BIRD SOUND CORRELATION USING MATLAB

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ECE 1004 – SIGNALS AND SYSTEMS

Abstract

In this project, we have examined the possibility of identifying species of birds from the sounds they produce through signal processing using MATLAB software. We also want to achieve a success rate of about 90% in a noise free environment

Introduction

For the project, a basic flow of data in a particular sequence is required to classify the result. The sequence consists of 3 parts:

1. Checking the variation of a particular signal over time (segmentation method).

2. Distinguishing feature for classification: Every signal must have a particular feature that distinguishes it from the others, a unique pattern or frequency.

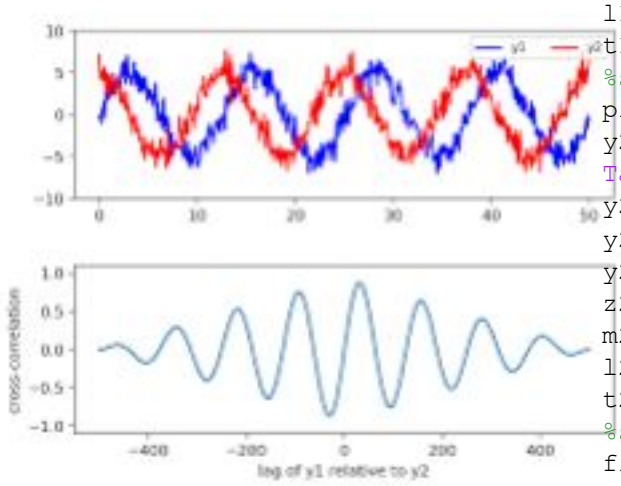
3. Combine and objectify: the final task is to access all the information and present it as a desired, combined output.

Design Aspects/Methodology

Various species of birds and animals have unique calls. These calls are distinct based on inflection, length, and context, meaning the same bird may have more than one call. A device that would analyse the signal and identify the animal based on the animal call could be of tremendous help to a scientist. This project proposed the development of this device using signal processing and embedded design. The first task was to find or create a database of high-quality calls to use for identification. Using this database, the team compared various features of calls of a certain species and ascertained the features which distinguish that species from other species. Using these features, a recorded call was identifiable as a species of animals.

Methodology

1. ***CROSS-CORRELATON:*** A signal processing technique we utilized was cross-correlation. Cross correlation is a measure of similarity of two waveforms, also known as a sliding dot product or inner product. Cross-correlation involves shifting one signal over another signal and looking for matches. It is similar to the convolution of two functions but instead of reversing a signal before multiplying and shifting it, correlation only involves multiplying and shifting (Cross-correlation). Cross correlation allowed comparison of a given call with the database of calls. The calls with the highest correlation in the time and frequency domains are the most likely matches.



2. Wavelet Transform for Denoising Denoising is a process by which we reconstructed a signal from a noisy one, used in the case of a cuckoo bird. The wavelet transform performs a correlation analysis; therefore the output is expected to be maximal when the input signal most resembles the mother wavelet. If a signal has its energy concentrated in a small number of wavelet dimensions, its coefficients will be relatively large compared to any other signal or noise that its energy spread over a large number of coefficients. Wavelet denoising works for additive noise since wavelet transform is linear

