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Exploration and research on melody detection technology on the basis of music cognitive principles

Yuan Liu

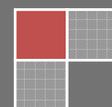
School of Luxun Art, Yan'an University, Yan'an, 716000, (CHINA)

ABSTRACT

For human beings, as one of the most important advanced cognitive functions, music cognition is also relevant to the acquired learning and the surroundings, in addition to basis of the congenital and phyla evolution. As music cognition pertains to a more complicated and multifarious cognitive system with more systems and components, which is closely connected with one another at its frontal lobe, parietal lobe and occipital lobe and so on, depending on man's whole cortex network. Moreover, as a historical art, music is closely related to people's inner feelings. As a matter of fact, it is an experience which combines people's various moods and emotions. Meanwhile, one of the primary techniques to express the theme of music is to get melodies applied. Therefore, as for research and analysis on melodies, it is a significant task to do research on and analyze music information retrieval. By sketching out music cognitive and music tension, this essay introduced the idea of auditory significant degree and put forward the exploration and research on melody detection technology on the basis of music cognitive principles, according to the correlational research achievements on the characteristics of music perception of brain nerve science and cognitive psychology. By analyzing the earlier stage processing and after-treatment as well as aiming to carry out research and analysis on the unique features of music, this essay managed to make closeness degree of music cognition verified.

KEYWORDS

Music cognitive principles; Melodies; Technological exploration.



INTRODUCTION

In all ages, music has been one of the indispensable arts of great importance in people's life, work and study. It can show their emotions and moods in a perfect way and ranks fairly high in audio visual, which reflects people's wisdom momentarily. Music resources exist in various forms and in a great number, as a result, when dealing with managing and applying music resources, it's hard to avoid such difficulties as searching and organizing. Simultaneously, as music information searching refers to such subjects as cognitive psychology, computer science, music theory, brain study and so on, doing retrieval research in the field of music information has become one of the research subjects carried out by massive research workers. Particularly, for melody discovery, exploration and research on melody detection technology on the basis of music cognitive principles in particular, has also become a significant research subject.

An introduction to music cognition

Music cognition, which means some identification, analysis, and judgment as well as integrally grasping in a vague sense on the level of integral grasp and understanding levels based on joining some activities with all of one's heart. Music cognition derived from the unceasing evolution of human beings, and it is relatively more stable phylogenetic evolutionary basis. However, in terms of evolutionary psychological study, man's music cognition lies not merely under its evolutionary basis but also it proves that apart from being genealogical, after research and analysis on the cranial nerve subject and cognitive psychology, cognitive level of mankind also includes acquired environment, learning and experience etc. With their life experience increasingly more and more. People have been kept developing their music cognition. On the whole, music cognition mainly includes representation system on the basis of the evolution and the representation system based on the acquired experiential grounding.

An outline of music tension

In reality, music tension is to perform and describe the relationship between musical structures and musical emotions in a more accurate way. In music, tension mainly embodies a relaxing or releasing feeling that audience desire to get when they are appreciating music. It can motivate people's emotions. In the process of music playing, the orientation of the keynotes can lead the audience to be relaxing or tense, what's more, after hearing, audience will receive expected results from its derivation in a certain degree.

MUSIC COGNITION AND ITS SIGNIFICANCE

Music cognition and melody discovery

In modern cognitive psychology, information processing remains dominating, which holds the view that in the cognitive process, information processing covers the three stages including input, storage and extraction in code of feelings. Due to the fact that in recent years, cognition has been introduced and studied in the aspects of pattern recognition and artificial intelligence, they have also been applied to music. According to the experimental and research results on the cognitive psychology of music research and application, while doing research, the research worker did separate the cognition among cognitive psychology, music theory and signal treatment. They either applied psychology to the research on the presentation as well as perception of the basic essential musical features in the frame of music theory, or extracted those features in the melodies by applying signal processing and pattern recognition. Seldom did they effectively combine cognitive psychology and computing methods.

