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Retraction

Retracted: Design of Piano Intelligent Teaching System Based on Neural Network Algorithm

Mobile Information Systems

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] B. Chen, "Design of Piano Intelligent Teaching System Based on Neural Network Algorithm," *Mobile Information Systems*, vol. 2022, Article ID 5991124, 10 pages, 2022.

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Research Article

Design of Piano Intelligent Teaching System Based on Neural Network Algorithm

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In recent years, with the improvement of economic level, music art has become a major focus of extracurricular teaching. Students of all ages are included. However, the high cost of piano teaching and the unique one-to-one teaching method of teachers and students lead to the lack of piano education resources. Learning piano has become a luxury activity. Therefore, using computer multimedia software to teach piano has become a feasible way to alleviate the current contradiction. For piano teaching, the main difficulties are the differences between teachers and students (i.e., the data change at both ends due to the network), the instability of the network system, and the neural network algorithm can solve these difficulties. Based on this point, this work aims to introduce neural network algorithm into piano teaching intelligent system. This paper first introduces the theoretical basis of the neural network algorithm, then expounds the algorithm flow and general framework of the algorithm in speech recognition, and explains the split explanation in combination with five aspects: preprocessing, character extraction, acoustic model, linguistic model, and decoding. Then, it introduces the system design of intelligent piano teaching and describes the general system requirements and product architecture. Finally, the intelligent piano teaching system is tested and applied to prove the effectiveness of the system. I hope this intelligent piano teaching system can provide more convenience for piano teaching.

1. Introduction

At present, due to the continuous economic development, people's living standards are improving day by day. In addition to meeting the most basic needs of clothing, food, housing, and transportation, people are looking at higher-level spiritual needs. Therefore, people are more and more enthusiastic about learning piano, and the piano teaching market is also growing. In recent years, the number of people who want to learn piano has increased dramatically [1, 2]. People of all ages have piano lovers, and the number of young children learning piano is the largest. Among the urban middle-class and above families, one-fifth of the families have parents who want their children to learn piano, and the number of people applying for piano grading examination is also increasing at a rate of 20% every year [3]. In addition, due to the implementation of the national education system reform and the continuous expansion of the scale of education, the demand for piano teachers in the education system is also increasing [4]. In this industry, talents with professional knowledge and teaching qualifications have become scarce resources, and this phenomenon cannot be effectively solved in the short term due to various reasons [5]. Based on this point, this paper focuses on the field of information technology and tries to introduce a neural network algorithm to simulate the teaching behavior of piano teachers. As artificial intelligence has a research history of decades, it has developed more maturely in many aspects and is competent to carry out research work [6]. In this paper, the neural network algorithm technology has interacted with the piano teaching intelligent system, and the neural network mathematical model is applied to the construction of the piano performance teaching system. Therefore, first, the principle of the neural network, the construction of the BP neural network, the system design principle based on the BP neural network, and the piano practice speech recognition technology are described, respectively. Second, the system demand analysis and system design structure are described, including the use process of piano intelligent teaching. Finally, the simulation system test is performed. According to the test results, the user experience of the intelligent teaching system designed in this study includes six dimensions: aesthetics, learning, efficiency, reliability, attractiveness, and satisfaction. Then, the intelligent piano teaching system is selected as the research object, a questionnaire survey is carried out on teachers and students, and the final recovered questionnaire is obtained. After analysis, the conclusion is that the system has obtained a good positive evaluation. It is hoped that such an intelligent piano teaching system, which does not need special hardware, covers a wide range of music resources, is easy to use, and can be closely combined with offline teaching scenes, can help piano lovers to invest in the learning process.

