

A Comparative Study of Mongolian Folk Songs Based on the Breathing Signals of Physiological Mechanism

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Abstract— Through capturing the speech, chest and belly physiological signals of Mongolian folk short *The song of Wining* and Mongolian folk long *Rich and vast la shan*, this article designed and extracted related acoustic and physiological parameters. Taking breath cycle as an unit, this paper has analyzed chest and belly aspiration pattern of this folk song. Some conclusions were found: 1) The average breathing length of Mongolian folk long songs is longer than folk short songs; 2) The Breathing Signal's line of folk short songs is not smooth, and its boundaries between breathing unit is very fuzzy, its range is very large, and it has strong leap; The belly physiological signals of Mongolian folk long song is very obvious, Each boundaries between breathing unit is very clear, The breathing amplitude is very stable, and is not big; 3) Each breathing unit has a continuous period, the continuous period amplitude of Chest signals is large and the belly signals is small, That means singer is basically rely on the chest to breath in the process of singing, And the adjustment mechanism of the abdominal muscles is relatively weak; 4) About lasting duration, the trend of abdominal Lasting Duration signals of Mongolian folk short the songs and chest Lasting Duration signals is opposite. The results of this study provide physiological and acoustic methods for Mongolian folk song study and basic data for singing and protection as well.

Keywords-Mongolia folk long song; Mongolia folk short song ;Breathing signal; Physiological parameter.

I. INTRODUCTION

Mongolian folk song is the most elegant and the most typical Mongolian cultural style, and it is a display of Mongolian living style in the form of art, so we will expand human art treasure house on the study of Mongolian folk songs, Mongolian folk song can be divided into two forms: Mongolian folk short and Mongolian folk long. Mongolian folk long spreads in the pasturing area, while Mongolian folk short mainly distributes in YinShan and south of the Hinggan

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mountains area. Mongolian folk song was called "WuRiTuoDao" in the Mongolian, Which means long songs. Its characteristics are little lyrics but long durations, loud but still can be heard in distance, free in forms but slow in rhythm. It is suitable for telling stories as well as expressing emotions. The lyrics were usually divided into upper part and lower part, describing Mongolian history, culture, cultural customs, ethics, philosophy and artistic feelings along with its distinctive characteristics of nomadic culture and its unique form of singing. Hence it is also known as "living fossil of prairie music". It is also famous for its large and complex formal structures, loud tone, broad range, large capacity and rich emotional tension. The melody is long and relieving, open in artistic conception and rich in decoration: appoggiatura before and after appoggiatura, glide, echo and so on). Mongolian folk short was called "BaoGeNiDao" in the Mongolian, Obviously different with Mongolian folk long, Mongolian folk short is generally two lines, there is a rhyme every two or four sentence and the beats are fixed. Lyrics are simple, but not inflexible. Repetition of words is widely used. The length is short, tune is compact, bright rhythm is in order, range are relatively narrow. Mongolian folk short including ancient hunting songs, the modern short songs, narrative songs and part of the custom songs, sometimes accompanied with dance. The combination of narrative and lyrical is an obvious character.

At present the study of Mongolian folk songs in general, also is not very perfect, it was only confined to the surface research of the belcanto and song style, the study of its internal characteristics with systematic, scientific, in-depth way also is very lack. In this article, we choose The song of Wining and *Rich and vast la shan* as the object, extracting inspiratory phase duration and amplitude, expiratory phase duration and amplitude and slope physiological in each breathing unit, and make some analyses of them.

II. EXPERIMENT METHODS

A. The experimental materials and subjects

This experiment was mainly collected the breathing signals of Mongolian folk short The song of Wining and Mongolian folk long the song of Rich and vast la shan, in the process of recording the text, the choice of Pronunciation for respiratory characteristics analysis plays a fundamental role, so the requirements of pronunciation is much higher before data collection. General elderly singer is more appropriate. In the study, we has chosen two folk singers as pronounce.

TABLE I. THE SITUATION OF PRONUNCE

Name	Gender	Age	Place of birth	Note
ERiGeJiDeMa	female	80	Inner Mongolia la shan ZuoQi cooper GaNaMuSuMu	Reward of Folk cultural lifetime
EERdengSaRen	female	59	Inner Mongolia la shan ZuoQi BaRunBaLaSuMuXiLAhudegazha	Folk singer

B. Laboratory equipment

This experiment collected acoustic data and respiratory data. The recording equipment including throat instrument (EGG), external sound card, microphone, 2 respiration belts, computer mixer .etc. We chose Powerlab as recording software. The signal sampling rate is 22KHZ.By using MATLAB platform and PRAAT software, we made acoustic samples fit breath samples in time, then disposed those datas.

