

# The Application of Acoustic Analysis in the Study of Yugur Traditional Folk Songs

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**Keywords:** Yugur traditional folk songs; Acoustic analysis; Experimental phonetics

**Abstract.** Yugur is a unique ethnic minority in Gansu province of China, mainly distributed in the territory of Sunan County in Gansu province. Yugur traditional folk songs recorded in history and culture, is one of the important forms of oral culture. This paper based on the previous research foundation, voice acoustic analysis technology was applied to yugur traditional folk songs research. By summarizing the basic fields and research methods of the study, provide a way for the folk acoustic research and speech research.

## Introduction

Yugur is one of the unique ethnic minorities in Gansu Province, China, which has a long cultural history and rich folk resources. Influenced by historical and geographical factors, the language of Yugur is complicated, and the characters of Yugur has been lost. There are three different languages used at present, namely Chinese dialect, eastern Yugur language and western Yugur language. Among them, the western Yugur language belongs to the Turkic branch of the Altaic language family, while the eastern Yugur language belongs to the Mongolian branch of the Altaic language family. With the development of the history, the contact and development of different languages are inconsistent, leading to the communication obstacle between eastern and western languages, so most of the Yugur use Chinese to communicate with each other.

Yugur folk songs are an important part of the traditional culture of Yugur, especially recorded the Yugur's ancient culture in the traditional folk songs, accompanied by the life of Yugur people. Because of the loss of characters, the history and culture of Yugur has been recorded by the means of the oral inheritance and the folk songs are a vital component of the oral culture. Affected by the language environment, Yugur folk songs also follow the geographical differences between the east and the west.

Compared with the normal voice, the folk song's voice has both similarities and differences when they are sung. Singing voices are also differences in terms of pitch, intensity, length and timbre. Timbre and the performance of the singing voice provide a physical basis for the artistic expression of folk songs. The acoustic analysis is applied to the study of singing voice, not only quantifying the speech signal by acoustic parameters, but also revealing the physiological and physical characteristics of the singing voice. The signal and parameters of acoustic analysis are important to the teaching, the inheritance and development of folk songs.

## Analysis of Singing Formant

The pronunciation processes of the singing and the normal voice are in a same way. The airflow exhales from the lungs, flowing across the glottis and vibrating vocal cords to produce glottis signal. Then, after the adjustment by resonance cavities such as oral cavity, nasal cavity and pharynx, glottis signal turns to be the sound we can hear through the radiation of lips. However the resonance of the sound signal and the characteristics of the singing rhythm are very important to the singing signal. Singing a pretty song needs not only the control of singing breath and the correct method of

vocalization, but also the appropriate resonance. The singing formant is the energy concentration area in the spectrum where the frequency is about 3000 Hz, after the sound source signal is adjusted by the resonance cavity during the singing process.

In the early 1930s, Bartholomew (1934) proposed the concept of singing formant. When he studied bel canto, he found that male singers produced an concentrated area of energy in the spectrum of 2000-4000Hz. Later, the singing formant was defined as an energy concentration area aggregated by the f3-f5 resonance peak in the J.Sundberg study[1]. By analyzing the X-ray of vowel pronunciation in the bel canto research, it was found that the volume of the pyriform sinus increased when the throat got lower during singing. In the later research, Sundberg utilized the copper pipe to simulate the throat, explaining why the singing formant occurs at the low throat position. What's more, he found when the ratio between the cross section of throat inlet and pharynx was less than 1: 6, a new resonance was produced in the pipe, resulting in a new formant. Then many Chinese scholars also researched the singing formant. A representative view such as Wang Shiqian (1986) argues that the singing formant is a group which is composed of a relatively dense 3-4 formant in the frequency range of 1800-3800 Hz, not all produced by a low throat[2].

Therefore, the singing formant can be used to as a standard to identify whether the singer has a professional voice and can reflect the singer's voice quality. With no accompaniment of music, sung in an original way and the prolongation of vowel part, Yugur traditional folk songs are especially suitable to identify the skill level of the singer's singing by the singing formant.

### **Analysis of Long-Time Mean Spectrum**

By the spectrum analysis of the pronunciation of folk singers, it can be observed the fundamental tone and overtones of the vocal signal. The frequency of the fundamental tone determines the pitch, while the overtone determines the different timbre.

Long-time mean spectrum is also called long-time mean Fast Fourier Transform power spectrum, using FFT methods to calculate the long-time mean of each frame spectrum, and is usually used to analyze continuous voice and singing. Showing spectral characteristics mainly by the average value of the sound pressure, it can directly reflect pitch period, harmonic energy, frequency, shape and so on, in which high energy corresponding to the position of the formant[3].

