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Research Article

Multitone Piano Transcription Analysis and Evaluation Relying on Hierarchical Analysis High-Performance Computing Algorithms

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Hierarchical analysis refers to the method of dividing the elements related to the result into different levels such as goals, methods, and processes and then performing quantitative and qualitative analysis according to different levels. It can hierarchize complex methods and make the solution process more scientific and reasonable. High-performance computing refers to computing systems and environments that usually use many processors or several computers organized in a cluster. In fact, there are many different types of high-performance computing systems on the market, most of which are used in conjunction with the network. For example, Ford built an online market with high-performance computers and connected to its more than 30,000 suppliers through the network. This kind of online procurement can not only lower prices and reduce procurement costs, but also shorten the procurement time. Ford estimates that this can save approximately $8 billion in procurement costs. In addition, fields such as manufacturing, logistics, and market research are also areas where high-performance computers show their talents. This article aims to study the analysis and evaluation of multitone piano transcription that rely on hierarchical analysis high-performance computing algorithms and hopes to use high-performance computing algorithms to make piano recordings more harmonious. This paper proposes a differential variable-multivariate curve resolution for accurate analysis of GC-MS overlapping peaks, mainly to solve the problem of inaccurate results caused by the difficulty in determining the components during the analysis of overlapping peaks; carrying out matrix calculation on the piano tone characteristic matrix, it realizes the electronic synthesis of the 25th harmonic of the piano tone. The experimental results in this paper show that when the number of Gaussians in the recording process becomes 5, the gap between the sound pressure amplitude and the sound pressure phase is significantly reduced; when the number of Gaussians is 10, the value of the sound pressure phase has an overshoot phenomenon; when the number of Gaussians is 15, the difference between the sound pressure amplitude and the sound pressure phase is the smallest, indicating that the error at this time is the smallest, and it is the most ideal recording environment.

1. Introduction

With the continuous deepening and development of economic globalization, competition among countries has become increasingly fierce. In the final analysis, the competition between countries is the competition of science and technology, so mastering high-end technology will greatly promote the international competitiveness of the country. Because high-performance computing can complete related work in universities within a limited time, it has been widely used and explored. High-performance computing clusters are mainly used to deal with complex computing problems and are widely used in meteorological, marine, and environmental fields (numerical forecasting, etc.), life sciences (gene sequencing, comparison, homology analysis, etc.), and computer-aided engineering (fluid mechanics, optimization analysis, characteristic analysis, simulation analysis, etc.). The piano was introduced to China after the Opium War. The piano is a stringed instrument with a very wide range. Because of its long and beautiful sound, the piano is loved by people all over the world. With the continuous development of science and technology, the audio technology has made great progress. The piano can be not only appreciated on the spot, but also preserved by recording technology. Although there are many recording techniques, in order to get the best recording effect, people have been finding the most suitable recording method according to the timbre characteristics. The emergence of high-performance computing algorithms provides a theoretical basis for multitone piano transcription. Therefore, this article aims to study the analysis and evaluation of multitone piano transcription that rely on hierarchical analysis high-performance computing algorithms, hoping that high-performance computing algorithms can achieve satisfactory recording results.

With the improvement of science and technology and living standards, not only have people improved their material standards to a large extent, but they also have higher requirements for the spiritual world. The appreciation of art such as piano can improve people's appreciation level to a certain extent, but not everyone has this condition, so recording came into being. Piano recording can reproduce the power of listening to the music at close range and reproduce the temperament and color of the music.

With the needs of social production, high-performance technology is used to varying degrees in various fields. Piano music enhances people's aesthetic appeal. In order to improve recording technology, high-performance computing and recording technology can be combined. Bridi et al. demonstrated the first search-based HPC machine job allocation and scheduling method, working in a production environment. Scheduling and scheduling tools for high-performance computing (HPC) machines have a key role in mapping jobs to available resources in an attempt to maximize performance and quality of service (QoS). Under normal circumstances, allocation and scheduling are well-known NP-hard problems, forcing commercial schedulers to adopt methods to improve performance and QoS. The scheduler is based on constraint programming, which is an effective programming technique for optimization problems. The resulting scheduler is flexible because it can be easily customized to handle heterogeneous resources, user-defined constraints, and different indicators to optimize the solution in this way [1]. Volovich et al. proposed to solve scientific problems in the field of materials science in the environment of high-performance computing systems. Mathematical modeling methods implemented by specialized modeling systems are used to solve certain problems in materials science. When deployed in a hybrid high-performance computing system (HHPC), the modeling system shows the highest efficiency, which allows the problem to be solved with sufficient accuracy within a reasonable period of time. However, in the HHPC computing environment, there are some limitations that affect the work of the research team using the modeling system. In the stage of developing and debugging algorithms in the modeling system, it is necessary to access the graphics accelerator, and multiple modeling systems need to be used. In order to obtain the optimal solution, it is necessary to dynamically change the settings of the modeling system to solve the problem, which requires the help of a high-performance computing system to solve the problem [2]. Sharif et al. proposed to solve the problem of designing workflow scheduling algorithms to meet customer deadlines without compromising data and task privacy requirements. This work is different from most studies on workflow scheduling, and its main goal is to strike a balance between ideal but incompatible constraints, such as meeting deadlines and/or minimizing execution time. Although many others have solved the trade-off between cost and time or privacy and cost, their work still does not fully consider the trade-off between privacy and time. In order to solve such defects, high-performance computing systems came into being [3]. Roberto et al. proposed a new thermal identification method for HPC systems in actual production. This method can extract thermal models from computing nodes affected by the quantization noise of temperature measurement and run in natural cooling mode. In current and future high-performance computing (HPC) systems, online optimization of heat-aware design and cooling work is becoming more and more important. A basic requirement for the effective development of such technologies is to have a distributed compact model that represents the thermal behavior of the system. The system recognition algorithm allows the model to be extracted directly from the thermal response of the target device. This method also allows identification of the physical layout of the CPU chip in the supercomputing node. The effectiveness of the proposed method has been tested on a node of the CINECA Galileo Tier-1 supercomputer system [4]. Sigtia et al. proposed a supervised neural network model for polyphonic piano music transcription. The architecture of the proposed model is similar to a speech recognition system, including an acoustic model and a music language model. An acoustic model is a neural network used to estimate the probability of pitch in an audio frame. The language model is a recurrent neural network that models the correlation between pitch combinations. The proposed model is universal and can be used to transcribe polyphonic music without imposing any restrictions on polyphony. Probabilistic graphical models are used to combine acoustic and language model predictions, and beam search algorithms are used to infer output variables [5]. Togootogtokh et al. proposed a state-of-the-art 3D finger gesture tracking and recognition method and used the depth sensor of both hands in real-time music playback. With the development of 3D depth cameras, a set of instruments based on 3D gestures have been implemented, such as Virtual Cello and Virtual Piano, which require precise finger tracking in 3D space. For hand tracking, model-based left-hand tracking and appearance-based right-hand tracking technologies are proposed. In order to detect finger gestures, its method includes many systematic steps, such as reducing noise in the depth map and geometric processing of the virtual cello. For the virtual piano, a neural network (NN) method is introduced to detect special gestures, which has a multilayer perceptron (MLP) structure with back propagation training. There are few examples in the literature that use the touch screen as a medium, with fixed coordinates and 2D gestures to control MIDI input [6]. Johnson et al. proposed a study to automatically evaluate the hand posture of pianists, aiming to help piano beginners improve their piano playing skills during practice. In order to automatically assess students' hand gestures, the author proposes a system that can recognize three types of gestures from a single depth map containing the pianist's hands during performance. In order to train the manual segmentation model, the author experimented with two feature descriptors, depth image feature and depth context feature, which describe the context of a single pixel neighborhood. In order to consider the changes in hand size and practice space, a support vector machine and the extracted descriptors are used to build a detection model for each student individually. Experiments have proved the effectiveness of this method, among which the histograms of deep context features and normal vectors perform best [7]. Although these theories have discussed high-performance technology and recording technology to a certain extent, the combination of the two is not obvious and not practical.

