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Explorative research on generating process of music creation based on computer simulation system

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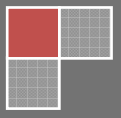
ABSTRACT

The fundamental goal of using computer simulation system in the generating process of music creation, is to complete the computer system's perception of music and intelligent creation of music at the information age. Under the current information age, in the field of music, multimedia technology is mainly used on the visual and auditory aspects. And the core of the multimedia technology is the audio technology. In modern society, music has been widely needed in many fields, such as: the film and television industry, stereo audio-visual publishing houses, concerts, and so on. Due to the fact that human energy is limited, the traditional production method of music creation also has some limitations for meeting the demand of music. For the music itself, it mainly comes from nature, and the sound of nature is interrelated with the emotional melody in human sense. In the field of music, sound is made up of four main factors, namely, pitch, amplitude, length and timbre. The orderly combination of these four factors has formed a set of reasonable and orderly computer simulation system of music creation. Note is the most basic unit in a group of wonderful music, the frequency of the sound and the length of the length of notes. That is to say, the computer simulation system has certain uniqueness while using in the generation process of music creation. Meanwhile in today's information age, computer technology has been equipped with mature software and hardware facilities.

KEYWORDS

Computer simulation system; Music sequence; Music creation; Music signals.



THE SIMULATION ANALYSIS OF MUSIC SEQUENCE

By using A/D, a piece of music can be converted into a set of number sequence, namely $\{x_i\}$ ($i = 1, 2 \ldots$), which has contained all the information of this piece of music. The above the number sequence is time sequence of music signal, and usually in the field of music, has been called music sequence for short. Figure1 shows the first six second's music sequence of <*I believe*>, a popular music in nowadays. And the frequency is 8000Hz, and the number of the resulting data records is 48000.

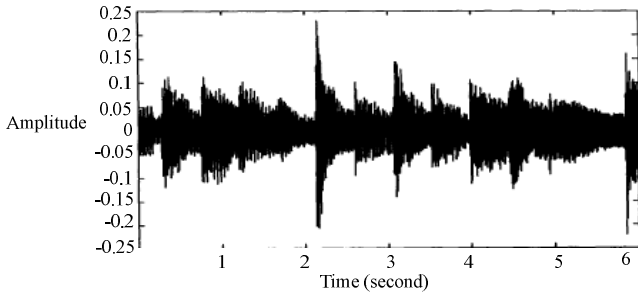


Figure 1 : The first six seconds' music sequence of *I believe*

MUSIC SEQUENCE MODELING AND SIMULATION EXPERIMENT OF COMPUTER SIMULATION SYSTEM OF MUSIC CREATION

Music sequence modeling

Music in terms of its specific form is a complex process. After spreading the sequence of the music signals, it can be found that music sequence is composed of a set of regular waves. Especially after filtering out the small waves in a music sequence by computer technology, a music form similar to the string vibration will appear[1]. On the basis of simplifying the music sequences to a certain degree, analyze the computer simulation system used for the generation process of music creation. And this research mainly uses the string vibration function model to describe music series with the music model being shown below:

$$x_k = A\exp(-\lambda k)\cos 2\pi fk + \delta_k \quad (k = 0,1,2,.....)$$

In the above model, A represents the maximum number of amplitude in the music rhythm cycle; λ is the reducing rate of the average sequence in the music sequence; *f* is the frequency of vibration in a music sequence; δ_k is the influencing factor causing the smallest wave in the music tone. At the same time, the following model can be made use of to study the generation process using computer simulation system in music creation.

