ISSN : 0974 - 7435 Volume 10 Issue 23

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(23), 2014 [14045-14051]

Fish voice spectrum analysis and research

Shen Weixing[1], Hu Qingsong[1]*, Li Chengxin[2], Shentu Jikang[3]
[1]College of Engineering Science & Technology, Shanghai Ocean University, Shanghai 201306, (CHINA)
[2]Shanghai Haifeng Aquaculture Co. Ltd., Jiangsu 224000, (CHINA)
[3]Ningbo institute of Marine and fishery, Zhejiang 315010, (CHINA)
E-mail: 1961707215@qq.com, qshu@shou.edu.cn

ABSTRACT

Fisheries acoustic has become an important technique to estimate fishery resource and monitor biological system. The study of fish voice and its application have a profound meaning in managing fishery resource. The fish in different region have different voices feathers, and the fish under different condition are more sensible to different voice. The study about the audio under what kind of frequency attracts fish most has a great value. In this paper a program based on the Matlab software is proposed and the program intends to analyze time domain and frequency of different fish voice. By program, the paper analyzes the features of fish under different region and time domain which is presented by the data map output by Matlab. The statistics present the features and differences between different fish voice which is fundamental in the classifiable analysis and application of fish voice.

KEYWORDS

Fish sound; Time domain; Frequency domain; Region; Classificationl.

INTRODUCTION

The sound generating principle of fish is the foundation in analyzing fish voice and different principles can generate different sounding features. This chapter will focus on the analysis of sound generating principle.

Generation of fish sound

Only a few kinds of fish have special vocal organs. For instance, crisp grass carp in Heilongjiang province of China can generate a loud squeak sound because the first pectoral fin rays can rub against each other. Most of the fish don't have special vocal organs but they can use other organs on his body to generate sound. For example, some generate sound by curving their vertebra and other skeleton connected with vertebra, some generate sound by the friction of their dorsal fin, pectoral, and auspicious fin, others make sound by their swim bladder which is the major vocal organ in its body[1].

There are many kinds of swim bladder shapes, such as heart-shaped, pyriform, and diamond. They don't only differ in size but also in structures. Some have space and bulge inside, others have nothing inside. Thus they can make different voices. Meanwhile, the difference on function and pattern of swim bladder can result in different sounds. Fish can rap swim bladder by using its muscle, or clash it like play the fiddle, or squash air in half swim bladder's into another half. In addition, swim bladder can not only make sound by itself, but also magnify other sound in the body.

Species of fish sound

Mainly there are three kinds of fish sound, which are presented as follows.

(1)Sound made by breathing. This is simple way to make voice. it refers to a kind of sound generated by air passing through the narrow place when the fish breath which is used by many freshwater fishes. For example, as a main commercial fish in china, crap can make breathe sound or small sound when it is lifted from the water.

(2)Sound made by friction. It refers to the sound made by friction between fin spine, tooth, hyomandibular bone and gill cover or other hard parts in a fish skeleton which is common among fishes. That's take yellow catfish, a kind of small carnivorous fish among freshwater fishes for example. Yellow catfish is famous for making sound by the friction of its fin spine, which sounds like honk, rolling. Another example is ocean sunfish can make some rough sound by the friction between its dens pharyngeala.

(3)Sound made by vibration of swim bladder and connected muscle. It refers to sound made by a complex sound generation progress. Lots kind of sheatfishes belongs to this kind of ways to generating sound. But the most famous fish which generates sound by this way is croakers which most of this kinds can generate sound and only a few can not generate sound. in some races only the male fish can generate sound, and in some others both the male and female fish can generate sound. They can generate different sounds and some can make very loud sound which sometimes can be heard in the deck such as the Johnius belengerii.

Background to conduct the research

The difference of sound generating principle leads to the difference on sound frequency which causes different sensitivity to different sound frequency. At the same time even the same kind of fish under different region and time have diiferent sound features. Matlab analysis on fish sound and its application will be highlighted in this paper.