The purpose of this paper is to study the analysis and evaluation of multitone piano transcription that rely on hierarchical analysis high-performance computing algorithms. The theoretical analysis is forward-looking to a certain extent, using spectrum analysis method to collect and analyze the characteristic matrix of piano timbre, innovate the way of piano recording, and make the recording sound more accurate.

2. Methods

2.1. Overview of the Piano. Sound is a common physical phenomenon, and the recording of sound requires audio recording technology. Audio recording technology has come into the public eye with the appearance of the phonograph. Based on physical knowledge, it is know that sound needs to use a medium to be transmitted to the eardrum and be perceived by humans [8]. The music tone has formed inherent laws through long-term improvement, which can convey the author's own emotions and thoughts, and form a specific music culture.

The piano has 88 keys, 52 of which are white keys and 36 are black keys. The first key is A2, and the 88th key is c5. The first key A2 is the lowest pitch, and the fundamental frequency of the musical tone is 27.5 Hz. The 88th key c5 is the highest pitch, and the fundamental frequency of the musical tone is 4186.01 Hz. The piano's key tone is formulated in accordance with the "twelve equal temperament." The production materials of piano strings are different, and the pronunciation is different [9]. From the overall structure, the piano is composed of three parts: shell, machinery and sound source. The mechanical part also includes keyboard machinery, string action machinery, and pedal machinery. The string action machinery includes hammers, couplings, butts, and other parts. The sound source is composed of strings, resonance, and structural support. The resonance system consists of three parts: resonance body, vibration wave transmission mechanism, and resonance auxiliary mechanism, including soundboard, string code, ribs, and other parts. The iron plate in the structural support system also has a resonance effect. In a complete piece of music, there are not many vibration waves of different frequencies, which we call the system of law academically. The temperament system stipulates the vibration frequency of the standard tone and also takes the twelve equal temperament as the criterion [10]. The twelve equal temperament

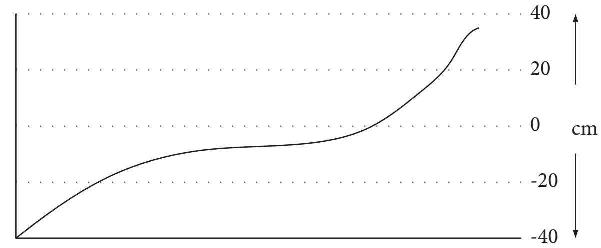

Figure 1: Piano pitch tuning curve.

determines the fundamental frequency of each musical tone of the musical instrument. In music theory, the difference in fundamental frequency of "octave" intervals is equivalent to the concept of frequency doubling in physics. In music theory, it is said that the pitch difference of two notes with the same name is an octave. In physics, it means that the fundamental frequency difference of two notes with the same name is one time. Modern piano sounds are determined by the twelve equal temperament, which is convenient for tuning and improves the interpretation effect. As we all know, piano keys include white keys and black keys, but whether they are white keys or black keys, the two adjacent keys are semitones different. The two white keys are arranged in a row. The interval distance between the two white keys is semitone. If there is a black key in the two white keys, the interval distance between the two white keys is full tone, and the interval distance between the white key and the black key sandwiched between them is semitone. It is customary to divide the seven keys into one group. According to what had been said before, the audio of this group is higher than the left group and lower than the right group [11, 12]. Figure 1 shows the tuning curve of piano pitch.

Pitch length refers to the duration of a single musical sound, which is essentially the duration of the string's vibration, so the recognition of the pitch is to realize the recognition of the duration of the string's vibration wave. But in order to pursue the beauty of music, although the length of the sound cannot be changed, its duration can be changed, which changes the overall rhythm of the music and forms different types of music [13]. Figure 2 is a schematic diagram of the music production model.