The generation process of music creation by using string vibration model in computer simulation system is relatively single. In order to create more beautiful music, a superposition of a number of sounds from different frequencies can be made to form a multi-level string vibration sequence[2]. Meanwhile, using the superposition of small waves of music sequences to further optimizing the status quo of sound being monotonous

The experiment method of using computer simulation system to generate music sequences

Based on the further analysis of the characteristics in music sequence, finally the specific steps of experiments of the simulating generation of music sequence can be concluded as followings:

(1) Research and analyze the original music, and then calculate the cycle length, amplitude and the average fluctuation frequency of music;

(2) If the calculated value and small fluctuations sequences shows a steady sequence, then use autoregressive model to make corresponding calculation for the two sets of data and start simulation experiments;

(3) Based on the sequence number and the small fluctuations sequences obtaining from the above two steps, use the string vibration function model in computer simulation system to generate the signal sequences of cycle simulation in music sequence;

(4) After the above three steps, connect the signal sequences of rhythm cycle which is simulated before in order, and then it will generate an orderly music signal sequence.

Through contrasting the tones of the music generated by computer simulation system and the original one, then use superposition of string vibrations in large fluctuations frequency of multiple music rhythm periods to generate fluctuations sequence in rhythm cycle which will provide the ideal experimental simulated music.

Music programming software of music sequence in computer simulation system

The main selected music programming software of this simulation experiment is MATLAB6.5. And the main functions of this software are to achieve the transformation of sound signal to music sequence, and provide the required function in terms of specific audio processing to make music work convenient[3]. As shown in TABLE 1, the major function names of this simulation experiment are provided in the table. And among them, the recording and playback functions in this experiment are described below:

(1) Wavrecord function

Its main function is to use Windows audio device to record and at the same time convert recorded simulated music signals into digital signals, with its sequence format as *y=avreeord(n,fs,dtyPe)*. Among them, *n* represents the sampling time of music signal, with unit of second. Also *n* represents the specific length of music recording; *fs* represents the sampling frequency, which is the collected number in each second, with 11025Hz as the default value; *dtyPe* represents storage form of sampling data in the music sequence And there are three main kinds of forms, namely double, single, and int. The lengths of first two are both 16 bit, and that of ints is 8 bit. Music sequence in computer simulation system converts the signals into number sequences and stores the final results in the array *y*, and it has mainly shown in above.

TABLE 1 : The related functions which convert the simulated sound sequence into number sequence in music programming software MATLAB6.5

Names of the functions	Function description
wavread	Files reading
wavwrite	Writing files
soundview	Playing sounds
soundse	Normalized playing sounds
wavplay	Playing sounds
wavrecord	Recording sounds

(2) Soundview function

The main role of this function is to convert audio output function in music into music by using the sound generating devices and the format of the function is *soundview(y,fs)*. Among them, *y* represents the array; *fs* represents the output frequency of music. Convert the digital signal *y* of the function into the *fs* audio signal mainly by using computer simulation system.

MUSIC SEQUENCE BASED ON SHORT-TIME FOURIER TRANSFORM

The major role of music sequence of Fourier transform is to create a bridge, which only connects a single from one domain to another domain without organic combinations between time domain and frequency domain. As a result, only according to amplitude and phase of one frequency component of signal between the frequencies spectrums, this method cannot clear summed up the frequency characteristic in a music sequence. Normally, the frequency spectrum of the signal has no relationship with the average spectrum of time information in the music sequence. Because the frequency characteristic in a music sequence does not change orderly with the sequence, the music signals of the two are completely different from each other. The two music signals mainly rely on the Fourier transform in computer simulation system to obtain the same music sequence spectrum[4].

For example, in the process of the analyzing and studying the computer simulation system used in music creation, the effect degree of a linear system to stimulation of stationary white noise and that of the entire computer simulation system to the pulse stimulation are consistent in spectral density. At the same time, frequency spectrums of frequency modulated signal and sinusoidal modulation signal in the system are consistent with each other. Therefore, the relationship between Fourier transform in the whole music sequence and related functions as well as power spectrum has no direct relationship to stationary signal in music sequence[5]. In the field of music, frequency characteristic of music sequence in many computer simulation systems orderly swings with the changes of the time in the system. However, if trough Fourier transform by using the music sequence in the system, spectrum changes can become regular, reasonable and orderly.