2. Related Work

Objective-C language is used in the development of document clients. The back end of the system mainly supports clients, WeChat, and web pages and provides restful API interfaces. The client can detect and evaluate the performance of students according to the existing multitone detection algorithm of the research group [7]. The client first provides tasks to enable students to complete their homework and show them to teachers for demonstration. The WeChat terminal mainly provides student assignment management, user information management, user social network, and other functions [8]. The literature describes the requirement analysis, design, implementation, and testing of the auxiliary piano practice system. The system will provide more convenience and better teaching effect for traditional piano teaching, help students learn piano, and provide convenient learning management tools for parents and teachers [9]. At present, the system has been online. It contains 26 books, 1256 electronic music resources, 6713 registered data, and 752 registered users. The system is well received by users. At the same time, the system is constantly improving through user feedback [10]. This paper presents an intelligent personalized teaching system. Its appearance has changed the traditional information-based education mode and provided a modern education mode for students [11]. Also, it has evolved from a static piano-assisted teaching method to a new system of educational theory with dynamic piano curriculum strategies [12]. The literature discusses the implementation method of piano teaching software and puts forward a new method to determine the piano performance by combining the neural network model (i.e., computer teaching is one-way, and only for the transfer of knowledge, there is no interactive link) to imitate teachers and carry out teaching activities for students [13]. The literature establishes the mathematical model of the neural network, completes the determination and quantification of input and output parameters, and then collects relevant data to train the network [14]. The input is evaluated through music performance, that is, the performance of playing instruments. A large part of the current research activities focus on the computer calculation of these music features, and there have been some research results.

3. Theoretical Basis of Neural Network Algorithm

3.1. Principle of Neural Network and Construction of BP Neural Network. Neuroanatomy and neurocytology show that human thinking is complete in the brain. The basic unit of the human brain is the neuron. Artificial neural networks (ANNs) are interconnected neural networks that receive and process information. Using mathematical and physical methods, the neural networks of the human brain can be simplified, abstracted, and simulated from the perspective of information processing, so as to open up a new method to solve the problems of uncertainty and nonlinear complexity. BP (backpropagation) neural network is the most widely used and deeply studied artificial neural network at present.

An artificial neural network captures and processes the information of neurons and simulates the structure and function of biological neurons. The process of transmitting information to artificial nerve cells is shown in Figure 1.

Neurons have multiple input signals *xio*. $W1j$ is the weight of the connection, *Oj* is the output of the neuron, and f is a specific transfer function relationship, called the excitation function or action function, which is usually a nonlinear function relationship, θ is the threshold value of the neuron, and the output neuron j can be expressed as

$$O_j = f\left(\sum_{j=1}^{n} \sigma_{ij} x_j - \theta_i\right) i \neq j. \tag{1}$$

Order is as follows:

$$y_i = \left(\sum_{j=1}^{n} \sigma_{ij} x_j - \theta_i\right). \tag{2}$$

Then,

$$\mathrm{O_j} = \mathrm{f}\left(\mathrm{y_i}\right). \tag{3}$$

The output "0" or "1" of each neuron indicates the "inhibition" or "excitation" status, respectively; then,

$$O_j = \begin{cases} 0 & y_i \geq 0, \\ 1 & y_i \leq 0. \end{cases} \tag{4}$$

3.2. System Design Principle Based on BP Neural Network. The basic idea of the BP neural network is the forward and reverse transmission of signals. Direct conduction is transmitted from the input layer to the output layer in turn. If the conduction results are inconsistent, the conduction drive will be performed. The error obtained by reverse conduction is transferred to the input layer through the hidden layer in a special way. Even if the weight is corrected, the error is suppressed in all respects to capture the error signal of each layer. In the process itself, the weights are constantly adjusted and iterated over and over again. In both cases, most of the training process of the neural network can be completed, and the learning times are within the predefined setting range.

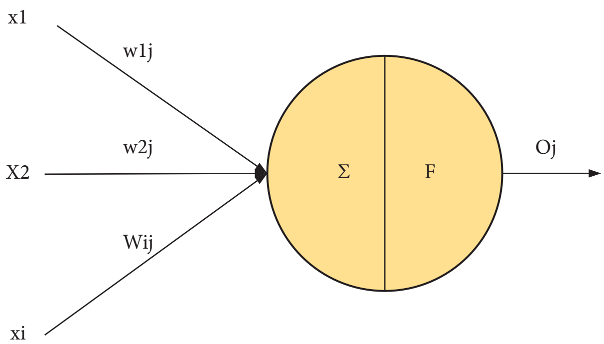

FIGURE 1: Information transmission process of artificial nerve cells.