The tone intensity of a piano refers to the loudness; the greater the amplitude, the greater the sound intensity. In fact, when playing the piano with exactly the same intensity and position, the loudness may not be the same [14]. This is because the strings are not only affected by the strength, but also have different sound strengths due to the quality of the strings and the resonance cavity. Piano is known as the "King of Musical Instruments." The low-range sound is thick, the midrange sound is natural, the high-range sound is transparent, and it has a unique charm. It is the most popular instrument of musicians and has the most extensive uses [15]. In fact, after simple training, different timbre can be distinguished. Due to the uniqueness of the piano, human beings can collectively recognize the sound of the piano from many musical instruments.

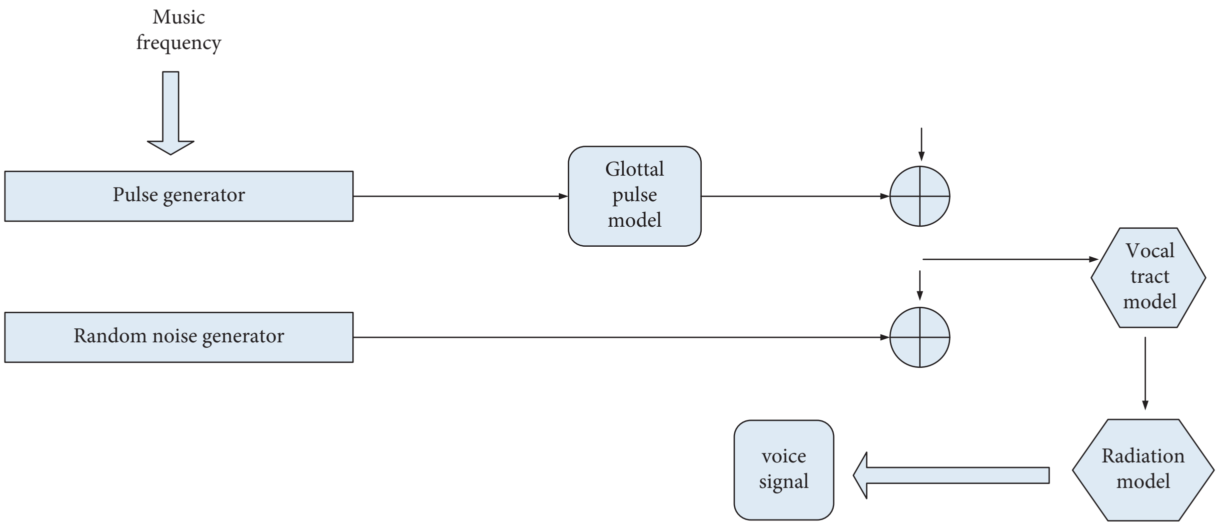

Figure 2: Music production model.

2.2. High-Performance Computing Algorithms. Since its appearance in 1946, computers have been continuously developed and advanced, and they have also been fully used in various fields of social production. Although the development is very rapid, human production needs are also expanding. Traditional computing performance cannot meet the current development needs, so high-performance computing has emerged. As the demand for computing power continues to increase, high-performance computing is also undergoing continuous development [16]. The current research directions of high-performance computing include cluster computing, network computing, cloud computing, and FPGA-based reconfigurable heterogeneous computing.

The initial high-performance computing was concentrated in the computing field, but with the continuous improvement of high-performance computing, high-performance computing has basically become a necessary means of research, and high-performance computing can be seen in various fields. Compared with traditional computing, high-performance computing has high-efficiency parallelism, capable of high-density computing, and has obvious advantages in parallel processing of large-scale data streams. High-performance computing technology is not only an important indicator of a country's technical level and comprehensive strength, but also a strategic commanding height technology for national development [17, 18].

From computers, minicomputers to mainframes, the rapid development of computers is still unable to meet the needs of computing. Scientific computing, network computing, terminal computing, cloud computing, super computing, intelligent computing, GPU computing, and other computing modes, concepts, technologies, and applications dominate the progress and development of science and technology [19]. Quantum computing, brain-like computing, borderless computing, human-machine-object ternary fusion computing, data-intensive computing, etc. have brought computing into a multielement era [20, 21]. Although high-performance computing has many advantages, however, the issues affecting the development of high-performance computing are power consumption, energy efficiency ratio, energy saving, ecological environment and industrialization, performance and scalability, reliability and fault tolerance, application efficiency and applicability, efficient management, and low-threshold operation and maintenance. Computing allows humans to explore the unknown; the future development is no longer just a certain technology or a certain type of calculation. It must be a combination of multiple calculations and multiple theories for mutual development [22]. Figure 3 is a schematic diagram of the high-performance scientific computing cluster architecture.

China's research on high-performance computing is relatively late, and the research has officially started since the advent of China's first shared storage multiprocessor system [23]. The Dawning 400A computing power developed in 2004 entered the world's top ten. In 2017, the world's first optical quantum computer that surpassed the early classical computers was born. In 2018, the E-class system was successfully developed. These show that China's computing level has entered the forefront of the world, and it occupies a very important position in the field of performance computing [24, 25]. Figure 4 is a schematic diagram of the high-performance computing architecture.

GC-MS is an analytical instrument that can obtain a set of chronological data during the experiment. During the experiment, the target object is composed of t parts, so each component is $1, 2, 3, \ldots, n$; the specific function expression is as follows:

$$\begin{aligned} W_1 &= W_{11}, W_{12}, \ldots, W_{1M}, \\ W_2 &= W_{21}, W_{22}, \ldots, W_{2M}, \\ W_N &= W_{N1}, W_{N2}, \ldots, W_{NM}. \end{aligned} \tag{1}$$

Among them, W represents different components.