The processing technology of short-term music signal in computer simulation system

Music signals and voice signal has a certain similarity, and music signal based on computer simulation system has the similar features with the short time signal. As a result, the analysis and study of processing technology of the music signal sequence is on the basis of the short-time signal analysis. Based on the above brief introduction of the technology, the first step is to store the digitized music signal sequence in the system into the array $\{ x_n \}$. And prior to the usage computer simulation system for music creation to make short-time Fourier transform, array $\{ x_n \}$ in the system needed to be framed

using computer simulation technology, In general, make segmental process to information in the array { x_n } according to its length in order to maintain inherent characteristics of the data information in the system and avoid the loss of data information caused by segmental processing, Then the data segments can go through overlap processing, during which the processed data in a computer simulation system is referred to as the frame, the length of frame in the system as frame length, data segment with overlapping data in the system as a frame shift. Make music signals sequence processing of the array { x_n } in the computer simulation system in order. In the unit of frame, out of the specified data information from the array, and release the processed information. Then use computer simulation system to process information data of the next frame[6]. On this basis, use computer simulation system to transfer the processed data information into music sequence. Usually, the frame length of the speech signal in music sequence is about 20m. But in processing of signals in music sequence, the continuity of the signal needs to be taken into consideration, and according to the relevant requirements in Fourier transform, the usual Fourier transform length is two on the number of power. Therefore in the process of the research on this system, the frame length of the sequence is 32 ms. Figure 2 shows the relationship between the frame shift and the frame length.

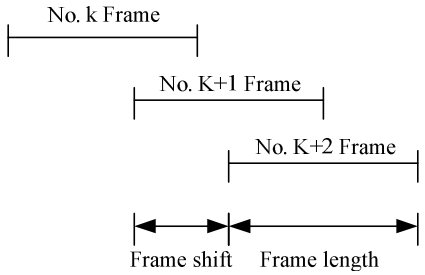


Figure 2 : The relationship between the frame shift and the frame length

During the generation process of music creation based on computer simulation system, the data information in a music signal sequence will appear certain characteristics of discontinuity, which will lead to the current situation of pseudo components produced in spectrum density. According to the above analysis of the status quo, the data segment in the system needs to be loaded to the weight function, and then process information by the way of spectrum transform. In order to clarify the correlation characteristics of signal in music sequence at specific time point, the characteristic of the related functions needs to be analyzed to summarize the rule of the changing of music sequence signal. The involved weight function is called window function in the computer simulation system, the main role of which is to reduce the number of leakages of frequency spectrum in music sequence. In the study of the system, the choice of window function needs to use short time Fourier transform in computer simulation system to make analysis of the signals in a music sequence as well as the final results of the creation. There are many types of window functions in the computer simulation system, with the typical window functions as rectangular window, hamming window, hanning window, blackman window, etc. The expression of window function is $w(n)=(n=0,\ l,\ 2...N-1)$ and N represents the window length. The concrete definitions of window functions of the above three kinds are shown below:

Rectangular window: $w(n)=\begin{cases}1, & n=0\sim(N-1)\\ 0 & n=other\ values\end{cases}$

Hamming window: $w(n)=\begin{cases}0.54+0.46\cos\left\{\left[\left(\dfrac{2n}{N-1}\right)-1\right]\pi\right\}, & n=0\sim(N-1)\\ 0 & n=other\ values\end{cases}$

Hanning window: $w(n)=\begin{cases}0.5+0.5\cos\left\{\left[\left(\dfrac{2n}{N-1}\right)-1\right]\pi\right\}, & n=0\sim(N-1)\\ 0 & n=other\ values\end{cases}$

Blackman window:

$$w(n)=\begin{cases}0.42+0.5\cos\left\{\left[\left(\dfrac{2n}{N-1}\right)-1\right]\pi\right\}+0.08\cos 2*\left\{\left[\left(\dfrac{2n}{N-1}\right)-1\right]\pi\right\}, & n=0\sim(N-1)\\ 0 & n=other\ values\end{cases}$$