The commonly used transfer functions in BP neural networks are unipolar log sig function, bipolar tansig function (or hyperbolic tangent function), and purelin linear function. The expression of the log-sig function is

$$f(x) = \frac{1}{1 + e^{-ax}}, (0 < f(x) < 1). \tag{5}$$

The expression of bipolar Sigmoid function (or hyperbolic tangent function) is

$$f(x) = \frac{1 - e^{-ax}}{1 + e^{-ax}}, (-1 < f(x) < 1). \tag{6}$$

The linear function purelin is expressed as

$$f(x) = k^* x + c. \tag{7}$$

Connecting weight W_{ij} and threshold with input layer Θ_j calculate the input s_j of each neuron in the hidden layer and then use s_j to pass the activation function:

$$f(x) = \frac{1}{1 + e^{-x}}. \tag{8}$$

Calculate the output b_j of each neuron in the hidden layer:

$$b_j = f(s_j), \tag{9}$$

of which

$$s_j = \sum_{i=1}^{n} W_{ij} \cdot a_i - \theta_j. \tag{10}$$

Calculate the input l_t (activation value) of each cell of the output layer with the output, connection weight, and threshold of the middle layer, and then, calculate the response c_t of each cell of the output layer with the activation function:

$$c_t = f(l_t), \tag{11}$$

of which

$$l_t = \sum_{j=1}^{p} V_{jt} \cdot b_i - \gamma_t (t = 1, 2, \ldots, q). \tag{12}$$

Using the expected output mode, the network actually outputs c_t to calculate the correction error d_t^k of each unit in the output layer:

$$d_t^k = (y_t^k - ct) \cdot c_t (1 - c_t)(t = 1, 2, \ldots, q). \tag{13}$$

Use V_t^j, d_t^k, b_j to calculate the correction error $e_j^k e^k_j$:

$$e_j^k = \left[\sum_{t=1}^{q} d_t^k \cdot V_{jt}\right] b_j (1 - b_j)(j = 1, 2, \ldots, p). \tag{14}$$

With d_t^k, b_j, V_t^j, and Υ_t, calculate the new connection weight between the next intermediate layer and the output layer:

$$V_{jt}(N + 1) = V_{jt}(N) + \alpha \cdot d_t^k \cdot b_j. \tag{15}$$

$$\gamma_t (N + 1) = \gamma_t (N) + \alpha \cdot d_t^k, \tag{16}$$

where N is learning times.

By ekj, aki, WiJ, and Θj, calculate the new connection weight between the next input layer and the middle layer:

$$W_{ij}(N + 1) = W_{ij}(N) + \beta \cdot e_j^k \cdot a_i^k, \tag{17}$$

$$\theta_j (N + 1) = \theta_j (N) + \beta \cdot e_j^k. \tag{18}$$

The learning process of the BP network is shown in Figure 2.

3.3. Speech Recognition Technology for Piano Practice. The structure of the algorithm and the process for language recognition include five aspects: preprocessing, feature extraction, acoustic model, language model, and decoding search, which will be described one by one below.

3.3.1. Preprocessing. The process of preprocessing speech signals mainly involves endpoint detection and noise reduction.

Endpoint analysis aims to preserve the effective part of speech in the speech stream and eliminate the invalid silent part, including the front-end and back-end recognition of effective speech. In a speech sample, the amplitude of the silent part of speech is small, that is, the signal strength is small, while the amplitude of the actual part of speech is large, that is, the signal strength is large. In terms of time period, the original speech signal is a continuous function. After sampling, it becomes a discrete sequence, which can be processed by a computer. The speech signal is squared and then integrated and summed to obtain the signal over the continuous time interval $[a, b]$, or the total energy of N sampling points from sampling point n,

$$E_{a,b} = \int_a^b v^2(t) dt, \tag{19}$$

$$E_n = \sum_{i=1}^{N} x_{n_j}^2. \tag{20}$$

The speech signal is divided according to the set time to get each part of the speech signal. These features are called