Introducing the above formula into the matrix, it can be simplified to

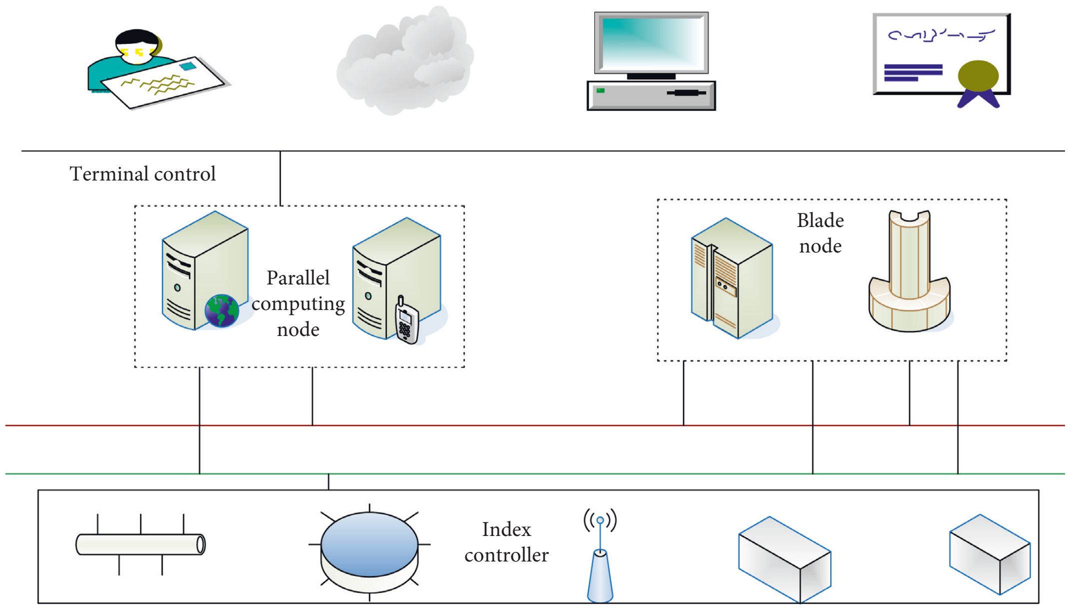

Figure 3: High-performance scientific computing cluster architecture.

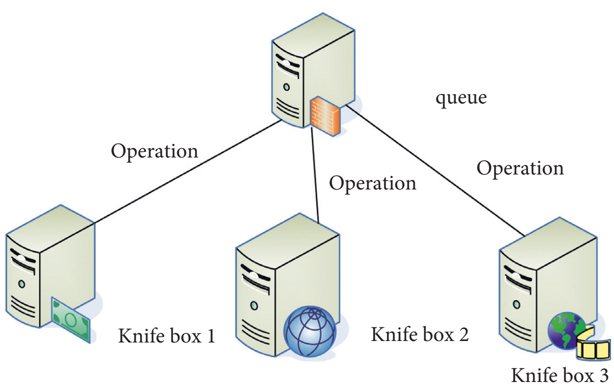

Figure 4: High-performance computing architecture.

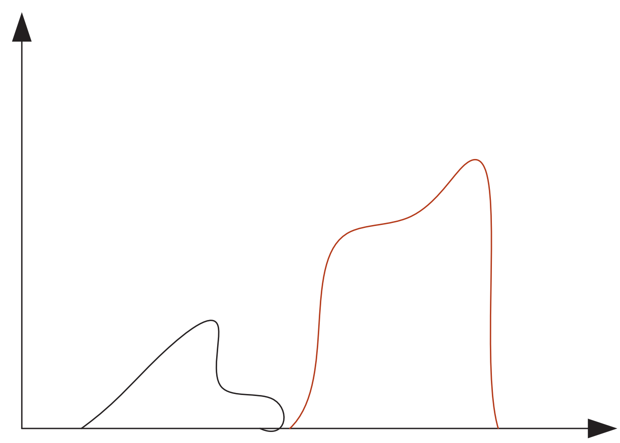

Figure 5: Joint matrix image.

$$W = \begin{pmatrix} W_{11}, & W_{12}, & \cdots, & W_{1M} \\ W_{21}, & W_{22}, & \cdots, & W_{2M} \\ \cdots & \cdots & \cdots & \cdots \\ W_{N1}, & W_{N2}, & \cdots, & W_{NM} \end{pmatrix}. \quad (2)$$

If the matrix is the distribution of n mixtures during the experiment, it can be represented by a two-dimensional matrix. Each row represents the time point, and each column represents the distribution status. The specific function expressions are as follows:

$$E = \begin{pmatrix} E_{11}, & E_{12}, & \cdots, & E_{1N} \\ E_{21}, & E_{22}, & \cdots, & E_{2N} \\ \cdots & \cdots & \cdots & \cdots \\ E_{U1}, & E_{U2}, & \cdots, & E_{UN} \end{pmatrix}, \quad (3)$$

where E represents a two-dimensional matrix.

In summary, formula (3) gives the final experimental results. This matrix is a combination of two matrices, including different time and distribution conditions. If an image is used to describe it, as shown in Figure 5,

$$Q_K(C) = \frac{2}{R(c)} \sum_{k=1}^{n} N_{uk} * Y_{uk}, \quad (4)$$

where Q represents the set of indicators and $Q_K(C)$ represents the indicator under point C.

$$\alpha(C) = \int_M^1 \left(Q_K(C) - \frac{1}{m} \sum_{k=1}^{m} Q_K(C) \right)^3. \quad (5)$$

Among them, according to $0 < Q_K(C) \le 1$, $0 \le \alpha(C) < 0.57$ can be obtained.

$$\beta(C) = 1 - 2 * \alpha(C). \quad (6)$$

Among them, according to $0 \le \alpha(C) < 0.57$, $0 < \beta(C) \le 1$ can be obtained. $\beta(c)$ represents the load index, and $\alpha(c)$ represents the domain of the load index.

$$QW_j(c,r) = \frac{1}{\sqrt{c}} \int_{-\infty}^{+\infty} j(r)\chi^*\left(\frac{w-t}{c}\right)\mathrm{d}w. \tag{7}$$

Among them, $QW_j(c,r)$ is the wavelet coefficient, $\chi(w)$ is the wavelet basis function, and $j(r)$ is the analysis signal.

$$L_V = \mathrm{Wdiag}\left(s_{(v)}\right)D^U + Q_v, \quad v = 1, 2, \ldots, V, \tag{8}$$

where L represents a cubic matrix, W represents a pure chromatogram, and D represents a pure mass spectrum.