Figure 3 is the comparison figure of the three types of window functions. The figure below clears shows the shapes and changes of the hanning window function and blackman window function. Compared with hamming window function, hills of hanning window and blackman window look sharper, and the ends of these two functions are close to zero value. It means that these two kinds of window functions have direct meaning and effect to reduce the boundary impact in music sequence. In addition, Figure4 shows the spectrum characteristics of three kinds of window functions mentioned above in music sequence, and at the same time it provides a contrast between the hamming window function and blackman window function.

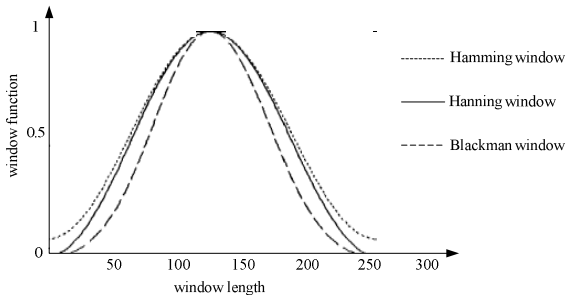
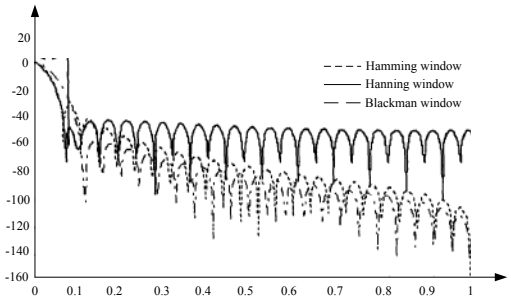


Figure 3 : The contrast of the three kinds of window functions



Figue 4 : The contrast between Blackman window function and hamming window function

The main feature of blackman window function is that its the main lobe in music sequence is the widest, while the widths of the main lobe in music sequence of hamming window function and hanning window function are equal to each other. The attenuation rate of the side lobe of hanning window function, however, is superior to that of hamming window function[7]. In the specific process of music handling, choose the appropriate window function, and then process each frame in music sequence with Fourier transform in the computer simulation system. Meanwhile extract the involved amplitude spectrum. And the specific expression is as follows, namely: $s_w(n) = s(n) \bullet w(n)$

Among them, $s(n)$ in the expression represents one frame data in music sequence, and $w(n)$ represents the hamming window function.

Method of predicting short-term amplitude spectrum of simulation music

According to the above models, and the analysis of the short-time amplitude spectrum $Y(N_1, b_m, m)$ of the original music, predict and simulate short-time amplitude spectrum through music sequences in the computer simulation system. Here the final experimental steps are summarized as the followings:

(1) First, determine the rhythm cycle number of the music sequence in computer simulation system of simulation which is expressed as m. Select the same number with that of the original music, which can be generated according to the specific music sequence;

(2) Then analysis each frame in music sequence according to the fluctuation situation. Determine frame length in the music sequence, and clarify the frame number b_m within the rhythm cycle of the music sequence in the simulated music sequence.;

(3) Within each rhythm cycle of a music sequence, the frequency range is between 1- 4000Hz. Using autoregressive models, make amplitude spectrum on the same frequency generate manner of music sequence.

Through the predicting and simulating the short-time amplitude spectrum of music sequence in the computer simulation system, the simulated 3D function $Y'(N_1, b'_m, m)$ in the computer simulation system is finally obtained.

Experiment of music creation in computer simulation system

Based on the short time Fourier transform of music sequence in a computer simulation system, analyze the signals of the amplitude in music sequence and the main simulation music creation process is summarized as the following points:

(1) First of all, process music sequence with short time Fourier transform, and then put the data information into the 3D function $Y(N_1, b_m, m)$;

(2) Based on the first step, make simulation studies on the 50 data information of the first frame in original music signal. Using Fourier transform in the computer simulation system, calculate the amplitude spectrum of the sampling results. Then according to the amplitude spectrum of the first frame in the sequence, by way of iterative sequences of the system, make superposition processing of the signals, and reply the data information in the first frame.