By studying and analyzing the cranial nerve science and cognitive psychology experiments, we can draw a conclusion that during the melody perception, people tend to be spontaneously selective towards the melody perception. The attention of the audience will spontaneously feel with the music melodies and they make choices on the melody perception. Therefore, it is of significance to explore and study melody detection technology on the basis of music cognitive principles.

The significance of auditory sense

Generally speaking, in order to apply human beings' attention to better simulating the spontaneous selection, under normal conditions, each part of the music shall be quantized, meanwhile, the change scopes in mankind's auditory sense shall be studied, analyzed and compared. The auditory cognitive concept of the auditory significance (AS for short) suggested from above, in fact, belongs to the a peculiar mapping of the collection objective things from O to the collection of subjective perception C:

fAS : O → C

(1)

Hereon, C pertains to the ordered set of the cognition space of the subjective sense of hearing. It can be perceived from the matters which can be heard impersonally via people's auditory perception, and then, it will be a collection of cognitive objective resulting from the action in a certain order. Next, the auditory nerve system will handle the stimulation created by the objective things according to the similar sequence. O, is an well-aligned or unordered set existing in the objective world, the set which can make the time-sequence which can be heard or the set of the audible things at the relative location. The cognitive function of the auditory significant degree, fAs, in truth, is an ordered map that simulate mankind's perceptual behavior. It is a special change of the audible things in O, which maps on C, in differently important degrees.

At the t+1 moment, according to the objective set O mentioned previously and the probability distribution set T in priority and Bayesian theory, the following formula was drawn:

$$P(T_{t+1} | O_{t+1}) = \frac{P(T_{t+1} | O_{t+1})}{P(O_{t+1})} P(T_{t+1}) \tag{2}$$

And then from the point of cognition science, we can draw an conclusion that At t moment, we have drawn the prior distribution:

$$P(T_{t+1}) = P(T_t | O_t) \tag{3}$$

After synthesizing (2) and (3), the following conclusion has been drawn:

$$P(T_{t+1} | O_{t+1}) = \frac{P(O_{t+1} | T_{t+1})}{P(O_{t+1})} P(T_t | O_t) \tag{4}$$

Combine Bayesian Inferences Theory, cognitive theory with the time series of nature, we can work out the new method of updating data distribution at the sequential time point.

MELODY DISCRIMINANCES:

The semitone detection method based on AS

When representing t moment, the spectrum density where spectral line k lies is shown by x[t, k]. At this moment, let's suppose x₀[t, k] the new data which spectral line k, may appear as, where pitch deviation is likely to emerge. In terms of moment, the Gaussian distribution, which can be established through the observation data in the scope of 100 cents with each semitone as the center are as follows:

$$P(O_i | T_i) = P(x_0[t, k], x_0(t, k) \alpha G(\mu_i, \sigma_2)$$

$$K \varepsilon[-50 + 100i, 50 + 100i], i = 1, 2, \dots, 61$$

Thereinto, let's suppose the standard deviation σ as the known number and the mean value μ_i as the unknown number. After studying and analyzing, the spectrum data results have been drawn.

By analyzing and studying the characteristics of the auditory significant degree, we can come up with Time Assembled Neural Network (TANN for short) and training algorithm as TABLE 1. Put all the contents with AS feature in the sub-band into TANN and have each one tested initially in the sounding changes within each semitone scope at each moment. Consequently, the semi-note of the auditory sense significance to be chosen will be confirmed. Next, these semi-notes to be chosen" of significance" will make up the melody flow structure at this moment. At this moment, there emerges the flow chart of melodic streams structure based on the auditory sense significance degree As Figure 1.