$$\begin{aligned}
W_{new} &= \left(\sum_{i=1}^{i} L_i \mathrm{Wding}\left(s_{(v)}\right)\right),\\
Q &= \left(\sum_{i=1}^{i} \mathrm{diag}\left(s_{(v)}\right)D^U \mathrm{Qdiag}\left(s_{(v)}\right)\right)^{-1},\\
U_{new} &= \left(\sum_{i=1}^{i} L_i^E \mathrm{Wdiag}\left(s_{(v)}\right)\right),\\
Y &= \left(\sum_{i=1}^{i} \mathrm{diag}\left(s_{(v)}\right)W^D \mathrm{Wdiag}\left(s_{(v)}\right)\right)^{-1},\\
s_{(i)}^D &= \left(W^D W * F^D F\right)^{-1} \mathrm{diag}\left(W^D L_i F\right)J,
\end{aligned} \tag{9}$$

where J stands for unit vector, $*$ stands for positive, and S stands for sum of squares.

$$\begin{aligned}
&\frac{|S(n) - S(n-1)|}{S(n-1)} \leq 10^{-5},\\
&S = \sum_{k=1}^{k}\sum_{b=1}^{b}\sum_{h=1}^{h} o_{\mathrm{kbh}}^3,\\
&S = \sum_{H=1}^{h} \left\| W_h - \mathrm{Ediag}\left(S_{(V)}\right)D^U \right\|_X^3.
\end{aligned} \tag{10}$$

The residual sum of squares is a measure of the degree of model fit in a linear model. It uses a continuous curve to approximate or compare a group of discrete points on a plane to represent a data processing method for the functional relationship between coordinates.

$$\begin{aligned}
a(y,u,i) &= \frac{\exp(-iy)}{2}\exp\left(i\left(\alpha + i\frac{\partial^3}{2}\right)\right),\\
K(h,j) &= \sum_{j=1}^{m} a\left(h, \varepsilon_i, j_i\right)u_i(h),
\end{aligned} \tag{11}$$

where K represents the experimental database, a represents the pure chromatographic matrix, and h represents the pure mass matrix.

With the continuous development of audio technology, the choice of recording equipment is becoming more and more diversified. In order to achieve the effect, some large studios often use expensive recording equipment for production. In this regard, the Abbey Road recording studio in the UK has to be mentioned. Both the volume and the audio equipment are very staggering, and the cost cannot be supported by any regular school. Of course, the service target of this equipment is also the top people in the industry or individuals who can pay for it [26]. The specific scale is shown in Figure 6.

A common form of recording in large recording studios is microphone recording, but the cost is very high. Before recording, in order to achieve the recording effect, it is necessary to accurately place the microphone position and even adjust the type of the microphone, which will consume a lot of time and affect the recording process. If the sea recording method is used, it can save a lot of debugging time, but the sea recording needs powerful recording equipment for support, such as track mixers and speech amplifiers, which are not what ordinary recording studios can provide. Therefore, only a small part of the population can use the microphone recording method [27].

During the recording process, multiple microphones are often placed, which can not only provide the most suitable piano sound for the later stage, but also collect the environmental reverberation sound to facilitate the later adjustment. The above introduction is the top recording equipment, but this is only a few cases; most people can not reach the top position in the industry and can only use some ordinary recording equipment. Under normal circumstances, only a computer, earphones, and microphone are needed to complete a recording. The simple recording equipment in this article refers to the use of stereo or mono recording methods for piano recording in different performance environments. The mixing equipment cannot be compared with large-scale studios, and special mixing equipment is very expensive. Downmixing technology refers to an audio processing method for multitrack sound materials formed by recording, sampling, or synthesis. That is, these multitrack sound materials are balanced and adjusted and mixed into a qualified audio work with good sound effects. Simple mixing equipment only needs to install music production software on the computer and then use headphones to monitor the sound for postproduction [28]. The volume of some audio tracks is sometimes too high and sometimes too low, because the dynamic range of the audio is too large. Therefore, it is necessary to use a compressor to control the sound, so that the sound can be moved within a certain range, and it is easier to master when listening to the entire sound track when mixing.

Recording is a field that combines sound with science and technology. In layman's terms, the recording microphone collects the sound and then chooses the correct recording method according to the characteristics of the work. The recording methods involved in this article include mono and stereo [29].

Mono recording is widely used in the field of solo musical instruments. This recording method mainly collects different types of sounds by adjusting the distance between the recording microphone and the sound source. Long-distance recording has a better environmental sense of space, but the reflections brought by the environment will also be included, which will cause greater damage to the overall music. The sound collected by close-range recording is more textured and the environment brings less noise, but the distance to the piano is too close, so that the collected piano sound loses its original sense of reality. Figure 7 is a framework diagram of abnormal sound recognition.

Figure 6: Abbey Road recording studio.

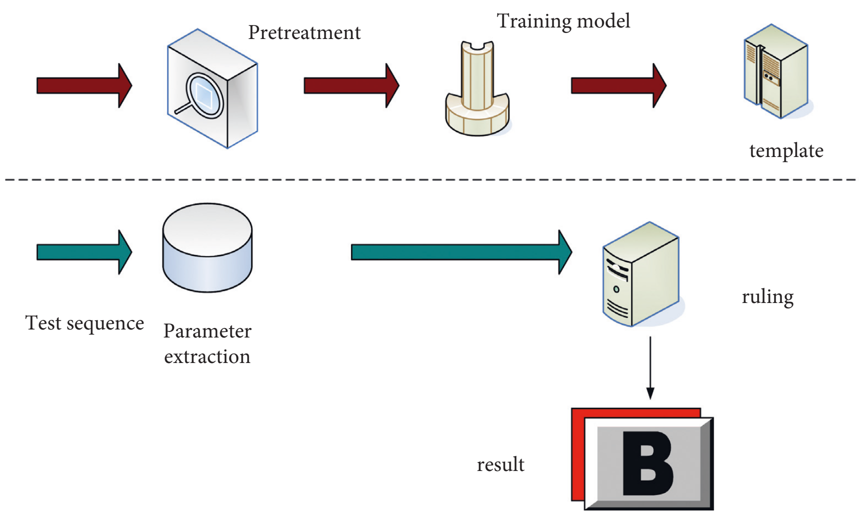

Figure 7: Frame diagram of abnormal sound recognition.