MATLAB Code

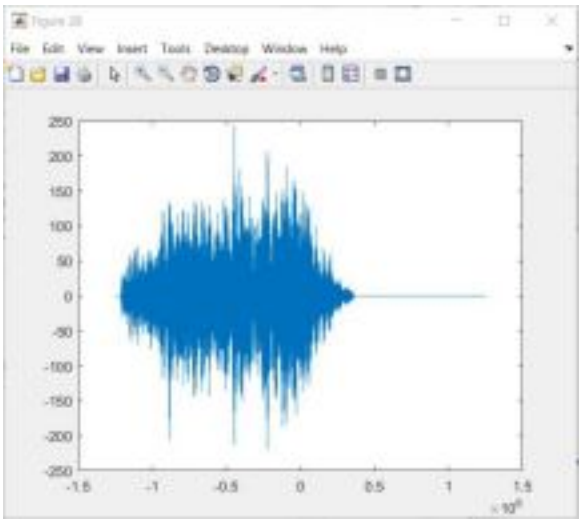
```
clc
clear all
[voice,fs]=audioread('Common
Pig.mp3');
%[voice,XN] =
wnoise('bumps',10,sqrt(6)); %xdMODWT =
wden(XN,'modwtsqtwolog','s','mln',4
,'sym4');
x=voice;
x=x';
x=x(1,:);
x=x';
y1=audioread('Bright-rumped
Attila.mp3');
y1=y1';
y1=y1(1,:);
y1=y1';
z1=xcorr(x,y1);
m1=max(z1);
l1=length(z1);
t1=-((l1-1)/2):1:((l1-1)/2); t1=t1';
%subplot(3,2,1);
plot(t1,z1);
y2=audioread('Dark-necked
Tailorbird.mp3');
y2=y2';
y2=y2(1,:);
y2=y2';
z2=xcorr(x,y2);
m2=max(z2);
l2=length(z2);
t2=-((l2-1)/2):1:((l2-1)/2); t2=t2';
%subplot(3,2,2);
figure
plot(t2,z2);
y3=audioread('Western Wood
Pewee.mp3');
y3=y3';
y3=y3(1,:);
y3=y3';
z3=xcorr(x,y3);
m3=max(z3);
l3=length(z3);
t3=-((l3-1)/2):1:((l3-1)/2); t3=t3';
%subplot(3,2,3);
figure
plot(t3,z3);
y4=audioread('Asian Brown
Flycatcher.mp3');
y4=y4';
y4=y4(1,:);
y4=y4';
z4=xcorr(x,y4);
m4=max(z4);
l4=length(z4);
t4=-((l4-1)/2):1:((l4-1)/2); t4=t4';
%subplot(3,2,4);
figure
plot(t4,z4);
y5=audioread('Narcissus
Flycatcher.mp3');
y5=y5';
y5=y5(1,:);
y5=y5';
z5=xcorr(x,y5);
m5=max(z5);
l5=length(z5);
t5=-((l5-1)/2):1:((l5-1)/2);
t5=t5';
%subplot(3,2,5);
figure
plot(t5,z5);
y6=audioread('Alder
Flycatcher.mp3');
```

```
y6=y6';
y6=y6(1,:);
y6=y6';
z6=xcorr(x,y6);
m6=max(z6);
l6=length(z6);
t6=-((l6-1)/2):1:((l6-1)/2);
t6=t6';
%subplot(3,2,5);
figure
plot(t6,z6);
y7=audioread('American
Woodcock.mp3');
y7=y7';
y7=y7(1,:);
y7=y7';
z7=xcorr(x,y7);
m7=max(z7);
l7=length(z7);
t7=-((l7-1)/2):1:((l7-1)/2);
t7=t7';
%subplot(3,2,5);
figure
plot(t7,z7);

y8=audioread('Blood Pheasant.mp3');
y8=y8';
y8=y8(1,:);
y8=y8';
z8=xcorr(x,y8);
m8=max(z8);
l8=length(z8);
t8=-((l8-1)/2):1:((l8-1)/2);
t8=t8';
%subplot(3,2,5);
figure
plot(t8,z8);

y9=audioread('Common Loon.mp3');
y9=y9';
y9=y9(1,:);
y9=y9';
z9=xcorr(x,y9);
m9=max(z9);
l9=length(z9);
t9=-((l9-1)/2):1:((l9-1)/2);
t9=t9';
    %subplot(3,2,5);
    figure
    plot(t9,z9);

    y10=audioread('Connecticut
    Warbler.mp3');
    y10=y10';
    y10=y10(1,:);
    y10=y10';
    z10=xcorr(x,y10);
    m10=max(z10);
    l10=length(z10);
    t10=-((l10-1)/2):1:((l10-1)/2);
    t10=t10';
    %subplot(3,2,5);
    figure
    plot(t10,z10);

    y11=audioread('Large-footed
    Finch.mp3');
    y11=y11';
    y11=y11(1,:);
    y11=y11';
    z11=xcorr(x,y11);
    m11=max(z11);
    l11=length(z11);
    t11=-((l11-1)/2):1:((l11-1)/2);
    t11=t11';
    %subplot(3,2,5);
    figure
    plot(t11,z11);

    y12=audioread('Lincolns
    Sparrow.mp3');
    y12=y12';
    y12=y12(1,:);
    y12=y12';
    z12=xcorr(x,y12);
    m12=max(z12);
    l12=length(z12);
    t12=-((l12-1)/2):1:((l12-1)/2);
    t12=t12';
    %subplot(3,2,5);
    figure
    plot(t12,z12);