TABLE 1 : Table of the value of zhengtai conjugate distribution minus divisor h

Value conditions of h	The Value of H	Described spectrum signatures
\bar{x}_i doesn't exist, which makes $\bar{x}_i > 1.10\bar{x}_i$	6	No spectrum signatures
\bar{x}_i only exists, which makes $1.10\bar{x}_i < \bar{x}_i \leq 1.17\bar{x}_i$	5	The fundamental frequency characteristics are not obvious, the distribution of the spectrum signatures distribute slowly
\bar{x}_i only exists as the maximum \bar{x}_i , which makes $1.17\bar{x}_i < \bar{x}_i \leq 1.23\bar{x}_i$	4	Begins to have fundamental frequency characteristics, but it may be caused by the sub-band disturbance in the neighborhood
\bar{x}_i only exists as the maximum \bar{x}_i , which makes $1.23\bar{x}_i < \bar{x}_i \leq 1.28\bar{x}_i$	3	Endows with specific fundamental frequency characteristics.
\bar{x}_i only exists as the maximum \bar{x}_i , which makes $1.28\bar{x}_i < \bar{x}_i \leq 1.32\bar{x}_i$	2	The fundamental frequency characteristics are obvious, the distribution of the spectrum signatures distribute slowly
\bar{x}_i exists, which makes $\bar{x}_i > 1.32\bar{x}_i$	1	The fundamental frequency characteristics are obvious,

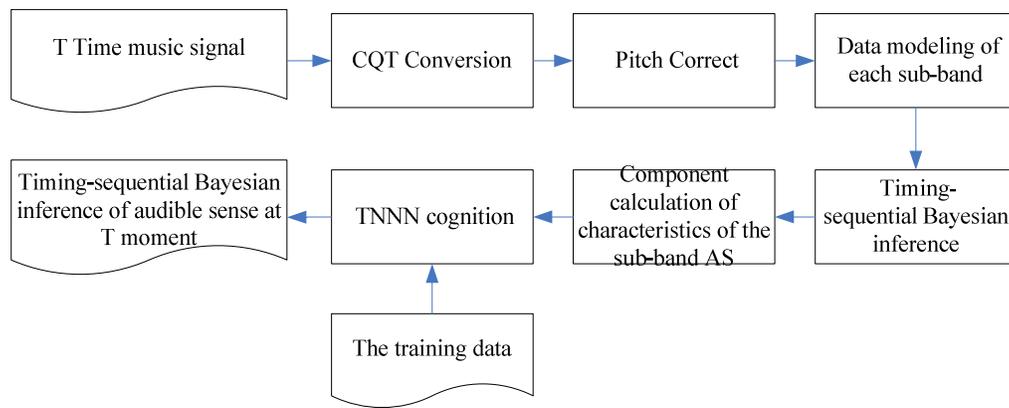


Figure 1 : The test process of significant degree of musical auditory sense

Post processing based on melody melodic streams

From large quantities of the experimental research results of auditory sense of experimental study and music psychology, we can draw a conclusion that in a traditional sense, melodies are in fact relatively simple melodies consisting of single notes sequence. When relatively abundant melodies lacks, it's limited to be able to express the main idea of music. In addition, it is less powerful for the audience to attain the function of emotion and sentiment. As an expression of music emotion, melody development as its variation consists of one of the most important factors.

If single-tone is merely used, it is far from satisfying the audience's demands and be effective.

It is well known that chord is the closest and basic unit which has most to do with emotion expression of music. Chord is superposed with several notes uttering at the same time, especially in western system, chord is one of its essential elements Whether classical or pop music, it occupies the central position and plays a particularly important role in the aspects such as describing, emphasizing and highlighting the music theme, as well as enriching the melody expression and so on. Melody streaming (MS for short)in fact pertains to a time sequence which is made up of notes or the superposition of several notes. Any time its acoustic structure tones can make up single notes consisting of melodic line. Meanwhile, it is also a chord-style or similar structure which can also make several notes sounding simultaneously. Melodic streams are similar to the authentic music scores, not only are they able to include the previous traditional melodic line, but also it can give play to the combined -style musical tones. Therefore, they can extremely maintain the similar degree in the original music and can conform with people's non-rational perception.

Considering the auditory sense significance and the methods of TANN Network, it can recognize the results of the dominating parts every moment, and keep consistent with the melodic streams referred to this matter. As a result, the treating processing of the melody stream of raising the depicting accuracy of the original music is as Figure 2: After the experimental research, we analyze the initial experimental results of the statistic and we draw a conclusion that the significance degree has been affected most in variation in its sub-band.