Based on the analysis of the long-time average spectrum, the tone difference of folk singers during singing folk songs can be obtained. By analyzing the sound in different frequency segments the average value of the sound frequency analysis in a certain time zone can be acquired, which actually is the energy distribution map of each harmonic frequency of singing voice. The spectrum shows the energy of singing voice at different frequency, which can visually show the form of the sound. By the analysis of the data over a long period of time, it can provide an objective reference to the folk songs singing state and has an important effect on the study of folk songs.

Yugur traditional folk songs are not influenced by accompaniment voice during singing, so singing voice plays a decisive role on the singing performance. By the analysis of long-time mean spectrum, not only harmonic energy and frequency of singing voice can be ascertained, but also the formant corresponding to harmonic can be gained. The analysis of the high-frequency energy in the long-time mean spectrum contributes to the further study of the singing formant.

### **Singing Voice Analysis**

Singing voice is an important indicator about the singing level and singing voice training has good significance in the process of learning folk songs. In the process of research, the spectrum analysis method to extract the fundamental frequency parameters of the voice is generally adopted, or uses the electro-laryngograph to collect the glottal signal to analyze the parameters of the open quotient, speed quotient, jitter, shimmer and so on. Researching the singing of folk songs by voice acoustic analysis method, the singing voice signal can be analyzed. And it is more intuitiver to study and show the singing voice features by transforming the glottal vibrate mode into visual parameters and graphics. What's more, it can also synthesize singing acoustics, phonetic acoustics and

phonological knowledge to explain the sound principle of folk songs in the singing. Combined with the signal acquisition and parameter extraction method, the subjective evaluation of folk songs has become an objective evaluation of parametric quantitative analysis, which has certain scientificity.

In the parameters of singing voice analysis, the fundamental frequency is the basic frequency of vocal cords vibration and expresses as pitch. In addition to the characteristics of the vocal cords themselves, the fundamental frequency is affected by the muscles of the throat and the airflow pressure under the glottis. Male and female also differ in the frequency range due to the physiological differences in the vocal cords. The male's fundamental frequency is lower with ranging from 50 to 250 Hz, while the female's ranges from 100 to 500 Hz. The study of singing voice is the same as normal voice, and Fourier transform is usually utilized, assuming that the characteristics of the sound signal within a short period is stable and reflecting the time domain performance of the signal to the frequency domain. The compound speech waveform of the singing signal is decomposed into multiple harmonics by the Fourier transform, and the frequency range has a higher peak in the lower frequency range, which is the fundamental frequency[4]. Therefore, the voice pitch in the singing process can be obtained by extracting the fundamental frequency parameters, which has an important reference effect on the acoustic range analysis.

The range analysis is an important aspect among singing voice analysis. The singing range can reflect the singer's singing level. The Yugur traditional folk songs are the same as other traditional folk songs. Most of them adopt the pattern of oral inheritance, and there are no systematic learning and training rules. In order to broaden the vocal range, the singers usually combine the innate vocal condition with the acquired training, and reach the standard of becoming a folk singer by continuous training. By the range analysis of the voice, the level of the singers after training can be measured and evaluated. Professional opera singers with strict and scientific training and concert singers can reach two octaves, a person who have gifted voice can achieve three octaves, a singing genius can even reach the range of four octaves, while an amateur singer without strictly trained can reach a little more than an octave[5].

In addition, the rest of the voice parameters such as the open quotient which reflects the opening degree of the vibrating vocal cords, and the speed quotient is used to measure the velocities of the vocal cords. The Jitter and Shimmer are indicators of short-term stability in the pronunciation, which are used to identify the extent to the vocal cords vibrating without cycles[6].

## **Summary and Prospect**

Yugur traditional folk songs to retain the original ecological singing method, whether singing speech or singing skills are passed through the oral tradition. The research methods of phonetics and acoustics can greatly promote the study of the original folk songs. In the past, the analysis of folk songs is subjective observation. Now, the previous observations can be quantified by acoustic analysis. Using acoustic parameters to analyze the singing speech parameters, it can directly display the pronunciation phenomenon and characteristics of folk songs.

Therefore, through the acoustic analysis, not only contributes to the inheritance of folk songs, but also combines the perceptual understanding of singing with the scientific conclusion, which is more conducive to the inheritance and research of traditional folk songs.

## **Acknowledgement**

This research was financially supported by Northwest MinZu University 2016 annual basic scientific research funds of the central university funding projects (Grant NO. 31920160072). Also are the national social science fund project stage results: The experimental phonetics research project of Yugur traditional folk songs inheritance and protection.

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