and Technology

Speech Signal Processing

# Lab 3 Report

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Question 1

Setting L = 21, we can plot the windows, as well as their dB scales as below:



Figure



Figure

As we can see, the rectangular window has the smallest main-lobe width, while Blackman window has the biggest width. But the hamming window has a better performance of the flatness of main-lobe. Therefore, each window has its own pros and cons, and we need to choose the better window according to our own case.

Question 2

Code:

function [ ] = audanalyze( input\_file, window\_type, window\_shift, window\_size)

%AUDANALYZE This function is to calculate and plot figures for lab3,q2.

signal = audioread(input\_file);

R = window\_shift;

L = window\_size;

figure;

subplot(4,1,1);plot(signal);title('waveform');xlim([0,length(signal)]);

% Use the attribute window type to determine the window

if window\_type == 'R'

window = ones(1,L)';

elseif window\_type == 'H'

window = hamming(L);

end

% short time energy

window\_e = window.^2;% effective window for short time energy

stenergy = zeros(1, round((length(signal)-L)/R));

for i = 1:length(stenergy)

map\_i = (i-1)\*R+1;% map\_i is n hat, beginning of each small piece

stenergy(i) = sum((signal(map\_i:map\_i+L-1).^2).\*window\_e);

end

subplot(4,1,2);plot(stenergy);title('short-time energy');xlim([0,length(stenergy)]);

% short time magnitude, almost the same with stenergy

stmagnitude = zeros(1, round((length(signal)-L)/R));

for i = 1:length(stmagnitude)

map\_i = (i-1)\*R+1;

stmagnitude(i) = sum(abs(signal(map\_i:map\_i+L-1)).\*window);

end

subplot(4,1,3);plot(stmagnitude);title('short-time magnitude');xlim([0,length(stmagnitude)]);

% short time zero-crossing rate, using the object to calculate

stzeroc = zeros(1, round((length(signal)-L)/R));

Hzerocross = dsp.ZeroCrossingDetector;

for i = 1:length(stzeroc)

map\_i = (i-1)\*R+1;

stzeroc(i) = step(Hzerocross,signal(map\_i:map\_i+L-1));

end

subplot(4,1,4);plot(stzeroc);title('short-time zero-crossing');xlim([0,length(stzeroc)]);

end



Figure 3 Hamming, L = 21, R = 10

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Figure 4 Rectangular, L = 21, R = 10

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Figure 5 ,Rectangular, L = 21, R = 2

We can see these figures are almost the same, regardless of changing window type or shift length. The only difference for R = 2 is the length of the signal has increased, since the sample rate is higher than R = 10.

Therefore, I suggest that shift length should be larger, for the consideration of saving calculation resource.

Question 3

Code:

[signal, Fs] = audioread('test\_16k.wav');

R = 5; % window\_shift;

L = [51, 101, 201, 401]; %window\_size;

figure;

% short-time energy

figure;

for j = 1:4

stenergy = zeros(1, round((length(signal)-L(j))/R));

window = hamming(L(j));

window\_e = window.^2;

for i = 1:length(stenergy)

map\_i = (i-1)\*R+1;

stenergy(i) = sum((signal(map\_i:(map\_i+L(j)-1)).^2).\*window\_e);

end

subplot(4,1,j);plot(stenergy);title(sprintf('short-time energy when L=%d', L(j)));xlim([0,length(stenergy)]);

end

% short time magnitude

for j = 1:4

stmagnitude = zeros(1, round((length(signal)-L(j))/R));

window = hamming(L(j));

for i = 1:length(stmagnitude)

map\_i = (i-1)\*R+1;

stmagnitude(i) = sum(abs(signal(map\_i:map\_i+L(j)-1)).\*window);

end

subplot(4,1,j);plot(stmagnitude);title(sprintf('short-time magnitude when L=%d',L(j)));xlim([0,length(stmagnitude)]);

end

% short time zero crossing

for j = 1:4

stzeroc = zeros(1, round((length(signal)-L(j))/R));

Hzerocross = dsp.ZeroCrossingDetector;

for i = 1:length(stzeroc)

map\_i = (i-1)\*R+1;

stzeroc(i) = step(Hzerocross,signal(map\_i:map\_i+L(j)-1));

end

subplot(4,1,j);plot(stzeroc);title(sprintf('short-time zero-crossing when L=%d',L(j)));xlim([0,length(stzeroc)]);

end



Figure



Figure



Figure

We can see that, different from window type or shift length in Q2, the window length L can significantly change the figure. When L gets bigger, it is equivalent with a low-pass filter with a lower cut-off frequency. Therefore, the high-frequency components are reduced when L increases.

This is either a pro or con, depending on your demand with the operation. If your only wish is to get the envelope, then bigger L is better, since you will not need another low-pass filter to get the envelope. But if the details of the signal is important for you, the smaller window length is the better choice, most of the high-frequency component is remained.