Stereo recording is more practical than mono recording. Common stereo recordings include A-B recording mode and XY recording mode [30].

The A-B standard recording method is to place two microphones together for recording. The diaphragms of the two microphones are directed toward the sound emitting body, and the microphone directivity is generally omnidirectional for recording. In the A-B recording mode, there will be a certain difference in intensity and time due to the distance between the two microphones. The sound obtained by the A-B standard recording is more similar to the sound heard by the human ear from the spatial environment, and the sound is more aesthetic. However, due to the placement of the microphone in the A-B format recording, the resulting sound appears to recede, and the overall sound will also diverge to both sides.

The XY recording method is to record two microphones by crossing them together. There are two ways to cross them together: one is to record in an *X* shape, and the other is to record in a *Y* shape. In XY recording mode, two microphones record at the same position, so there is no time difference in recording, but there will be a difference in sound level.

3. Experiment

3.1. Experimental Data. In this experiment, we classify and identify different types of piano music. Each type is composed of 40 seconds of music. These music fragments are mainly intercepted from mobile phone audio. The storage type of each music fragment is the same. The details are as follows.

According to the data in Table 1, use classical, hip-hop, blues, and rock music as experimental subjects and divide them into four groups. The training number is 300, the verification number is 50, and the test number is also 50.

According to the data in Table 2, we also use classical, hip-hop, blues, and rock music as experimental subjects and divide them into four groups. However, the number of trainings and the number of verifications and the number of tests are different. The number of trainings is changed to 400, the number of verifications is 70, and the number of tests is also 70, in order to form a contrast.

3.2. Piano Intonation. Although all pianos now use the twelve equal temperament, the twelve equal temperament was not used when the piano first appeared. Pure law, as an

Table 1: Experimental music data.

Group	Style	Number of training	Number of verifications	Number of tests
0	Classical	300	50	50
1	Hip-hop	300	50	50
2	Blues	300	50	50
3	Rock	300	50	50

Table 2: Experimental data set.

Group	Style	Number of trainings	Number of verifications	Number of tests
0	Classical	400	70	70
1	Hip-hop	400	70	70
2	Blues	400	70	70
3	Rock	400	70	70

earlier law system, laid the foundation for the development of the entire law system. Pure law refers to the method of dividing each consecutive 4 fifths into a group (the generation of the major third is determined by the consecutive four fifths), with a total of 3 groups, and the last fifth of each group is divided into a common pitch method.

According to the data in Table 3, pure law is divided into pure fifth degree, major third degree, and minor third degree. The main advantage of pure temperament is the large number of pure tones, but there are also disadvantages. Pure temperament has more wolf-tone fifths and more types of minor thirds, which makes the whole temperament too complicated. In addition, the impure fifth degree has a wide distribution range, which makes it more difficult to transfer.

3.3. Twelve Equal Law. The twelve equal law was proposed in the 16th century. The twelve equal temperament is the simplest of all temperament systems. Through the principle of equal frequency ratio of adjacent semitones, the temperament with unequal sound in the past has become the real homophone in the current sense. At the same time, the consistency of intervals, chords, and similar modes of various tones are realized. Because the twelve equal temperament has a proportional relationship, it can carry out the conversion of various complex works and can be freely converted, which realizes the diversified aesthetic needs of the audience. The beat note plays a very important role in the twelve equal temperament and has an important influence on the strength of the entire music. Due to the appearance of wide interval and narrow interval, beat notes appear when the twelve equal temperament is divided. In the entire tuning process, the technician mainly adjusts the pitch by listening to the beat note, which plays a very important role in the piano tuning process.

According to the data in Table 4, the change of the beat note is regular. If an interval moves to a higher sound zone than it, the speed of the beat note will increase. Conversely, if the interval shifts to a lower range, the beat speed will slow down. The change of the beat frequency changes with the change of the interval-frequency ratio. The greater the interval-frequency ratio, the greater the beat frequency, and vice versa, the smaller the beat frequency.

Table 3: Pure law cycle.

Group	bb	f	g	a	b	e	c
Pure fifth	0	0	−22	0	22	0	0
Major third	0	0	0	0	43	0	0
Minor third	7.23	7.21	22	0	22	0	0

Table 4: Interval coordination.

Interval	Four degrees			Five degrees		
Key tone / Pitch frequency	31E 163	36A 220	Beat	32E 163	37A 250	Beat
Overtone frequency	499	440	x	499	440	x
	1150	1050	√	1200	1235	√
	1312	1320	√	1421	1478	x

4. Results

4.1. Sound Field Perception Analysis. During the recording process, check the recording on each track, replace the redundant sounds and bad parts that appear during the recording process with other recording backups, and delete the paused part of the performance.

According to the data in Figure 8, the two variables in the picture are the sound pressure amplitude and the sound pressure phase, and the abscissa is the number of Gaussian components. When there is no Gaussian influence during recording, there is a certain gap between the sound pressure amplitude and the sound pressure phase, but when the number of Gaussians becomes 5, the gap between the sound pressure amplitude and the sound pressure phase is significantly reduced. When the number of Gaussians is 10, the value of the sound pressure phase has an overshoot phenomenon. When the number of Gaussians is 15, the difference between the sound pressure amplitude and the sound pressure phase is the smallest, indicating that the error at this time is the smallest, and it is the most ideal recording environment. When the number of Gaussians is determined, the number of trainings needs to be determined next. From the data in Figure 8, it can be seen that when the number of trainings is 5, the gap between the two is the smallest, indicating that the number of trainings at this time is the best.