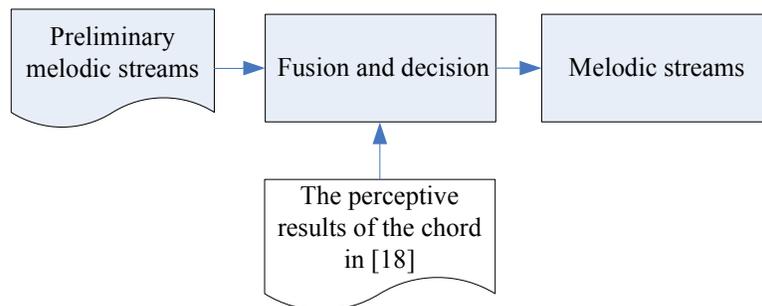


Figure 2 : The standardization and revision process of melodic streams

INTERPRETATION OF RESULT OF THE EXPERIMENTAL RESEARCH OF MELODY DISCOVER

We have drawn the experimental results shown in Figure 3 after the experimental study and analysis of music melody discovery, especially after the processing phase in the previous stage. As is seen Figure 3, in a certain degree, setting the semi-note scope is rather effective, in particular within the scope of lower that A2 but higher than B7. Basically, obvious and effective spectrum data points can't be observed There is only very slight trace, but compared with the other data in the whole region, it can be negligible. As for the pitch calibration technology, after the relative location of each sub-band is

adjusted in a certain degree, it will be just like the whole frequency spectrum’s parallel translation towards the treble or the low pitch. Even though, for the relative data which distribute from A2 to B7, they won’t be affected.

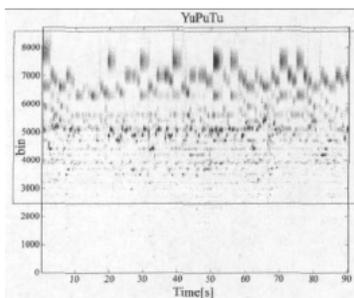


Figure 3 : The semitone CQT frequency spectrum of the song“2 beds and a coffee machine” and the scope which this experiment refers to

From the analysis and experimental research results above, we can draw a conclusion that this experiment is an expression of melodic streams which is distinctive form the previous traditional test result based on different bases. What’s more, the evaluating standard platform of this field is not perfect enough,therefore, to make the evaluation results more accurate and precise, we may evaluate and analyze the test results in both subjective and objective aspects. In order to recognize and evaluate traditional melodic line results, we bring a certain component frequency in the melody into correspondence with the master work of the standard melodic line at this moment, it can be labelled correct. The results are as follows in TABLE 2. We can see in TABLE 2 that whether classical or light music, these methods mentioned in the experiments with those distinctively leveled melodies can be commanded more accurately,although these music is played with the melodies which is less used idiophones such as classical music and light music; However, it embodies an ordinary effect for the melodies of rock & roll, an heavy metal music. The expression results in jazz are much less effective than expected. Therefore, in the process of recognizing, it causes certain interference and influence on our work.

TABLE 2 : Discovery results of the melodic lines in the self-built database

Music Type	Total frames	Correct frame	Fraction of coverage
classical	57600	47410	82.30%
Light music	57600	48083	83.50%
Rock & Roll	32400	21979	67.80%
Jazz	32400	23952	73.90%
Total	180000	141424	78.60%

It is clear that people’s music cognition pertains to a physical and mental process which endows with complexity, therefore, in order to enhance its degree of accuracy in recognition, the relevant musical theories and cognition theories can be brought in to help with melodies discovery. In addition, by combining subjective methods with objective methods, we can analyze, assess and test the melodic line, increasing the accuracy of the melodic line.

CONCLUSION

In conclusion, after the initial understanding of music cognition and music tension, we put forward the correlative methods and concepts related to signal processing technology and the auditory significant degree, in accordance with the specific research findings based on cognitive psychology and brain nerve science. Also, we have applied these findings and concepts to signal processing technology as well as music theories and others to the technology of melody discoveries, effectively promoting the accuracy and making the music more accurate.

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