Extended Abstract

Musical Information Research In Russia (History And The Present Time)

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Introduction

Musical sound can be measured with the help of physical methods, and on the other hand, it will be percept with human's hearing. In order to use objective measurements of the sound in musicology, these two kinds of information extraction must be compared and associated with each other.

About the musical sound research in Russia

In 1920th, some Russian researchers fulfilled significant works on the field of musical sound investigations. Vsevolod S. Kazansky and Sergey N. Rzhevkin studied the timbre properties of a singing voice and string instruments [1]. V. S. Kazansky developed also a recording device where the form of sound oscillations was fixed with a light ray on a photo-sensitive film.

At this time professor Nikolay A. Garbuzov, who had both technical and musical education, organized in Moscow the State Institute for Musical Science (1921–1931) and then the Scientific Research Institute of Music (since 1931). In 1929, prof. N. Garbuzov proposed to use the oscillation-recording device for exact measurement of melody. This work have been fulfilled by A. V. Rabinovich, who published the results in a 32-pages brochure [2]. He calculated the number of oscillation periods on a known time interval and derived on this way the main tone frequency. Using this method, A. Rabinovich estimated the deviation of tones from the standard pitch values in violin music performance. He showed that the changing of sound pitch is a usual performer's method for improving the harmony.

From 50th until 80th of the XX century, several measurements of this kind have been made. In this investigations, chromatic stroboscopes and other technical devices were used. These works have been

fulfilled in Acoustical Laboratory of Moscow Conservatory by pupils of N. Garbuzov Sergey Screbkov, Eugeny Nazaikinsky, Youry Rags, Olga Sakhaltueva etc.

After the end of 1980th, musical sound investigations will be based on computer methods. Nikolay Bazhanov in the Conservatory of Novosibirsk examined performance styles of different famous piano-players with the help of a personal computer and self-made sound card. In 1994 N. Bazhanov published a book with results of these investigations [3].

In 1993, the computer center of Moscow P. I. Tchaikovsky Conservatory have been organized. Since 1994, we began to study vocal sounds with computer and a 'Soundblaster' card. Some measurements of vowel sounds were fulfilled under the direction of the vocal sound expert prof. Vladimir P. Morozov (who began the investigations of singing voice in the 1960th).

In 1995, the author of this report began to develop his own computer program for measurements of musical sound. This work will be continued until present day [4].

Methods

For computer study of musical sound, mostly 'sliding' methods will be used, i.e. the estimation of sound properties happens in a 'window' with a width τ, which moves along the time axis with a small step ΔT. 'Sliding' Fourier transform allows to follow the spectrum changing during the musical piece. The form of used 'window' causes more or less estimation errors of spectrum components. Spectrum resolution ΔF and time width τ are in an 'uncertainty relation': $\Delta F \times \tau = Const.$, which limits the possibilities of exact estimation of parameters in time- and frequency- domain.

The immanent properties of musical sounds require high resolution in frequency domain. For instance, frequency difference between stages *c* and *cis* vary from 1.95 Hz in contraoctave to 248,91 Hz in 5th octave; in musical scale, it is always the interval 100 cents. According to human's hearing possibilities, the accuracy of about 4..5 musical cents (1/20 of octave) must be assured for sound pitch estimations. Non-ideality of sound structure and noise, witch contains any sound recording, and other voices and also errors of numerical methods used in computer programs are the main causes of result errors.

For the calculation of changing sound pitch, i.e. melody, both spectral and temporal methods can be used. In order to study properties of musical sound of different traditional cultures, some new methods measurements have been developed by the author. For example, a special technique of estimation of pitch row was elaborated, based on phonogram processing.

Results and Discussion

Accuracy control

An investigation of characteristic estimation errors for different sound parameters have been made by the author, including the pitch extraction methods — difference method (YIN), autocorrelation method and cepstrum method. The estimation errors were measured statistically for test-sounds in four 'central' octaves and in consideration of influence of 'white' noise with different levels, additional tones and for various 'window' width τ. The method parameters and conditions for keeping the summary error under 4..5 cents have been defined.

Some results of ethnomusicologycal investigations

Folklore Singing. In many folk singing examples the sound pitch row contains an equidistant stage structure like the European equal tempered pitch row. But, as a rule, there are more then 12 stages in octave — this number varies from 15 to 30 or more. In some other pieces, the pitch row contains linear rising steps between stages (from about 30 cents to 90..100 cents within 1,5..2 octaves) [5, 6, 7].

Tuva throat (overtone) singing (khoomei). In this traditional singing pieces usually contain a vocalization part, which sounds like a flute with an additional lower voice (bourdon). This effect was usually explained through two independent oscillations — of 'true' and 'false' ferrein's cords, but the spectrums show only one overtone system. In author's investigation, based on modulation theory (radio-signal transmission systems), a new model of sound production was offered, which allows to explain this spectrum structure. A computer simulation (in SPAX program) discovered also the 'mechanism' of two-voice hearing during vocalize part in khoomei [8].

Traditional Kazakhstan instruments. In this computer investigation, the traditional dombra pitch row was studied, based on old master's recordings. This investigation showed that the pitch row includes stages with are close similar to Pythagorean's, pure scale or equal tempered scale and includes also very 'narrow' intervals like ⅛, ⅓, and also ¾ of a halftone [9, 10].

Classical music of the East: analysis of performance style parameters. Traditional performance of classical music of Transcaucasia and Central Asia have been compared on the basis of phonograms of famous Azerbaijani and Tadjik musicians, belonging to two generations. This analysis showed some 'historical' differences during the period 1960^{th}–2010^{th} in the used pitch row — an increasing of percentage of 'European' intervals (multiple of 100 cents) instead of small intervals (about 25 cents and multiple of it). It indicates a certain trend in the thinking of musicians who studied western music and played pianoforte in conservatory [11].

Conclusion

Contemporary computer investigations on the field of musical information research in Russia mostly deals with traditional music and instruments study. On this way, some interesting new results have been obtained, which are useful for musicology and ethnomusicology.

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