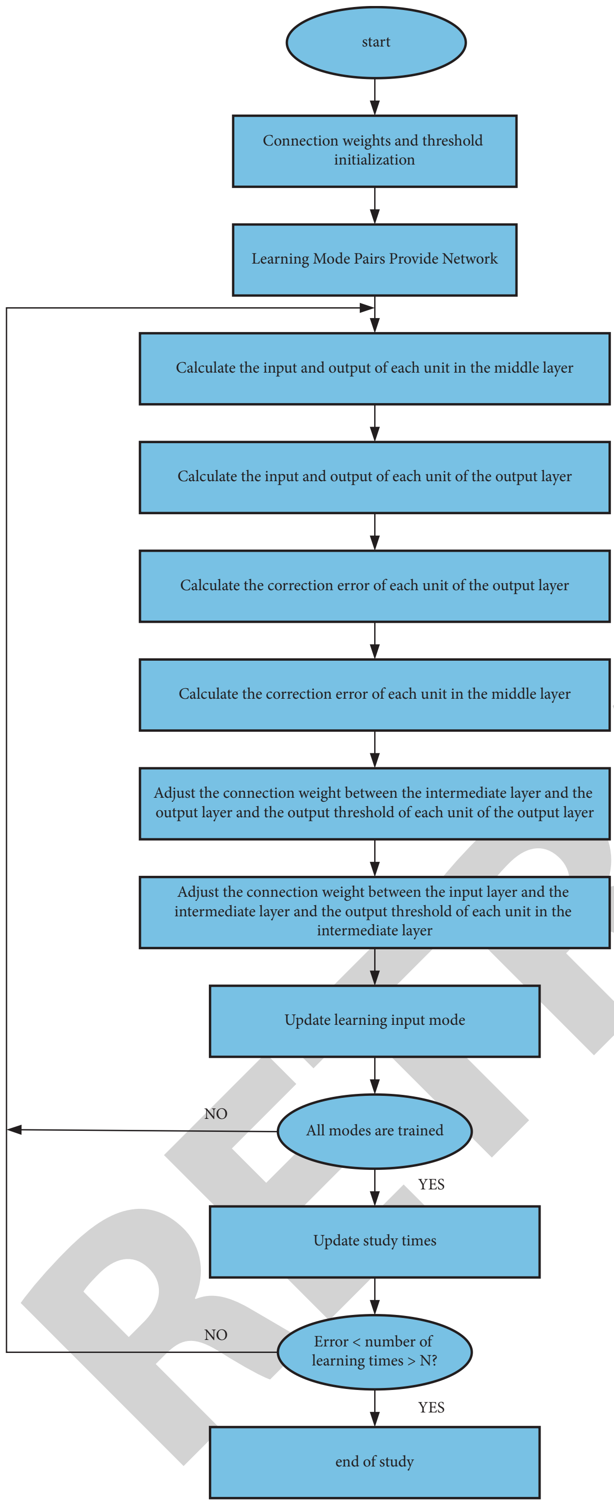

Figure 2: BP neural network learning process.

frames. There are n sampling points in a frame, and the energy value of a frame signal can be obtained from (20). By changing the energy value of each frame, if the energy value of the continuous frame $A0$ before a point is lower than the default standard $E0$, and the energy value of the continuous frame $A0$ is higher than the threshold e, it is called the front end point; if the energy value of a frame point $A0$ is higher than the preset threshold $E0$, and the energy value of subsequent consecutive frames $A0$ is lower than the threshold e, it is called the back endpoint.

3.3.2. Feature Extraction. The speech time domain signal is a waveform sampling point, which is often not directly used for recognition because it is difficult to find the pronunciation rules of the time signal. Even if the pronunciation is similar, it may vary greatly in the time domain. Therefore, the sound spectrum is obtained by a short-time Fourier transform. Then, according to the auditory perception mechanism, the amplitude of each component of the spectrum of the sound segment is adjusted in the unit of frame, so that it can be parameterized to obtain the correct speech signal feature vector, which is expressed as acoustic characteristics.

