SIGNALS AND SYSTEMS LAB-PROJECT

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Problem Statement:

To detect applause in a given sound sample using decay factor and first local minimum values of the autocorrelation function of the signal.

1) CODE:

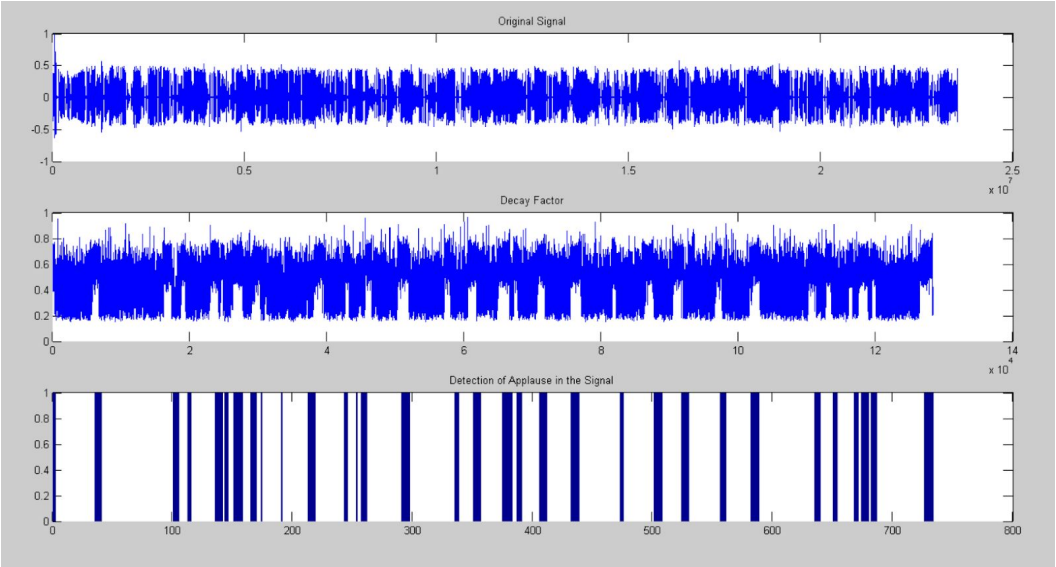
```
clc;
close all;
clear all;
S = wavread('b1.wav');
S = S(1:23552000,1);          %converting into mono
l=3;
for k=1:(length(S)-1)         %applying moving average
    M=S(k:k+1);
    S(floor(l/2)+k) = mean(M);
end
S = S - mean(S);
Max = max(abs(S));
S=S./Max;                     %Normalising
i=0;
E1=0;E2=0;S1=[];
Nsamp1 = 16000*2;

while i*Nsamp1<length(S)
    s1 = S(i*Nsamp1+1:(i+1)*Nsamp1);
    ds = s1.^2;
    E1 = sum(ds);
    if(E1>0.3)
        S1 =[S1 i*Nsamp1+1];
    end
    E=0;
    i=i+1;
end
Nsamp2 = 16*16;
Olap = 128;
Appct=0;
AppCtAr=[];RArr=[];
for q=1:length(S1)
    r=S1(q);
    while r<S1(q)+Nsamp1-Olap-1
        S2 = S(r:r+Nsamp2-1);
        DS = S2.^2;
        E2 = sum(DS);
        if(E2>0.01)
            R=0;
             w=hamming(Nsamp2);
             AutCor=autocorr(S2,Nsamp2-1);
```

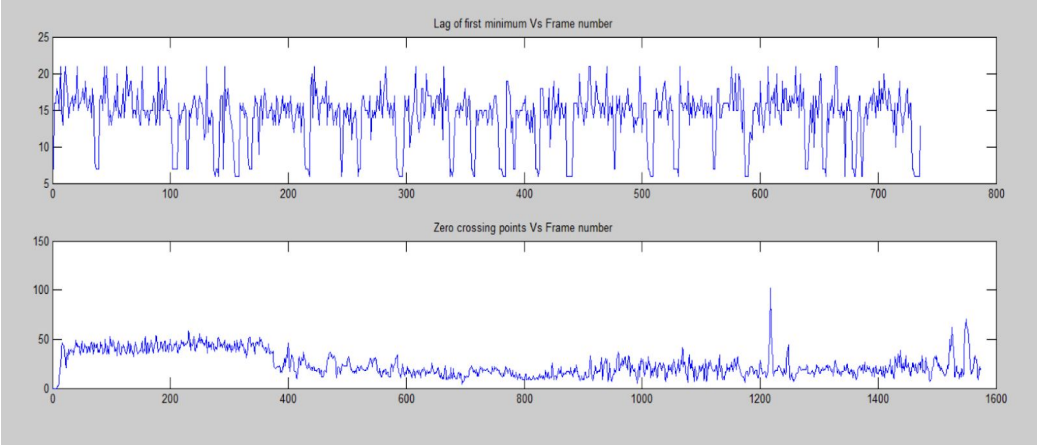
```
            AuC=AutCor(1:16);
            R = (sum(AuC.^2))/(sum(AutCor.^2));      %Finding decay factor
            RArr = [RArr R];
            if R > 0.6 && R < 0.8
               Appct = Appct + 1;
            end
        end
      r = r + Olap;
    end
    AppCtAr = [AppCtAr Appct];
    Appct = 0;
end
%plot(AppCtAr);
ApplauseCnt = zeros(1,length(AppCtAr));
for i=1:length(AppCtAr)
    if AppCtAr(i)>40
        ApplauseCnt(i)=1;
    end
end

i=0;Minim=[];
Nsamp3 = 32000;
while i*Nsamp3<length(S)
        T=autocorr(S(i*Nsamp3+1:(i+1)*Nsamp3));
        [mini,minId] = min(T);
        Minim = [Minim minId];
        i = i + 1;
end
zcp = zc(S);
figure;subplot(3,1,1);plot(S);title('Original Signal');
subplot(3,1,2);plot(RArr);title('Decay Factor');
subplot(3,1,3);bar(ApplauseCnt);title('Detection of Applause in the Signal');
figure;
subplot(3,1,1);plot(Minim);title('First local minimum Vs Frame number');
subplot(3,1,2);plot(zcp);title('Zero crossing points Vs Frame number');

------------ZERO CROSSING POINTS FUNCTION:-------------------------

function l = zc(x)
l=[];
n=0;
for i=1:127:200000
    for j=i:(i+255)
    if(x(j)*x(j+1)<0)    %checking the zero crossing points
        n=n+1;
    end
    end
    l=[l n];
    n=0;
end
end
```