Program on fish sound based on matlab

The audios in this research mostly can be found on the internet, which are put into the Matlab document that is the storage for sample audios. The program is as follows.

```
Program1
[y,Fs,bits]=wavread('audio.wav'); % output the signals, sampling rate and sampling digit.
y=y(:,1); %selecting the Mono to analyze
sigLength=length(y);
Y = fft(y,sigLength);
Pyy = Y.* conj(Y) / sigLength;
halflength=floor(sigLength/2);
f=Fs*(0:halflength)/sigLength;
figure;plot(f,Pyy(1:halflength+1));xlabel('Frequency(Hz)');
t=(0:sigLength-1)/Fs;
figure;plot(t,y);xlabel('Time(s)');
```

As for special audios Matlab shoud be used for finite-precision analysis. The program is as follows.

```
Program2 x=wavread('audio of fish.wav');
sound(x);
fs=100;N=128;
y=fft(x,N);
magy=abs(y);
f=(0:length(y)-1)'*fs/length(y);
subplot(221);plot(f,magy);
```

```
xlabel('frequency(Hz)');ylabel('Amplitude);
title('N=128(a)');grid
subplot(222);plot(f(1:N/2),magy(1:N/2));
xlabel('frequency(Hz)');ylabel('Amplitude ');
title('N=128(b)');grid
fs=100;N=1024;
y=fft(x,N);
magy=abs(y);
f=(0:length(y)-1)'*fs/length(y);
subplot(223);plot(f,magy);
xlabel('frequency(Hz)');ylabel('Amplitude');
title('N=1024(c)');grid
subplot(224);plot(f(1:N/2),magy(1:N/2));
xlabel('frequency(Hz)');ylabel('Amplitude ');
title('N=1024(d)');grid
```

SPECTRUM ANALYSIS AND REGULAR OF FISH SOUND

Audio analysis on different fishes

Audio on Giant salamander, Oyster toadfish and other varieties of fishes will be analyzed in this part.

(1)Giant Salamander

Giant salamander which scientific name is giant salamander, is the biggest amphibian existed in the world[2]. Program one is applied here to analyze it. Firstly using the program one and output the following oscillogram.

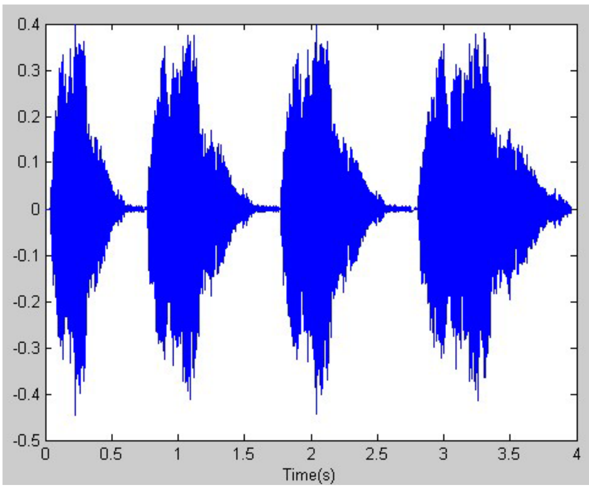

Figure 1 : Time domain

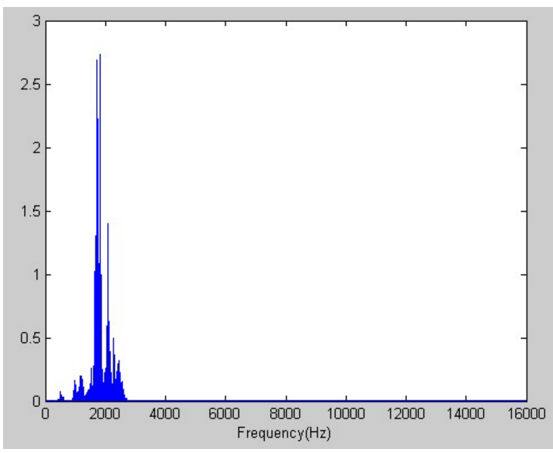

Figure 2 : Frequency domain

As is shown in Figure 1 and Figure 2, the sound of giant salamander contains the strongest energy around 2000Hz.

(2)Oyster Toadfish

Oyster toadfish comes from Milano and most of them live in Caribbean[3]. Program two is applied here to analyze it and output the oscillogram as follow.