In this paper, the most widely used and effective Mel frequency cepstrum coefficients (MFCCs) are used as characteristic acoustic parameters, which are cepstrum parameters derived from the Mel scale frequency range. Frequency Mel defines the nonlinear characteristic of human ear frequency, and its relationship with linear frequency is shown in the following formula:

$$Mel(f) = 2595\log\left(1 + \frac{f}{700}\right). \tag{21}$$

3.3.3. Preemphasis. The purpose of this step is to improve the high-frequency part of the signal and flatten the signal spectrum, so as to ensure that the low-frequency to high-frequency part of the whole frequency band can get a uniform signal-to-noise ratio. The principle of preemphasis is to let the signal pass through a high pass filter, and its response function is shown in the following formula:

$$H(z) = 1 - \mu z^{-1}, \tag{22}$$

where the value of u is between 0.9 and 1.0, and 0.97 is taken here.

3.3.4. Windowing. Multiply each frame by the signal framed by the Hamming window to increase the continuity of the left and right frames, where the window function is expressed by the following formula:

$$w(n,a) = (1-a) - a^{*}\cos\left(\frac{2n\pi}{(N-1)}\right), 0 \le n \le N-1. \tag{23}$$

N is the frame size, and the Hamming window generated by different values has no directionality. 0.46 is taken in this paper.

3.3.5. Mel Filtering. Pass the energy spectrum through a set of triangular filter banks on the Mel scale, assuming that the number of filters in the filter bank is m (this paper is 24), and the center frequency of the filter is $f(m)$, $m = 1, 2, \ldots, M$. The frequency response of the triangular filter is given in the following formula:

$$H_m(k)=\begin{cases}\dfrac{2(k-f(m-1))}{(f(m+1)-f(m-1))(f(m)-f(m-1))}, & \\ f(m-1)\le k\le f(m) & \\ \dfrac{2(f(m+1)-k)}{(f(m+1)-f(m-1))(f(m)-f(m-1))}, & \\ f(m-1)\le k\le f(m), & \\ 0,\text{OTHER}. & \end{cases} \tag{24}$$

3.3.6. Logarithmic Operation. Perform logarithmic operation on the output energy, as shown in the following formula:

$$s(m)=\ln\left(\sum_{k=0}^{N'-1}\left|X_a(K)\right|^2 H_m(k)\right),0\le m\le M. \tag{25}$$

3.3.7. Discrete Cosine Transform. MFCC coefficient is obtained by discrete cosine transform, as shown in the following formula:

$$C(n)=\sum_{m=0}^{N-1}s(m)\cos\left(\frac{n\pi(m-0.5)}{M}\right),n=1,2,\ldots,L, \tag{26}$$

where l is the order of MFCC coefficient, M is the number of triangular filters, and the calculation of differential parameters is shown in the following formula:

$$dt=\begin{cases}C_{t+1}-C_t, & t<K,\\ \dfrac{\sum_{k=1}^{K}k(C_{t+k}-C_{t-k})}{\sqrt{2\sum_{k=1}^{K}k^2}}, & \text{OTHER},\\ C_t-C_{t-1}, & t\ge Q-K,\end{cases} \tag{27}$$

where dt represents the order difference of t, C_t represents the cepstrum coefficient, t represents the order of cepstrum coefficient, and K represents the time difference of the first derivative. Second-order variable parameters can be obtained.

3.3.8. Acoustic Model. The function of the acoustic model is to calculate $P(x|w)$, which represents the probability of being recognized as a speech signal in a text sequence (where X represents the feature extracted from the speech frame, and W represents the text sequence). The acoustic model is the mapping relationship between the basic unit of speech and acoustic model. You can select different basic acoustic units to create an acoustic model. English usually uses phonemes for modeling, while Chinese can use phonemes, syllables, or words for modeling. For large recognition words, phonemes are usually used as the basic model.