2) ALGORITHM:

1) The sample sound is read using ‘wav read’ function.
2) It is then converted into mono-syllable.
3) Then moving average is applied to filter the noise and smoothen the signal.
4) The sample is then normalized to scale the heterogeneous set of data.
5) Next, the signal is divided into frames of 32000 samples each and Energy of each frame is calculated.
6) If the Energy is less than 0.3, that particular frame is considered as silence. The first index of the frames whose energy is greater than 0.3 is stored in array S1.
7) Next, the signal which are not considered as silence are again divided into frames of 256 samples each with an overlap of 128 and energy of each frame is calculated.
8) If the frame energy is greater than 0.1, auto correlation function and decay factor of the frame is calculated.
9) Decay factor is the ratio of energy in first L values of autocorrelation function to the total energy in auto correlation function.
10) If the value of decay factor lies in between 0.6 and 0.8, then applause count in that frame is increased.
11) All the applause counts are stored in an array ‘AppCtAr’.
12) If the number of applause counts are greater than 40, then it is prominent applause and thus stored in another array ‘ApplauseCnt’.
13) This is plotted in a bar graph to find the positions of applause in the signal.
14) The signal is again divided into frames of 32000 samples. Auto correlation function and zero crossing points are then found for each frame. The first local minimum of the auto correlation function gives the lag of the first minimum in each frame.
15) If the lag of first minimum is in between 4 and 7, then it is detected as applause.
16) To detect the applause, all the 5 plots are plotted.
17) The original signal, decay factor and the positions of applause (calculated using decay factor) are plotted in one window.
18) The lag of first minimum and zero crossing points are plotted in another window.

3) RESULTS:





Workspace

Stack: Base | Select data to plot

Name	Value	Min	Max
AppCtAr	<1x733 double>	0	182
Appct	0	0	0
ApplauseCnt	<1x733 double>	0	1
AuC	<16x1 double>	-0.8910	1
AutCor	<256x1 double>	-0.8910	1
DS	<256x1 double>	1.2763...	7.9076...
E	0	0	0
E1	159.7852	159.78...	159.78...
E2	3.1556e-04	3.1556...	3.1556...
M	[-2.0740e-04;-2.7466e...	-2.746...	-2.074...
Max	0.1263	0.1263	0.1263
Maxim	<1x736 double>	1	1
Minim	<1x736 double>	6	21
Nsamp1	32000	32000	32000
Nsamp2	256	256	256
Nsamp3	32000	32000	32000
Olap	128	128	128
R	0.2116	0.2116	0.2116
RArr	<1x128270 double>	0.1478	0.9616
S	<23552000x1 double>	<Too ...	<Too ...
S1	<1x733 double>	1	23520...
S2	<256x1 double>	-0.0028	0.0024
T	<21x1 double>	-0.8294	1
ds	<32000x1 double>	9.0901...	0.1994
i	736	736	736
k	23551999	23551...	23551...
l	3	3	3
maxId	1	1	1
maxi	1	1	1
minId	13	13	13
mini	-0.8294	-0.8294	-0.8294
q	733	733	733
r	23551873	23551...	23551...
s1	<32000x1 double>	-0.3780	0.4465
w	<256x1 double>	0.0800	1.0000
zcp	<1x1575 double>	0	102

4) OBSERVATIONS:

- By using the decay factor, we could detect the applause in a given sound sample. If the decay factor is in between 0.6 and 0.8, then that corresponding frame sample is identified as applause.
- The lag of first minimum of the autocorrelation function of the sample is also used to detect applause. If its value is between 4-7, then the corresponding frame sample is identified as applause.
- The frame at which the applause is detected by the above two methods are found to coincide.