    y13=audioread('Says Phoebe.mp3');
    y13=y13';
    y13=y13(1,:);
    y13=y13';
    z13=xcorr(x,y13);
    m13=max(z13);
    l13=length(z13);
    t13=-((l13-1)/2):1:((l13-1)/2);
    t13=t13';
    %subplot(3,2,5);
    figure
plot(t13,z13);

y14=audioread('Smiths
Longspur.mp3');
y14=y14';
y14=y14(1,:);
y14=y14';
z14=xcorr(x,y14);
```

```
m14=max(z14);
l14=length(z14);
t14=-((l14-1)/2):1:((l14-1)/2);
t14=t14';
%subplot(3,2,5);
figure
plot(t14,z14);

y15=audioread('Tataupa
Tinamou.mp3');
y15=y15';
y15=y15(1,:);
y15=y15';
z15=xcorr(x,y15);
m15=max(z15);
l15=length(z15);
t15=-((l15-1)/2):1:((l15-1)/2);
t15=t15';
%subplot(3,2,5);
figure
plot(t15,z15);

y16=audioread('Trumpeter
Swan.mp3');
y16=y16';
y16=y16(1,:);
y16=y16';
z16=xcorr(x,y16);
m16=max(z16);
l16=length(z16);
t16=-((l16-1)/2):1:((l16-1)/2);
t16=t16';
%subplot(3,2,5);
figure
plot(t16,z16);

y17=audioread('Veery Catharus
fuscescens.mp3');
y17=y17';
y17=y17(1,:);
y17=y17';
z17=xcorr(x,y17);
m17=max(z17);
l17=length(z17);
t17=-((l17-1)/2):1:((l17-1)/2);
t17=t17';
%subplot(3,2,5);
figure
plot(t17,z17);

    y18=audioread('White-crowned
    Sparrow.mp3');
    y18=y18';
    y18=y18(1,:);
    y18=y18';
    z18=xcorr(x,y18);
    m18=max(z18);
    l18=length(z18);
    t18=-((l18-1)/2):1:((l18-1)/2);
    t18=t18';
    %subplot(3,2,5);
    figure
    plot(t18,z18);

    y19=audioread('White-winged
    Crossbill.mp3');
    y19=y19';
    y19=y19(1,:);
    y19=y19';
    z19=xcorr(x,y19);
    m19=max(z19);
    l19=length(z19);
    t19=-((l19-1)/2):1:((l19-1)/2);
    t19=t19';
    %subplot(3,2,5);
    figure
    plot(t19,z19);

    y20=audioread('Winter Wren.mp3');
    y20=y20';
    y20=y20(1,:);
    y20=y20';
    z20=xcorr(x,y20);
    m20=max(z20);
    l20=length(z20);
    t20=-((l20-1)/2):1:((l20-1)/2);
    t20=t20';
    %subplot(3,2,5);
    figure
    plot(t20,z20);

    y21=audioread('Horse.mp3');
    y21=y21';
    y21=y21(1,:);
    y21=y21';
    z21=xcorr(x,y21);
    m21=max(z21);
    l21=length(z21);
    t21=-((l21-1)/2):1:((l21-1)/2);
    t21=t21';
    %subplot(3,2,5);
    figure
    plot(t21,z21);

    y22=audioread('Asiatic Lion.mp3');
    y22=y22';
y22=y22(1,:);
y22=y22';
z22=xcorr(x,y22);
m22=max(z22);
l22=length(z22);
t22=-((l22-1)/2):1:((l22-1)/2);
```

```
t22=t22';
%subplot(3,2,5);
figure
plot(t22,z22);

y23=audioread('North American
Grizzly Bear.mp3');
y23=y23';
y23=y23(1,:);
y23=y23';
z23=xcorr(x,y23);
m23=max(z23);
l23=length(z23);
t23=-((l23-1)/2):1:((l23-1)/2);
t23=t23';
%subplot(3,2,5);
figure
plot(t23,z23);

y24=audioread('Common Pig.mp3');
y24=y24';
y24=y24(1,:);
y24=y24';
z24=xcorr(x,y24);
m24=max(z24);
l24=length(z24);
t24=-((l24-1)/2):1:((l24-1)/2);
t24=t24';
%subplot(3,2,5);
figure