3.3.9. Linguistic Model. The purpose of acoustic model is to map the acoustic features of speech to the basic units of phonemes or words, while the purpose of the language model is to decode phonemes or word sequences into complete expected sentences. For example, Yuanli is decoded in the acoustic model, but there is more than one equivalent result, such as principle and distance. The task of language model prediction is to find the most appropriate result from these possible results. The language model refers to the probability of word event sequence. Suppose a sentence consists of $W=W1,W2,Wn$, the probability of generating sequence W is expressed by the following formula:

$$P(W)=P(w_1)P(w_2|w_1)P(w_3|w_2,w_1)P(w_4|w_3,w_2)\ldots P(w_n|w_{n-1},w_{n-2}). \tag{28}$$

3.3.10. Decoding Search. The purpose of decoding is to find the most likely phrase for the input speech signal after participation according to the acoustic and language patterns. The scores of the trained acoustic model and the language model are obtained, respectively, and then, the two scores are combined to search for the best candidates, and finally, the results of language recognition are obtained as shown in the following formula:

$$W^*=\arg\max_W P(X|W)P(W). \tag{29}$$

4. Piano Intelligent Teaching System Design

4.1. System Requirements Analysis. For an online education product, the overall needs analysis of the system is inseparable from the subjects, namely students. The intelligent piano teaching system in this paper is aimed at students and needs the participation of parents to achieve better teaching results. At the same time, through the research on the offline piano education market, we found that all students studied in the piano school, and the piano school appointed teachers to train students. Therefore, we also need to organize teachers through principals. In short, there are five types of users of the intelligent piano teaching system: system administrators, parents, students, teachers, and principals. The system administrator is responsible for uploading and managing scores, viewing and analyzing performance data, and analyzing user behavior. Parents are responsible for providing and supervising homework and managing student information. Students must review the presentation and complete the assignment. Teachers are responsible for supervising students and assigning homework. The principal is responsible for teacher development. Based on the above analysis, the overall requirements diagram of the system can be fundamentally determined, as shown in Figure 3.

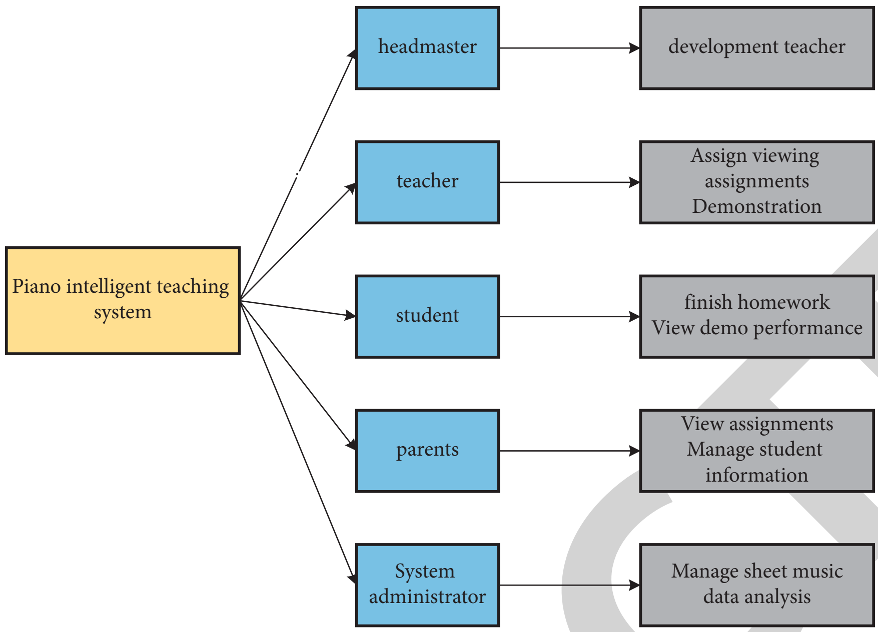

Figure 3: Overall system requirements diagram.