C. Parameter design

A complete Breath process is called a breathing unit (Breath Cell), including an Inspiratory Phase, an Expiration Phase and a Lasting Duration. Respiratory signal curve rising general corresponding to the speech signal muting section is Inspiratory Phase, Signal downing general corresponding to the speech signal speech segment is exhalation phrase. Lasting duration comes after exhalation phrase. when there is no gas in the stomach any more, inspiratory muscle group continue to contract to ensure there is enough air, until the end of sentence lyrics [3].The parameters are as follows:

TABLE II. THE DESIGNLIST OF BREATHING UNIT PARAMETER

Breathing Unit (Breath Cell)					
Inspiratory Phase		Expiration Phase		Lasting Duration	
Duration	ID	Duration	ED	Duration	LD
Peak	P	Peak	V	Starting	Ls(starting)
Slope	$\frac{IK(n)-IQ(n)}{ID}$	Slope	$\frac{EK(n)-EQ(n)}{ED}$	Ending	Le(ending)
Inspiratory capacity	$\frac{IQ(n)-P(n)-V(n-1)}{V(n-1)}$	Epiratory capacity	$\frac{EQ(n)-P(n)-V(n)}{V(n)}$		

III. ANALYSIS OF RESPIRATORY PHYSIOLOGY MECHANISMS

The power of the human speech mainly results from breathing, so does singing, but it is much more complicated than speech. Here is the study about Mongolia Folk short from chest signal and abdominal signal.

Singing is a kind of advanced and complex state, and is dependent on the regulation of breathing, Singing breathing methods can be divided into three types- thoracic breathing, abdominal breathing, and combination chest type with abdominal type breathing. This study focuses on the third methods, we will use Praat software and MATLAB platform to extract parameters, establish database, to analyze the breathing characteristics and sound way.

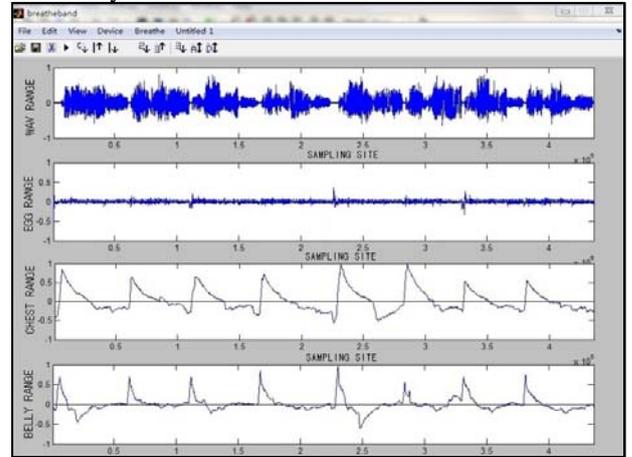


Fig. 1. THE MATLAB PLATFORM

A. Chest respiratory physiology mechanism

We collected related parameters through MATLAB software, the parameters are as follows:

1) Mongolian folk long song Rich and vast la shan

TABLE III. THE DATA SHEET OF CHEST SIGNAL PARAMETERS

Breathing Unit \ Parameter	1	2	3	4	5	6	7	8
	Inspiratory duration(s)	0.92	2.16	1.68	1.44	2.16	1.68	1.92
Exhalation duration (s)	14.89	16.34	8.89	9.13	12.97	8.41	6.25	15.13
Lasting Duration (s)	10.81	8.17	10.09	12.49	8.89	10.33	9.37	14.65
Total Time (s)	26.63	26.67	20.66	23.06	24.02	20.42	17.54	32.19
peak value	0.97	0.81	0.66	0.43	0.61	0.46	0.51	0.64
valley value	-0.31	-0.31	-0.05	-0.12	-0.28	-0.15	-0.21	-0.06
Inspiratory phase slope	1.05	0.38	0.39	0.30	0.28	0.27	0.26	0.27