plot(t24,z24);

y25=audioread('African
Hippopotamus.mp3');
y25=y25';
y25=y25(1,:);
y25=y25';
z25=xcorr(x,y25);
m25=max(z25);
l25=length(z25);
t25=-((l25-1)/2):1:((l25-1)/2);
t25=t25';
%subplot(3,2,5);
figure
plot(t25,z25);


m26=300;
a=[m1 m2 m3 m4 m5 m6 m7 m8 m9 m10
m11 m12 m13 m14 m14 m15 m16 m17 m18
m19 m20 m21 m22 m23 m24 m25 m26];
   m=max(a);
   h=audioread('allow.wav');
   if m<=m1
    soundsc(audioread('Bright
   rumped Attila.mp3'),50000)
    soundsc(h,50000)
    test=('Bright-rumped
   Attila');
    sprintf('Bright-rumped
   Attila')
   elseif m<=m2
    soundsc(audioread('Dark-necked
   Tailorbird.mp3'),50000)
    soundsc(h,50000)
    test=('Dark-necked
   Tailorbird');
    sprintf('Dark-necked
   Tailorbird')
   elseif m<=m3
    soundsc(audioread('Western Wood
   Pewee.mp3'),50000)
    soundsc(h,50000)
    test=('Western Wood
   Pewee');
   elseif m<=m4
    soundsc(audioread('Asian Brown
   Flycatcher.mp3'),50000)
    soundsc(h,50000)
    test=('Asian Brown
   Flycatcher');
   elseif m<=m5
    soundsc(audioread('Narcissus
   Flycatcher.mp3'),50000)
    soundsc(h,50000)
    test=('Narcissus
   Flycatcher');
   elseif m<=m6
    soundsc(audioread('Alder
   Flycatcher.mp3.mp3'),50000)
    soundsc(h,50000)
    test=('Alder Flycatcher'); elseif
   m<=m7
    soundsc(audioread('American
   Woodcock.mp3'),50000)
    soundsc(h,50000)
    test=('American Woodcock'); elseif
   m<=m8
    soundsc(audioread('Blood
   Pheasant.mp3'),50000)
    soundsc(h,50000)
    test=('Blood Pheasant'); elseif
   m<=m9
    soundsc(audioread('Common
   Loon.mp3'),50000)
    soundsc(h,50000)
    test=('Common Loon'); elseif
   m<=m10
 soundsc(audioread('Connecticut
Warbler.mp3'),50000)
 soundsc(h,50000)
 test=('Connecticut
```

```
Warbler');
elseif m<=m11
 soundsc(audioread('Large-footed
Finch.mp3'),50000)
 soundsc(h,50000)
 test=('Large-footed
Finch');
elseif m<=m12
 soundsc(audioread('Lincolns
Sparrow.mp3'),50000)
 soundsc(h,50000)
 test=('Lincolns Sparrow'); elseif
m<=m13
 soundsc(audioread('Says
Phoebe.mp3'),50000)
 soundsc(h,50000)
 test=('Says Phoebe'); elseif
m<=m14
 soundsc(audioread('Smiths
Longspur.mp3'),50000)
 soundsc(h,50000)
 test=('Smiths Longspur'); elseif
m<=m15
 soundsc(audioread('Tataupa
Tinamou.mp3'),50000)
 soundsc(h,50000)
 test=('Tataupa Tinamou'); elseif
m<=m16
 soundsc(audioread('Trumpeter
Swan.mp3'),50000)
 soundsc(h,50000)
 test=('Trumpeter Swan'); elseif
m<=m17
 soundsc(audioread('Veery
Catharus fuscescens.mp3'),50000)
soundsc(h,50000)
 test=('Veery Catharus
fuscescens');
elseif m<=m18
 soundsc(audioread('Western Wood
Pewee.mp3'),50000)
 soundsc(h,50000)
 test=('Western Wood
Pewee');
elseif m<=m19
 soundsc(audioread('White-winged
```