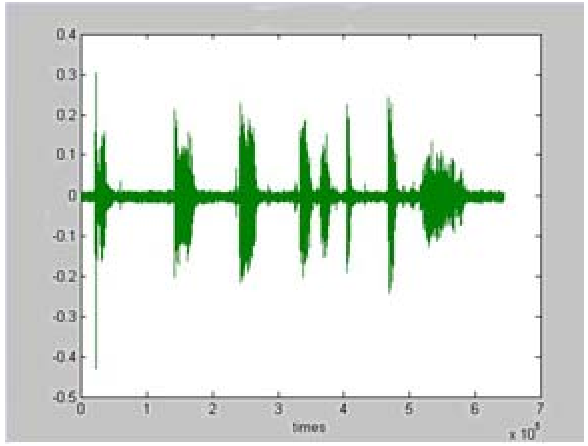

Figure 3 : Time domain oscillogram

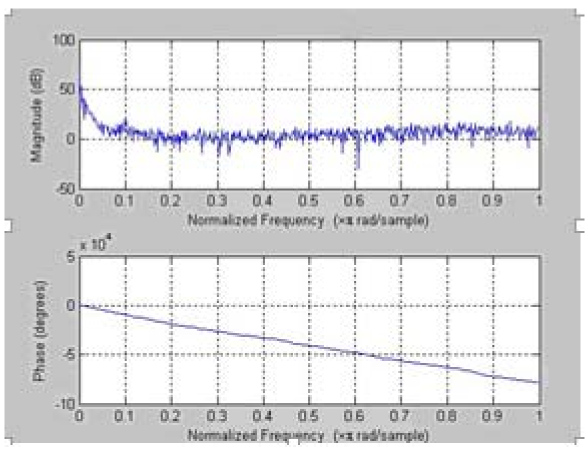

Figure 4 : Response diagram of frequency

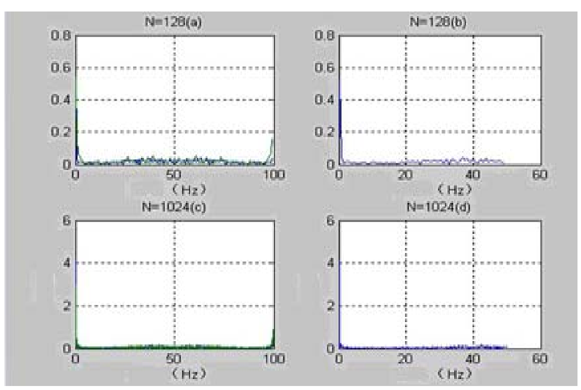

Figure 5 : Fixed-point analysis diagrams

Figure 3 is the time domain oscillogram of Oyster toadfish, Figure4 and Figure5 are the frequency domain oscillogram. From these three charts, it is clear that Pic.a and Pic.b in Chart.5 are N=128 pint frequency domain oscillogram and Pic.c and Pic.d are N=129 pint frequency domain oscillogram. Because the sampling frequency is f=100Hz, thus the frequency of Nyquist is 50Hz. Pic.a and Pic.c are frequency domain oscillogram from 0Hz to 100Hz, Pic.b and Pic.d are from 0Hz to 50Hz. Pic.a and Pic.c show that the whole frequency domain oscillogram is axial symmetric around Nyquist.

Therefore using FFT to analyze frequency spectrum of signals, as long as inspect the features of frequency 0 between Nyquist. After compared Pic.a with Pic.c, the size of amplitude is related with count N which the FFT selected. However if count N is largh enough, it will not affect the result of the study. It is obvious from the sheet on the visible spectrum that sinusoidal component is included in signal of 15Hz and 40Hz. If the length of the signal T=25.6s, that is x(n) is T/Ts=256 after sampling, the resolution of frequency is Hz[5]. Using that to inspect the influence of the length of N to DTFT.

(3)Other species

Program1 and Program2 are applied to analyze audios of other kind of fishes in this part. The result is as shown in list.1.

TABLE 1 : Data of audios of other kind of fishes

Date / Name	the peak of frequency/HZ	the peak of Time Domain/s
Giant salamander	2000	0.35
Oyster toadfish	400	0.3
ricefield eel	1200	0.9
catfish	900	0.8
butterfishes	2000	0.5
piranha	400	0.005
grouper	650	0.7
Stripe eel	350	0.9

From list.1 it is obvious that different kind of fishes can generate different kinds of audio. Giant salamander and butterfishes have the highest peak of frequency which is around 2000Hz among these audios. Stripe eel has the lowest peak of frequency that is 350Hz. The result can be analyzed and stimulated further in order to reach the best effect to attract fishes.