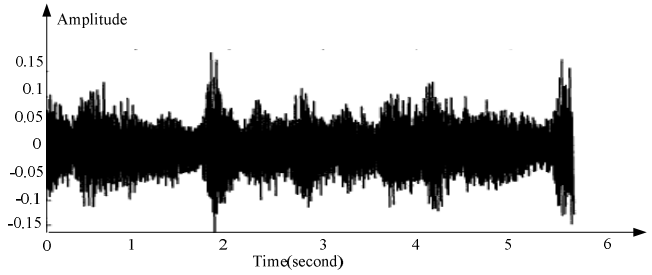


Figure 5 : The simulation music after reconstructing the signals of music sequence

After listening to the music sequence in the above computer simulation system, strong noise will be found existed in the rhythm and the melody of the music. The main reason is that during the process of music creation with computer simulation system, the sampling goal is to reconstruct the musical signals with the musical amplitude spectrum which cannot be achieved. Therefore, during the process of music sampling with computer simulation system there will produce certain errors and deficiencies.

APPLICATION OF SIMULATED GENERATING METHOD OF MUSIC SEQUENCE

The comparison of autocorrelation coefficients of music sequence in computer simulation system

Figure 6 shows the comparison of autocorrelation coefficients of music sequence, in which the abscissa refers to positioning difference, ranging from 0-500, and its ordinate refers to the autocorrelation coefficient in a sequence of music. In order to clearly and concisely show the process of this study, the following simulative music1 represents the music simulated from the time domain characteristic values in music sequence, while the simulative music 2 represents music sequence by the way of short time Fourier transform in computer simulation system.

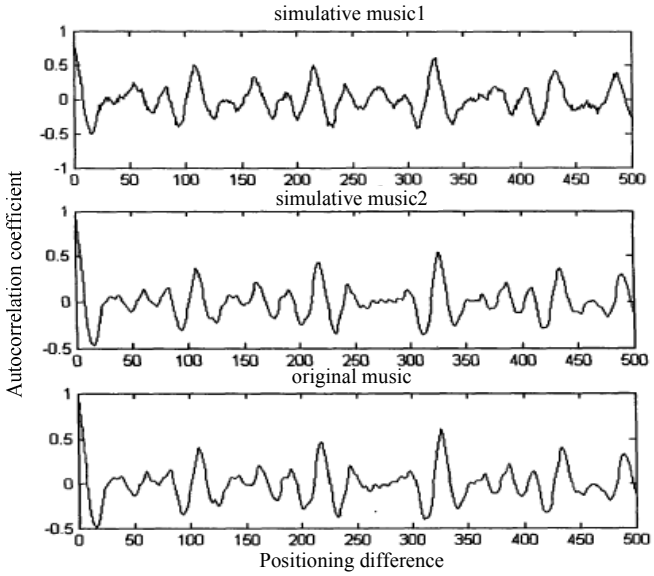


Figure 6 : The comparison of autocorrelation coefficients of music sequence

The analysis of frequency spectrum

Figure 7 shows the comparing results of the tones and frequency of the two pieces of simulative music, mainly using Fourier transform in the computer simulation system. And analyze the results through the spectrum figure. From the following three figures, it can be analyzed that in the three pieces of the music sequence, the main music frequency ranges from 0-1000Hz, with specific contrast of the tone frequencies shown below.

