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,windo
w_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

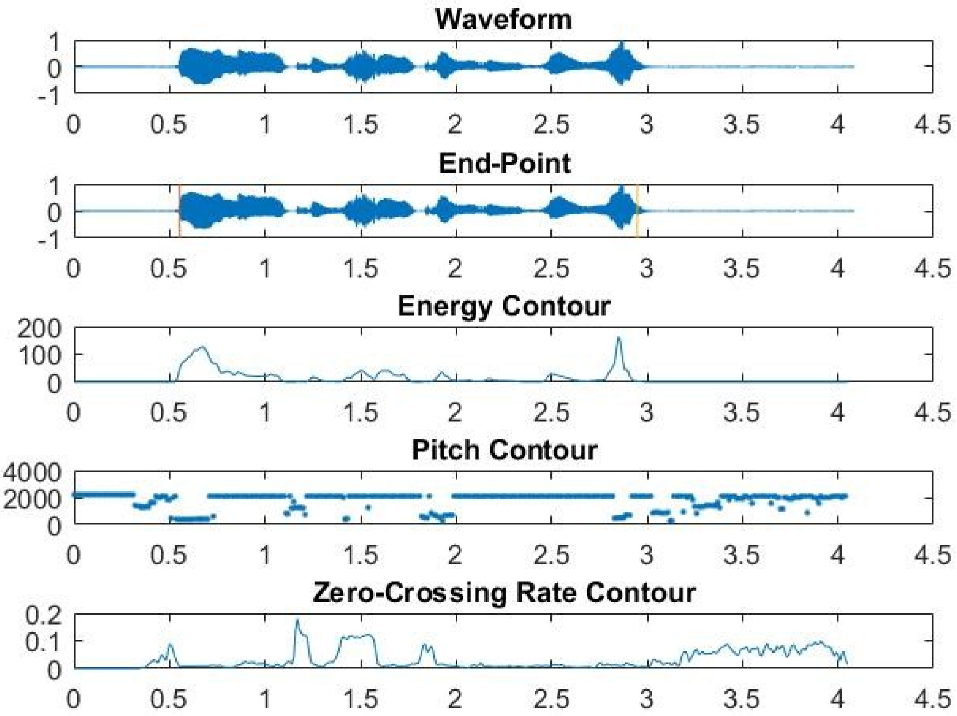
Pitch contour：

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：


Waveform
1
0
-1
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5
End-Point
1
0
-1
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5
Energy Contour
200
100
0
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5
Pitch Contour
4000
2000
0
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5
Zero-Crossing Rate Contour
0.2
0.1
0
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5