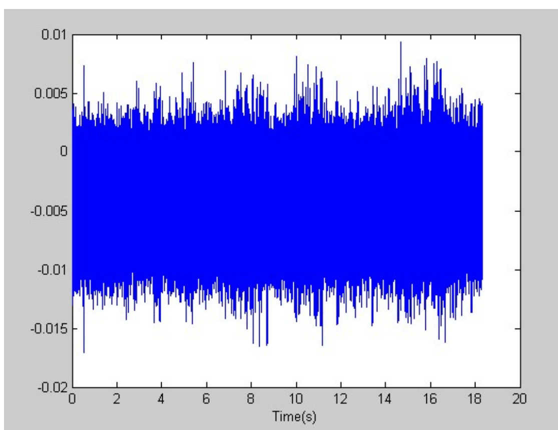

Figure 6 : Time domain oscillogram (North Carolina)

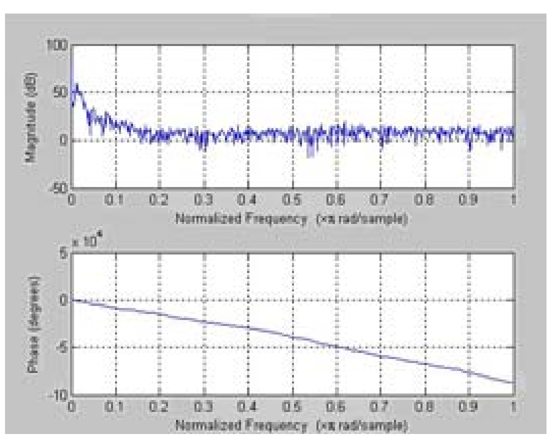

Figure 7 : Tesponse diagram on frequency

Audio analyses on same variety in different areas

Same kind of fish can generate different kinds of sound according to their different producing areas. For example drum fish which is called croaker, have more than 160 varieties[4]. They generally are demersal and predacity. Mostly they located coastal of warm and tropical oceans. The samples selected in this paper are respectively from North Carolina and Maryland in America.

(1)Program 2 is applied in analyzing the sample from North Carolina. Calling program and changing the audio address will output the oscillogram as follow.

(2)Program 2 is applied in analyzing the sample from Maryland. Calling program and changing the audio address will output the oscillogram as follow.

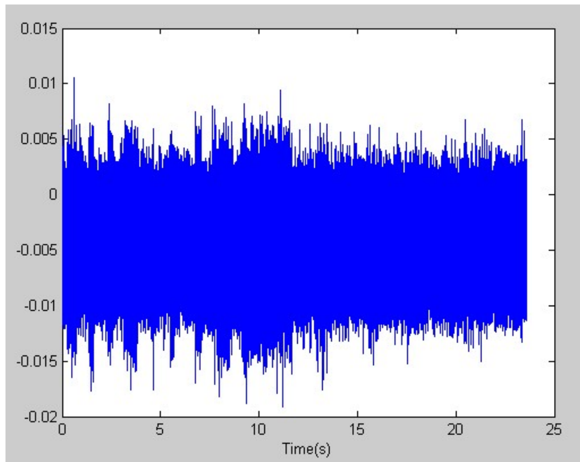

Figure 8 : Time domain oscillogram (Maryland)

CONCLUSIONS

In this paper, a program to analyze the fish sound is proposed. Different kinds of fish sounds are analyzed.From the data we can find out that even the same kind fish under different time domain, they may have different voice frequency which sounds no different to human ears, however, it can reflect through Matlab. Thus analysis by Matlab is the foundation and the priority among priorities for the whole program. It is clear that even if the same kind of fish in the same area can have different voice frequency after combining the data sheet with the data graph outputted by Matlab. Therefore, species region and growth period should be highlighted in the application of fish sounds.