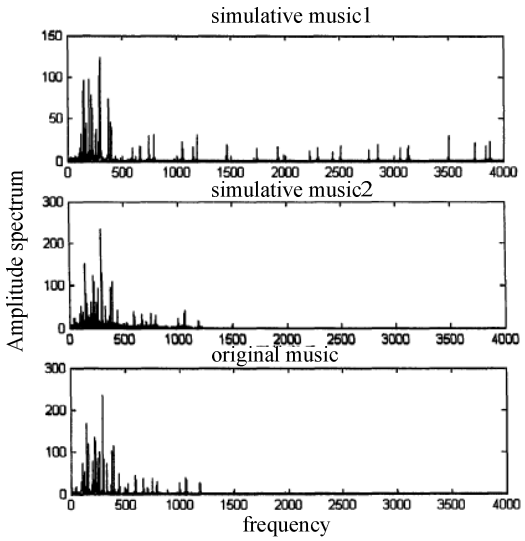


Figure 7 : The comparing results of the tones and frequency of the two pieces of simulative music

To make a detailed analysis and research on the rule of the frequency changing in the simulative music, short time Fourier in the computer simulation system is needed. The following Figure 8 research focuses on the comparison in the same period of short-time amplitude spectrum. On the basis of the fact that these two pieces of music have the same number of frames, use the short time Fourier transform to carry out the process.

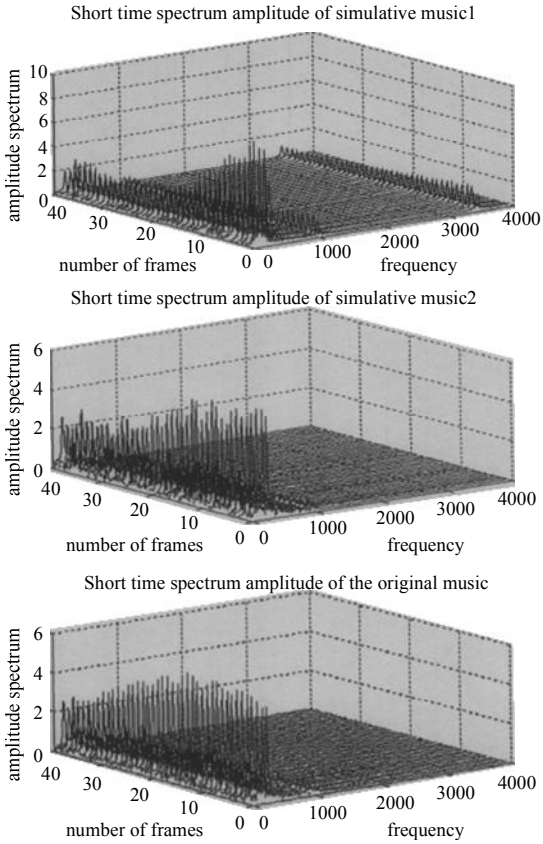


Figure 8 : Comparison of short time spectrum amplitude at both ends of music sequences

The application of music method in simulative experiment

In order to apply the method using in the above two pieces of music sequence to different simulative experiments and confirm its feasibility, the following four segments of music are going to be made a model analysis respectively. The four pieces of music mainly include piano, *High Mountain and Running River* (the Zither Music), music owned by Windows system and symphony. Every piece of music has its own characteristic. As for these four pieces of music, the music sequence of piano is characterized by cadence; the music sequence of Zither Music is characterized by ups and downs; the main feature of music owned by Windows system is its declining music tone; music sequence of symphony is characterized by its evident rises and falls[8].

CONCLUSIONS

This paper mainly studies the generation process of music creation with the computer simulation system and the used experimental method can be applied to various aspects in the field of music. In addition, during the simulative experiment of the music creation, the parameters of the music sequence had been effectively estimated, and the involved parameters as well as functions have a direct impact to musical melody. In the field of music, frequency of many music sequences in the computer simulation system is fluctuated orderly with the time changes of the system which can make the changes of spectrum reasonable and orderly. The fundamental goal of using computer simulation system in the generating process of music creation, is to complete the computer system's perception of music and intelligent creation of music at the information age.

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