Breathing Unit	1	2	3	4	5	6	7	8
Parameter								
Expiratory phase slope	-0.012	-0.013	-0.002	-0.006	-0.013	-0.008	-0.014	-0.002

Table III is the second paragraph parameters of Mongolian folk long song Rich and vast la shan, from the table, we can see:

- The second paragraph of Mongolian folk long song is divided into eight big breathing units the average breathing unit lasts 23.9s, the biggest breathing unit lasts 32.19s, minimum breathing unit lasts 17.54 s.
- The average inspiratory duration is 1.8 s, and the average expiratory duration is 11.5 s. The ratio of the inspiratory duration and expiratory duration is about 1/7.
- There is an obvious lasting duration in each unit. It is between the inspiratory duration and expiratory duration, the average lasting duration is 10.60s.
- The average peak value of inspiratory unit is 0.64, the maximum peak value which appears in the first breathing unit is 0.98, and the minimum value is 0.43, appears in the forth breathing unit. The average valley value -0.19, the maximum valley value which appears in the first breathing unit is -0.31, and the minimum value is -0.195, appears in the third breathing unit.
- The average inspiratory phase slope is 0.40, and the maximum value is 1.05, the minimum value is 0.26 ; The average expiratory phase slope is- 0.01, and the maximum value is -0.014, the minimum value is -0.002.

2) Mongolian folk short song The song of Wining

TABLE IV. THE DATA SHEET OF CHEST SIGNAL PARAMETERS

Breathing Unit	1	2	3	4	5	6	7	Average value
Inspiratory duration(s)	0.43	0.56	0.09	0.28	0.53	0.55	1.53	0.57
Exhalation duration (s)	3.91	3.85	3.78	2.22	2.67	5.25	0.78	3.21
Lasting Duration (s)	3.66	2.22	1.30	2.11	4.53	3.63	5.13	3.23
Total Time (s)	8.01	6.63	5.17	4.62	7.74	9.42	7.44	7.00
peak value	0.39	0.98	0.14	0.34	0.52	0.72	0.13	0.46
valley value	-0.195	-0.234	-0.305	-0.221	-0.380	-0.669	-0.544	-0.36
Inspiratory phase slope	1.15	2.10	2.77	2.30	1.40	1.58	0.21	1.64
Expiratory phase slope	0.15	0.29	0.12	0.25	0.25	0.17	0.86	0.30

From the table, we can see:

- This short is divided into seven big breathing unit, the average breathing unit lasts 7s, the biggest breathing unit lasts 9.42 s, minimum breathing unit lasts 4.62 s.
- The average inspiratory duration is 0.57 s, and the average expiratory duration is 3.21 s. The ratio of the inspiratory duration and expiratory duration is about 1/5.
- There is an obvious lasting duration in each unit. It is between the inspiratory duration and expiratory duration, the average lasting duration is 3.23s.
- The average peak value of inspiratory unit is 0.46, the maximum peak value which appears in the second breathing unit is 0.98, and the minimum value is 0.13, appears in the seventh breathing unit. The average valley value -0.36, the maximum valley value which appears in the sixth breathing unit is -0.669, and the minimum value is -0.195, appears in the first breathing unit.
- The average inspiratory phase slope is 1.64, and the maximum value is 2.77, the minimum value is 0.21 ; The average expiratory phase slope is 0.30, and the maximum value is 0.86, the minimum value is 0.12.

Through the comparison we can see:

- Each breathing unit has a lasting duration, The average lasting duration time of Mongolian folk long song is three times as large as Mongolian folk short songs.
- The ratio of the Mongolian folk long song inspiratory duration and expiratory duration is about 40:1, and the ratio of the Mongolian folk short song inspiratory duration and expiratory duration is about 9:1, So you can see, the requirement of Mongolian folk long song in breath is very high, Control of the breath is higher than short songs, that means is when the singer is singing, The inspiratory speed is very fast, and amplitude is very big, but in the process of Exhaling, the speed is very low, the expiratory phase slope is small.