4.2. System Architecture Design. Intelligent teaching system is an important development direction of CAI. This means that developers are using artificial intelligence technology to make computers play the role of teachers in personalized teaching and implement personalized teaching modes for students. Students with different learning characteristics and abilities should adopt different learning strategies to carry out adaptive teaching in the future learning direction of students, so as to achieve the purpose of truly personalized teaching. Generally speaking, the logical structure of intelligent teaching system is roughly divided into three module structures and four module structures. However, with the progress of science and technology and the emergence of new technologies, the logical structure of intelligent teaching system has also been affected, resulting in appropriate changes.

Generally speaking, the basic logical architecture of intelligent teaching system is usually composed of three basic modules: student module, teacher module, and knowledge base, as shown in Figure 4.

4.2.1. Student Module. This module is responsible for recording students' personal information, courses, and examination questions. Teachers can master students' basic information, learning ability, and cognitive ability through this module. It also analyzes the students' current information data to correctly judge the students' understanding of knowledge and adopts appropriate teaching methods for personalized teaching.

4.2.2. Teacher Module. Through this module, teachers can understand students' different information, select the teaching content that students need to learn, and present it to students in the form that students will accept, so that students can get good guidance from teachers and study teaching strategies suitable for students. Through this system, teachers can master students' basic information, learning ability, knowledge mastery, and examination results and then formulate corresponding teaching arrangements.

4.2.3. Expert Knowledge Module. Knowledge base, which is used to store all teaching knowledge, facilitates students' learning and provides students with the knowledge they want to learn. The characteristics of the knowledge base are ready-made and applicable, which is the need to solve the problems in the professional field. All teaching knowledge stored, organized, and managed in computer memory is stored in the form of knowledge base, which can be used in other modules. The database server is mainly used to store various teaching resources, such as students' and teachers' personal model information base, professional knowledge base, model teaching knowledge base, and learning/testing history database, as shown in Figure 5.

4.3. System Use Process. The design of UT (user interface) has a very important impact on the quality of software. There is a lot of knowledge involved, but the general principle is to let the user spend less time and steps on operation and complete as many tasks as possible. The minimum time means the time required for the user to be familiar with the interface.

Learning music theory knowledge is accomplished by combining text, photos, sound, animation, and other multimedia teaching contents. This can be accomplished in two steps: one is the process of knowledge transfer, and the other is the process of knowledge qualification level verification. Music theory knowledge should be classified first. These courses can be selected according to different characteristics.

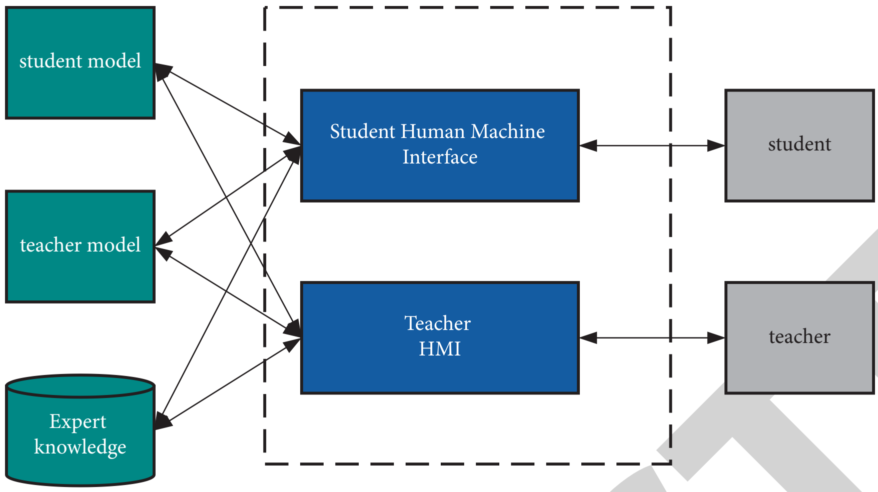

Figure 4: Logical structure of intelligent teaching system.