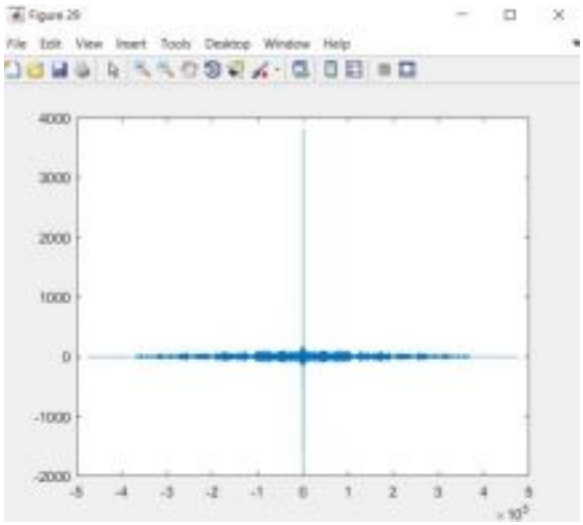
```
Crossbill.mp3'),50000)
 soundsc(h,50000)
 test=('White-winged
Crossbill');
elseif m<=m20
 soundsc(audioread('Winter
Wren.mp3'),50000)
     soundsc(h,50000)
     test=('Winter Wren');  elseif
    m<=m21

    soundsc(audioread('Horse.mp3'),5000
    0)
     soundsc(h,50000)
     test=('Horse');
    elseif m<=m22
     soundsc(audioread('Asiatic
    Lion.mp3'),50000)
     soundsc(h,50000)
     test=('Asiatic Lion');  elseif
    m<=m23
     soundsc(audioread('North
    American Grizzly Bear.mp3'),50000)
    soundsc(h,50000)
     test=('North American
    Grizzly Bear');
    elseif m<=m24
     soundsc(audioread('Common
    Pig.mp3'),50000)
     soundsc(h,50000)
     test=('Common Pig');
    disp('Common Pig'); elseif
    m<=m25
     soundsc(audioread('African
    Hippopotamus.mp3'),50000)
     soundsc(h,50000)
     test=('African
    Hippopotamus');
    else

    soundsc(audioread('nomatch.wma'),50
    000)
     soundsc(h,50000)
     test=('no match');

    end
```