4.2. Sound Spectrum Recognition Analysis. In the experiment, we classified different types of piano music. In the specific recording process, we need to identify the map of the piano music. The specific analysis is as follows.

According to the data in Figure 9, in the experiment, we divided the time window into four categories: 0.5 s, 1 s, 1.5 s, and 3 s. Figure 9 shows the microscopic measurements of various analysis frame sizes. With the gradual increase of the analysis window, the overall microdata shows a trend of increasing first and then decreasing at 0.5 s. The trend at 1 s is similar to that at 0.5 s, but the downward trend is less than

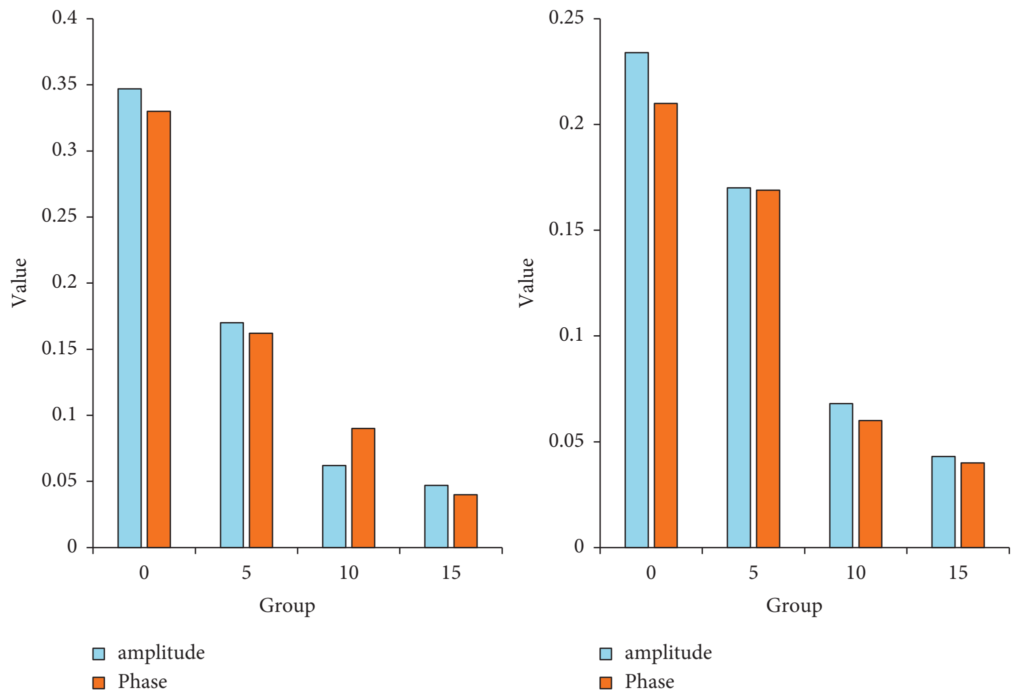

Figure 8: Sound field perception data.

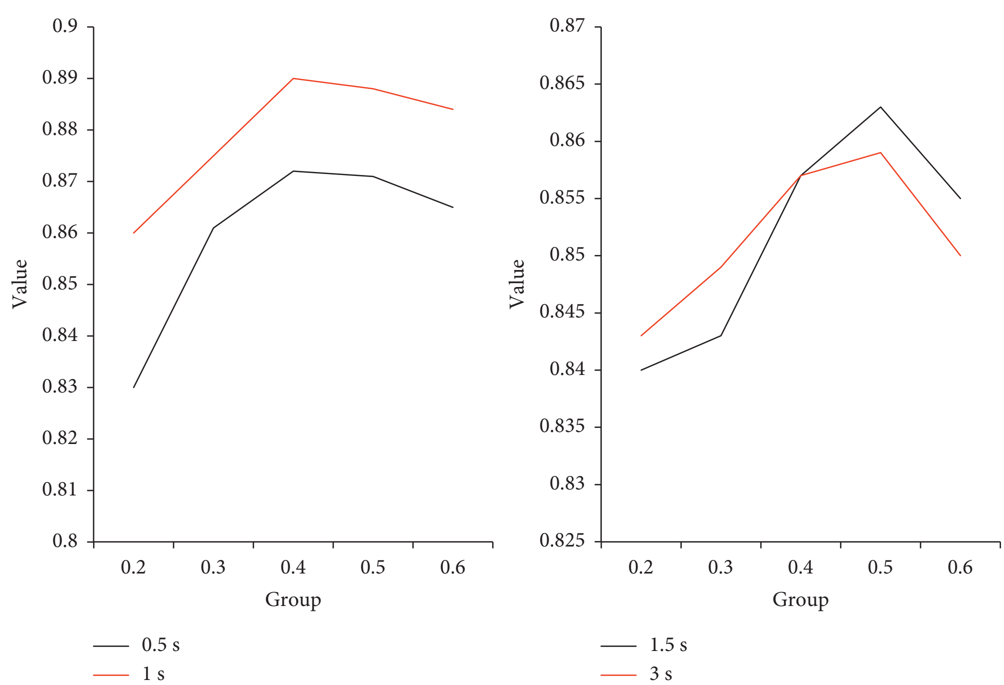

Figure 9: Microwindow analysis.

0.5 s. Although the trends presented by 1.5 s and 3 s are relatively similar, the overall magnitude is smaller.

