**Code :**

**Project1.m (Main 主要執行) :**

clear('all');

close('all');

[y,fs] = audioread('TEST.wav'); %read auio file

frame\_size = 20; %setting

frame\_shift = 10;

window\_type = 'rectwin';

max\_value = max(abs(y));

y = y/max\_value;

energy = short\_term\_energy(y,fs,frame\_size,frame\_shift,window\_type); %call short\_term\_energy

zcr = zcr(y,fs,frame\_size,frame\_shift,window\_type); %call zcr

tt = 1/fs:(frame\_size/2000):(length(energy)\*(frame\_shift/1000));

subplot(5,1,3);

plot(tt,energy);

title('Energy Contour');

subplot(5,1,5);

plot(tt,zcr);

title('Zero-Crossing Rate Contour');

avg\_energy = sum(abs(energy)) / length(energy); %for calculating ITU & IZCT

%fprintf('avg\_energy = ');

%disp(avg\_energy);

var\_energy = var(abs(energy));

%fprintf('var\_energy = ');

%disp(var\_energy);

avg\_zcr = sum(abs(zcr)) / length(zcr);

%fprintf('avg\_zcr = ');

%disp(avg\_zcr);

var\_zcr = var(abs(zcr));

%fprintf('var\_zcr = ');

%disp(var\_zcr);

ITU = avg\_energy;

IZCT = avg\_zcr;

begin\_p = 0;

end\_p = 0;

begin\_temp = 0;

end\_temp = 0;

count = 0;

for i = 1:length(energy) - 1 %find begin point

if(energy(i) < ITU)

if(energy(i + 1) > ITU)

begin\_p = i;

break

end

end

end

for j = length(energy):-1:2 % find end point

if(energy(j) < ITU)

if(energy(j - 1) > ITU)

end\_p = j;

break

end

end

end

%cal Pitch

frame\_size = 30;

frame\_shift = 10;

max\_value=max(abs(y));

y=y/max\_value;

window\_period = frame\_size / 1000;

window\_length = window\_period\*fs;

shift\_period = frame\_shift / 1000;

sample\_shift = shift\_period\*fs;

pitch\_freq = 0;

sum1 = 0;autocorrelation = 0;sample\_no = 0;

for i = 1:(floor((length(y))/sample\_shift)-ceil(window\_length/sample\_shift)) % for setting the window size in short term

k = 1;yy = 0;

for j = (((i-1)\*sample\_shift)+1):(((i-1)\*sample\_shift)+window\_length) % copy data in short term

yy(k) = y(j);

k = k + 1;

end

for l = 0:(length(yy) - 1) % calculate the pitch

sum1 = 0;

for u = 1:(length(yy) - l)

s = yy(u)\*yy(u + l);

sum1 = sum1 + s;

end

autocor(l + 1) = sum1;

autocorrelation(l + 1,i) = autocor(l + 1);

end

auto = autocor(21:160);

max1= 0;

for uu = 1:140

if(auto(uu)>max1) % get the average pitch

max1 = auto(uu);

sample\_no = uu;

end

end

pitch\_freq(i) = 1/((20+sample\_no)\*(1/fs)); % save data in pitch\_freq

end

[rows,cols] = size(autocorrelation);

pitch\_t = 1/fs:shift\_period:(cols\*shift\_period);

subplot(5,1,4);

plot(pitch\_t,pitch\_freq,'.'); % plot pitch contour

title('Pitch Contour');

t = 1/fs:1/fs:(length(y)/fs); % plot end-pont

subplot(5,1,2);plot(t,y);hold on;

plot([(begin\_p \* (length(y)/fs)/length(energy)),(begin\_p \* (length(y)/fs)/length(energy))],[-1,1]);hold on;

plot([(end\_p \* (length(y)/fs)/length(energy)),(end\_p \* (length(y)/fs)/length(energy))],[-1,1]);

hold off;

title('End-Point');

**short\_term\_energy.m (function calculate short trem energy) :**

function [ c ] = short\_term\_energy( signal,fs,frame\_size,frame\_shift,window\_type )

y = signal;

frame\_size = frame\_size/1000;

frame\_shift = frame\_shift/1000;

t = 1/fs:1/fs:(length(y)/fs); % plot wave form

subplot(5,1,1);plot(t,y);

title('Waveform');

window\_length = frame\_size \* fs;

sample\_shift = frame\_shift\*fs;

sum1 = 0;

energy = 0;

w = window(window\_type,window\_length);

jj=1;

for i = 1:(floor((length(y))/sample\_shift)-ceil(window\_length/sample\_shift)) % for setting the window size in short term

for j = (((i-1)\*sample\_shift)+1):(((i-1)\*sample\_shift)+window\_length)

y(j) = y(j)\*w(jj); %calculate the energy

jj = jj + 1;

yy = y(j) \* y(j);

sum1 = sum1 + yy;

end

energy(i) = sum1;

sum1 = 0;jj = 1;

end

w = 0;

c = energy;

%return c;

end

**zcr.m(function calculate zero-crossing rate)**

function [ c ] = zcr( signal,fs,frame\_size,frame\_shift,window\_type )

y = signal;

frame\_size = frame\_size/1000;

frame\_shift = frame\_shift/1000;

window\_length = frame\_size \* fs;

sample\_shift = frame\_shift\*fs;

sum1 = 0;

zcr = 0;

w = window(window\_type,window\_length);

jj=1;

for i = 1:(floor((length(y))/sample\_shift)-ceil(window\_length/sample\_shift))% for setting the window size in short term

y(((i-1)\*sample\_shift)+1) = y(((i-1)\*sample\_shift)+1)\*w(jj);

jj=jj+1;

for j = (((i-1)\*sample\_shift)+2):(((i-1)\*sample\_shift)+window\_length)

y(j) = y(j)\*w(jj); % calculate the zero-crossing rate

jj = jj + 1;

yy = y(j) \* y(j-1);

if(yy<0)

sum1 = sum1 + 1;

end

end

zcr(i) = sum1 / (2\*window\_length);

sum1 = 0;jj = 1;

end

w = 0;

c = zcr;

%return c;

end

**程式碼解說 :**

**Waveform :**

在讀進音檔時，把資料存在變數，然後再將其與時間一起畫出來

**Short term energy.m**

我設定frame size和 frame shift各為20ms&10ms，而頻率為44100Hz，也就代表在一個frame裡面會有882個樣點，而frame shift為441個

然後藉由上面的設定所的得到的樣本數，來計算每個frame的short term energy，之後再將其畫出來

**Zcr.m :**

和計算能量的方式一樣，也事先設定好frame size 和 frame shift後，算出各個frame所得到的zero crossing rate，再將其畫出來

**Pitch contour :**

方法和前兩個很類似，先算出各個frame的autocorrelation之後，然後災挑出各個frame裡最大的peak，並將其畫出來，最後就會得到pitch contour

**End-point :**

我偵測end-point的方法是只單純去看energy的大小，而沒有去看zero-crossing rate，但這樣的問題在於會沒有辦法判斷氣音，至於我偵測能量則是藉由short-term energy所得到的資料來計算其平均值及variance，然後藉由這樣去推算出其起點及終點

**Result :**