Graphs of cross correlation. The one with the highest maxima represents maximum correlation and therefore is the signal that is matched.

Denoising

```
rng default;
X='Samp 1.wav';
```

```
 [X,XN] =
wnoise('bumps',10,sqrt(6))
; subplot(211)
plot(X); title('Original
Signal');
AX = gca;
AX.YLim = [0 12];
subplot(212)
plot(XN); title('Noisy
Signal'); AX = gca;
AX.YLim = [0 12];

 xdMODWT =
```




```
wden(X,'modwtsqtwolog','s','mln
' ,4,'sym4');
figure;
plot(X,'r')
hold on;
plot(xdMODWT)
 legend('Original
Signal','Denoised
Signal','Location','NorthEastOu
t side')

axis tight;
hold off;
```

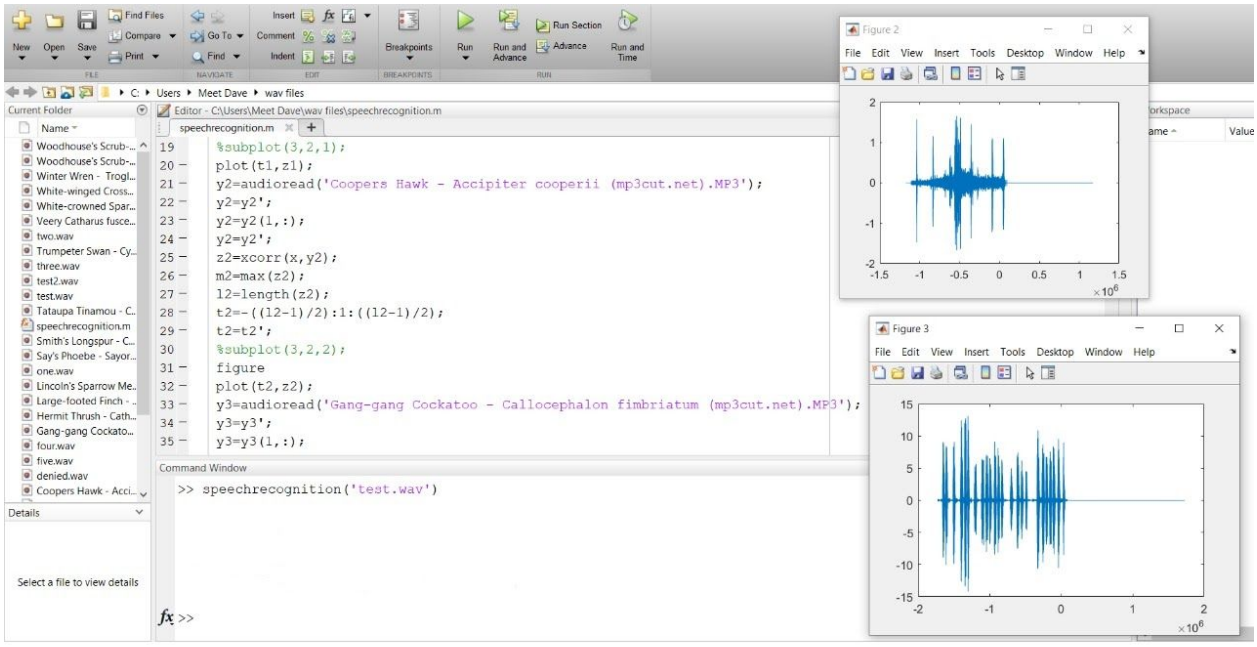


Figure 2
File Edit View Insert Tools Desktop Window Help
Figure 3
File Edit View Insert Tools Desktop Window Help
Editor - C:\Users\Meet Dave\wav files\speechrecognition.m
speechrecognition.m
%subplot(3,2,1);
plot(t1,z1);
y2=audioread('Coopers Hawk - Accipiter cooperii (mp3cut.net).MP3');
y2=y2';
y2=y2(1,:);
y2=y2';
z2=xcorr(x,y2);
m2=max(z2);
l2=length(z2);
t2=-((l2-1)/2):1:((l2-1)/2);
t2=t2';
%subplot(3,2,2);
figure
plot(t2,z2);
y3=audioread('Gang-gang Cockatoo - Callocephalon fimbriatum (mp3cut.net).MP3');
y3=y3';
y3=y3(1,:);
Command Window
>> speechrecognition('test.wav')
Select a file to view details