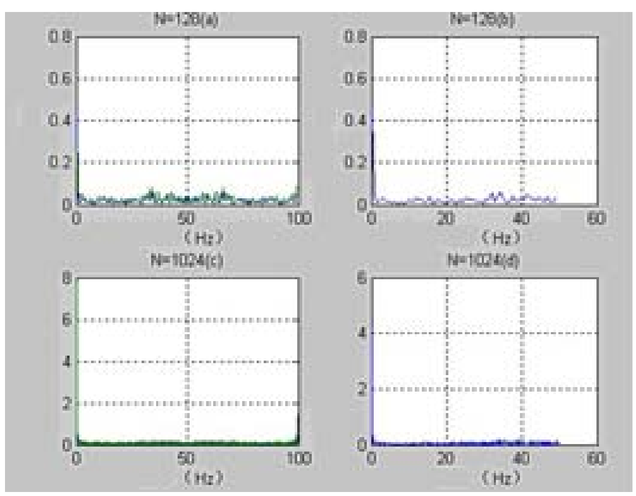

Figure 9 : Response diagram on frequency

Moreover compared with audio analysis from Narragansett experiment and North Carolina silver perch audio, the summary sheet on frequency of drum fish is concluded as shown in Fig 10. Through thesheet of data we can realize that even the same kind of fish under different conditions may have the different audio frequency. Thus marine ranching or fish domestication should be adjusted measures to local conditions and the sound need to be different in wavelength and amplitude for different regions.

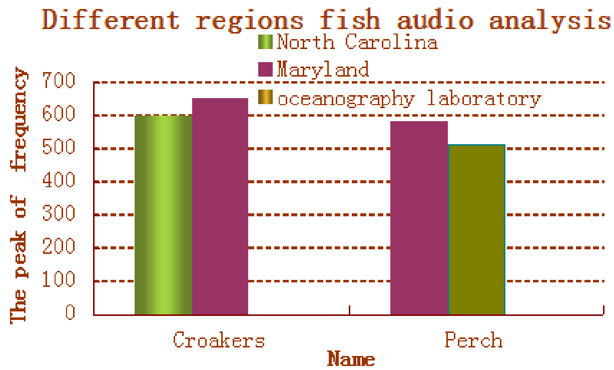

Figure 10 : Different regions fish audio analysis

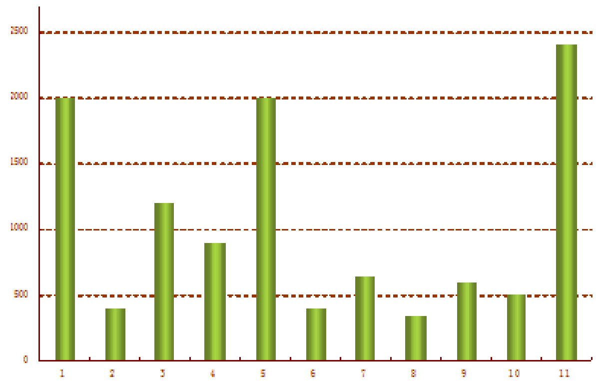

Figure 11 : The peak of frequency

The result of audio analysis above is concluded in Fig 11. In Figure11, 1.Giant salamander 2.piranha 3.ricefield eel 4.catfish 5.butterfishes 6.Oyster toadfish 7.grouper 8.Stripe eel 9.grouper(North Carolina)10.Perch(oceano-graphy laboratory) 11.haddock

ACKONWLEDGEMENTS

The authors acknowledge the support of Innovation Pr-ogram of Shanghai Municipal Education Commission (12YZ133), Shanghai Science and Technology Agriculture Promotion Project (2012-3-3), Ningbo Science & Technology Project (2013C11014) and Public Science and Technology Research Funds Projects of Agriculture (201303047). Qingsong Hu is the corresponding author of the paper and the contact email is qshu@shou.edu.cn.

REFERENCES

[1] Yun Zhi; Mysteries of fish sound, Life cycle of blue, **(2008)**.

[2] WangYiqiang, Huang Shijiao; Fish Physiology, The Science & Technology Press in Shanghai, 110-111 **(1990)**.

[3] Du Gonghuan, Zhu Zhemin, Gong Xiufen; Acoustics foundation, The college Press in Nanjing, 238-244 **(2001)**.

[4] Wang Mingdei; Research achievements of China's freshwater fishing gear and the future research direction, Journal of Fishery Sciences of China, **3(4)**, 118-123 **(1996)**.

[5] Rapp LM, B.L.Tolman; C.A.Koutz et a1.; Predisposing factors to light-induced photoreceptor cell, damage: retinal changes in maturing rats, Invest Ophthalmol Vis Sci., **51(2)**, 177-184 **(1990)**.