According to the data in Figure 10, the experimental settings are similar to the micro, and the time window is also divided into four categories: 0.5 s, 1 s, 1.5 s, and 3 s. In the macro comparison chart, there are obvious differences between the four groups. But combining the two sets of pictures can be seen, no matter from the microscopic or macroscopic point of view; when the time is 3 s, the values presented by the pictures are the worst. As the analysis window shrinks, the microscopic view shows the highest value. According to this rule, we can

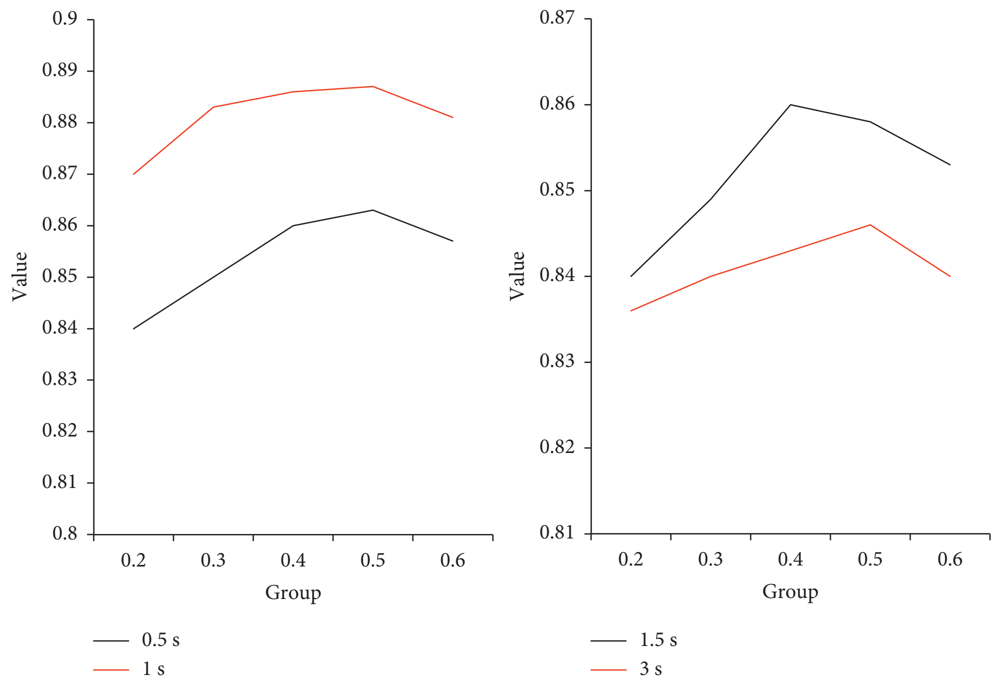

Figure 10: Macro window analysis.

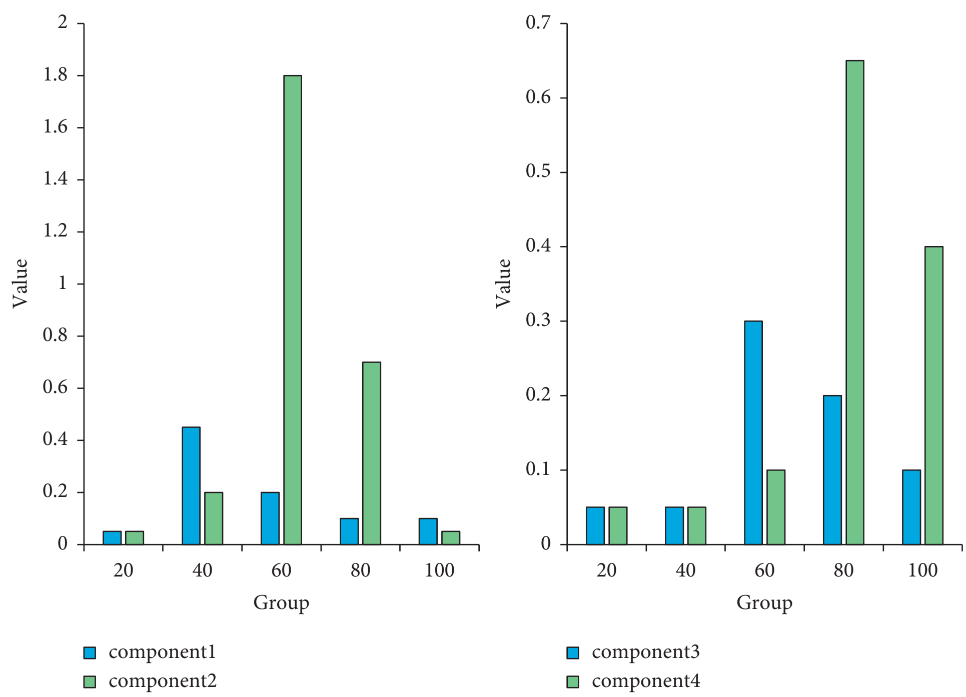

Figure 11: Original chromatographic curve.

think that the overall performance is the best when the whole is in 1 s.

4.3. Kurtosis Matrix. According to the data in Figure 11, the test time during the experiment is 20 s, 40 s, 60 s, 80 s, and 100 s, and the main components are divided into four groups. When the retention time is 20 s, the kurtosis of the four groups is low; when the retention time is 40 s, the kurtosis of the first group of data reaches 450, and the other three groups are still low; when the retention time is 60 s, the kurtosis of the second group is as high as 1800, and the kurtosis of the third group is as high as 3000; when the retention time is 80 s, the kurtosis of the second group is as high as 7000, and the kurtosis of the fourth group is as high as 6500; when the retention time is 100 s, the kurtosis of the four groups has a decreasing trend.

5. Conclusion

With the continuous development of science and technology, people's production needs are increasing, and traditional computing capabilities cannot meet the needs of production. Therefore, high-performance computing has become a current research hotspot. High-performance computing is mainly used to deal with complex computing problems and is widely used in meteorological and environmental fields. With the continuous deepening of research, the amount of data analysis has also increased exponentially. Simply improving hardware equipment can no longer solve the problem, so as to improve computing power is the best way to solve the problem. While the material standard of living continues to improve, the spiritual world also needs to be satisfied. Piano music can cultivate sentiment and is loved by the majority of people. However, the consumption of piano art is high, and how to promote it to the public is a problem that needs to be solved. The combination of high-performance computing and piano recording technology can improve the recording level and meet higher aesthetic needs. In this article, the following work has been mainly completed: (1) exploring the piano architecture, discussing the two recording methods of mono and stereo, and briefly explaining the advantages and disadvantages of the two recording methods. (2) By comparing different window times and thresholds, find the most suitable environment and optimize the recording method.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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