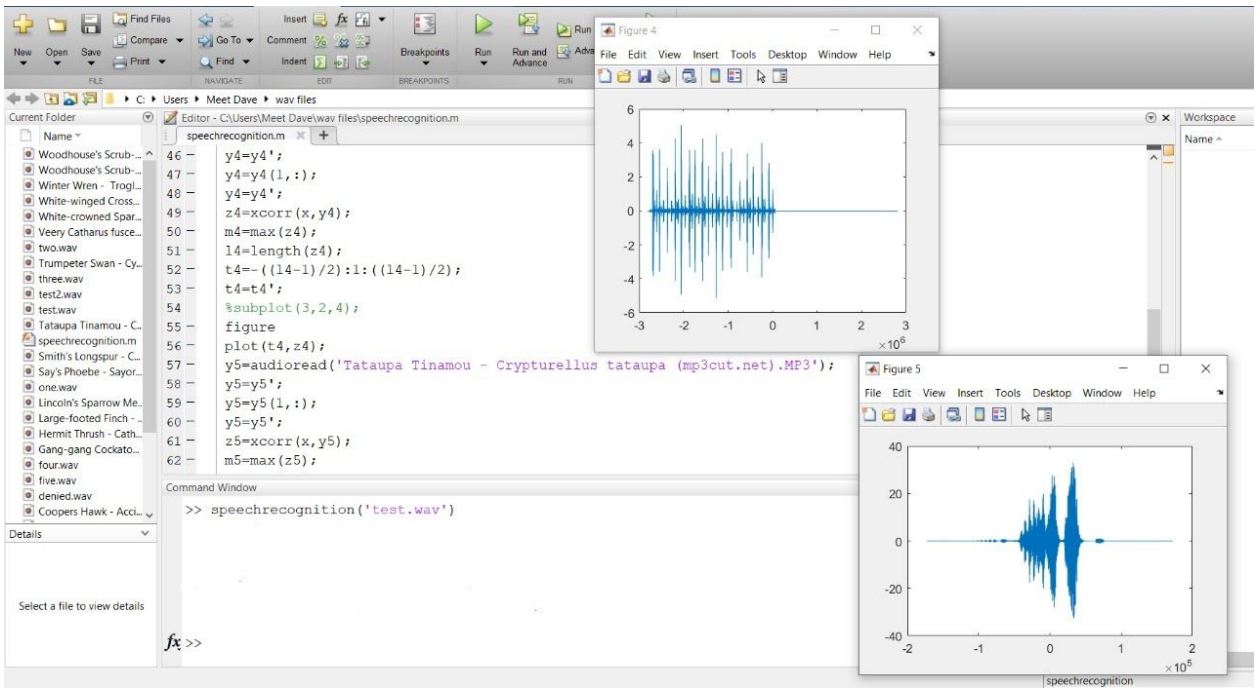
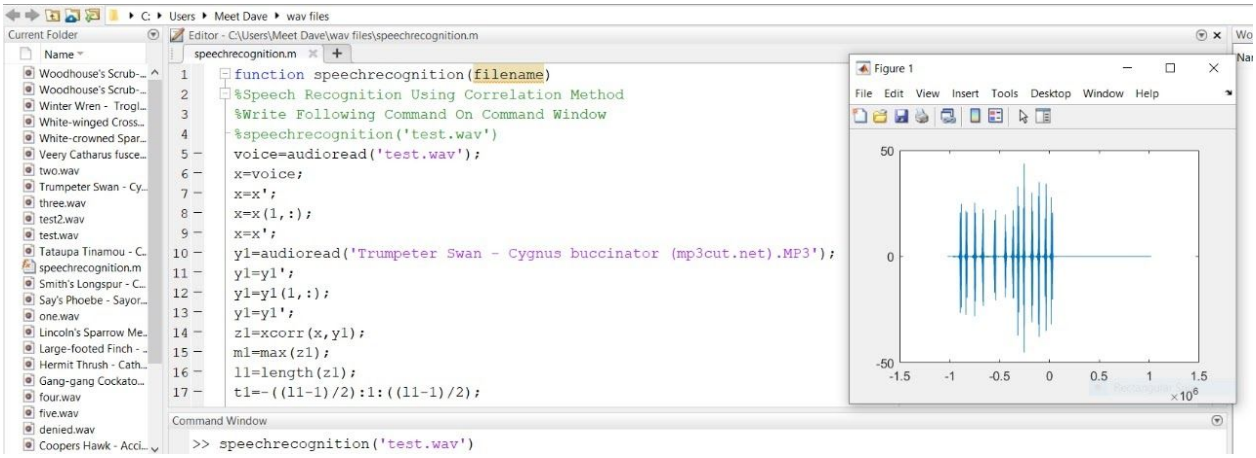
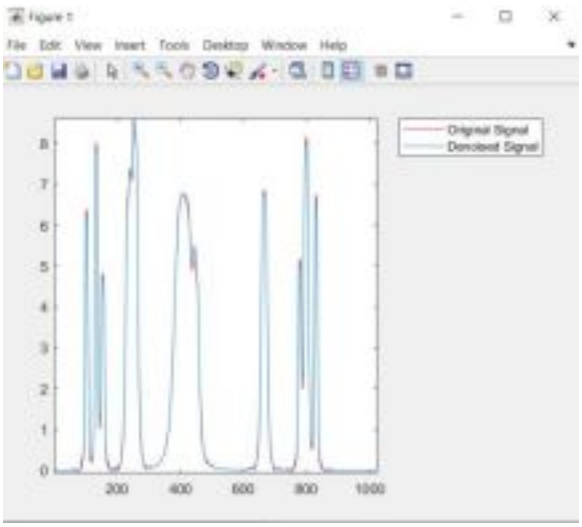


Figure 4
File Edit View Insert Tools Desktop Window Help
Figure 5
File Edit View Insert Tools Desktop Window Help
Editor - C:\Users\Meet Dave\wav files\speechrecognition.m
speechrecognition.m
y4=y4';
y4=y4(1,:);
y4=y4';
z4=xcorr(x,y4);
m4=max(z4);
l4=length(z4);
t4=-((l4-1)/2):1:((l4-1)/2);
t4=t4';
%subplot(3,2,4);
figure
plot(t4,z4);
y5=audioread('Tataupa Tinamou - Crypturellus tataupa (mp3cut.net).MP3');
y5=y5';
y5=y5(1,:);
y5=y5';
z5=xcorr(x,y5);
m5=max(z5);
Command Window
>> speechrecognition('test.wav')
Select a file to view details
speechrecognition



Signal without noise and added Gaussian noise.



Denoised signal.

Conclusion

The team checked 25 signals of different and animals having 1 signals and almost 90% of the times the required output was obtained. Also, we checked for noise reduction and implementation of inputing the sound through the system . At the end of this project, we gained a working knowledge of the correlation concept and the wavelet transform method to denoise.