B. Abdominal physiology mechanism

Abdominal breathing can simply rely on the decline of diaphragm to expanding the abdominal cavity. This kind of breathing method emphasizes the depth of breath in abdomen, the deeper, the better. So there will be enough power for singing. Abdominal respiration signal diagram is as follows:

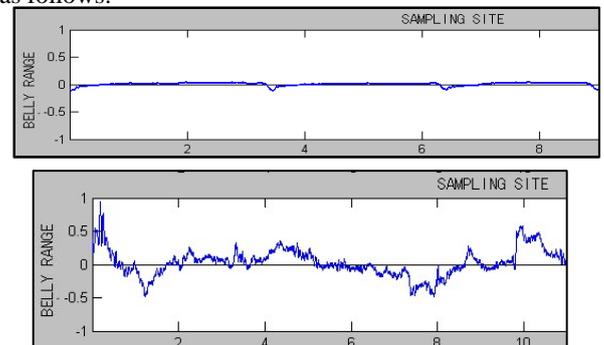


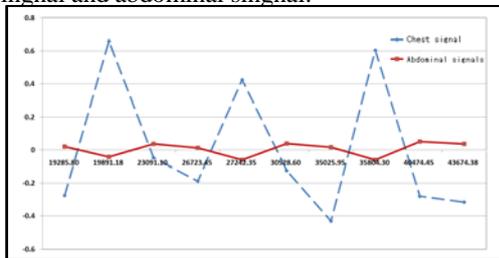
Fig. 2. ABDOMINAL RESPIRATION SIGNAL CONTRAST FIGURE OF MONGOLIAN FOLK SONGS

From the picture, above figure is abdominal respiration signal of Mongolian folk long song, Below is Abdominal respiration signal of Mongolian folk short songs, Compare the two pictures we can see:

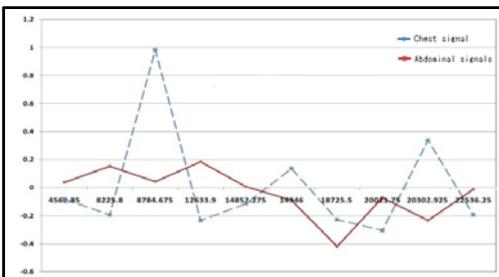
- Abdominal respiration signal of Mongolian folk long songs is very obvious, the boundaries between each unit is very clear, The overall abdominal breathing amplitude is not very big;
- Abdominal respiration signal line of Mongolian folk short songs is not smooth, Boundaries between breathing unit is very fuzzy, and the breathing amplitude is very big, Abdominal breathing unit contains many fluctuations, that is because abdominal cavity have to adapt itself to chest cavity.

C. Analysis of the relationship between chest breathing and abdominal breathing

It is not hard to find that there is a big difference between singing breath and speech breathing from the chest and abdominal respiratory signal. In the process of speech breathing, sternum, fixed collarbone and plate straight thoracic in inspiratory group contracts, the diaphragm falls .When singer is exhaling, inspiratory muscle group starts to contract, the abdominal muscle group work together, the diaphragm rise. In the process of singing breath, when inhaling, there are several more muscles join in the action ; when exhaling, inspiratory muscle group keep on shrinking, chest and abdomen shrink consistently[1].The next photo is the contrast of chest signal and abdominal signal:



(1) The contrast photo of chest and abdominal signals of Mongolian folk long songs



(2) The contrast photo of chest and abdominal signals of Mongolian folk short songs

Fig. 3. THE CONTRAST PHOTO OF CHEST SIGNAL AND ABDOMINAL SIGNAL

From the photo,we can see:

- Overall, the fluctuation amplitude and air change rate of chest signal bigger than the abdomen's. The abdominal signals changes slowly, and there are some small fluctuations, it is mainly a assistance of chest breathing and singing;
- In comparison, the abdominal signal hop of Mongolian folk short songs is more apparent than Mongolian folk long songs, because the rhythm of Mongolian folk short songs is compact;
- About the Lasting Duration, the trend of abdominal Lasting Duration signals of Mongolian folk short songs and chest Lasting Duration signals is opposite, but the trend of abdominal Lasting Duration signals of Mongolian folk short songs and chest Lasting Duration signals is same.

IV. SUMMARY

Through capturing the speech, chest and belly physiological signals of Mongolian folk short The song of Wining and Mongolian folk long Rich and vast la shan , this article designed and extracted related acoustic and physiological parameters. By using the Matlab software, we made a detailed analysis about chest respiratory signal, abdominal respiratory and the relation between them. There are still lots of jobs to do, such as the jumping and transition between each breathing unit, the characteristics of the rhythm and the emotion in physiology, acoustic signal parameters.

V. ACKNOWLEDGEMENT

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