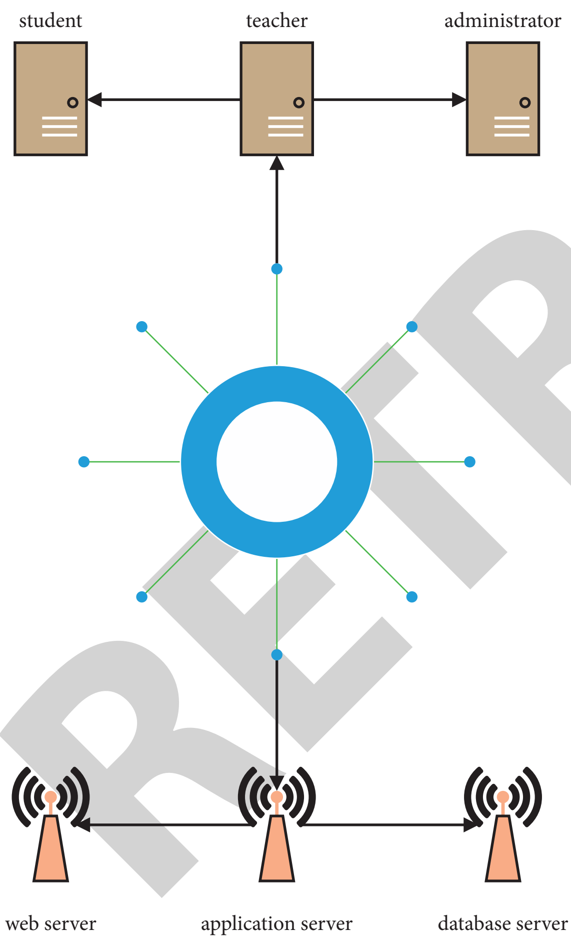

Figure 5: Topology diagram.

For example, according to the order of learning difficulty, the learning order includes staff, fingering, chord, and rhythm. At the same time, students can choose courses according to different arrangements, such as choosing chord courses, which are arranged according to chord names. In this way, students can not only learn step by step but also browse different knowledge points easily and quickly.

4.3.1. Playing Music. When learning the course, students should first understand the learned repertoire by playing music, and students will have an impression: "the effect they should achieve when playing this song". Music playback is divided into two modes: accompanied and unaccompanied. When playing music, the staff is dynamically displayed.

4.3.2. Performance Practice. The performance practice adopts a 3D animation mode, so that students can clearly see each key played, each key corresponds to different fingering, and the staff is dynamically displayed at the same time.

4.3.3. Audio Visual Explanation. The software can imitate the piano teacher for teaching, which can be realized by recording and playing the piano teacher's video and audio.

The most important thing in learning the piano is practice. Once the theoretical knowledge is understood, it does not need to be understood in the performance process, so that the player can correctly and skillfully use the skills described by the theoretical knowledge of piano performance. When playing the piano, first determine the repertoire to be played, and then practice it in the following different ways.

After the track is determined, the score is displayed. The performer will decide the time and speed of performance and then perform the verification performance. During this performance, the system will automatically identify the performance progress and display the corresponding music score.

After the track is determined, the score will be displayed and played at standard speed. During the performance, the performer must follow the progress shown in the music score. If the notes are lost, the score progress is displayed in black, and the completed notes are highlighted in red or green. The performer can choose whether to activate the metronome during the performance.

After the track is determined, the music score will not be displayed, and the standard speed will be used for performance. The notes are played in an animated way, and the

Table 1: System read performance under short connection.

Number of threads	Number of connections	Average requests per second	Average request processing time (MS)	Success rate (%)
8	20	12141.39	10.18	100
8	50	14038.95	11.64	100
8	200	17182.08	13.37	100
8	500	15337.66	20.29	100
8	1000	11646.57	28.47	100

pitch description of the notes is displayed in different positions by displaying the notes to be played in advance.

Different lengths are used to represent the duration of notes, and different brightness is used to represent the intensity of notes. If the note animation falls into a certain position, the player must play the note. The player can choose whether to activate the metronome during performance.

The three modes of playing practice have their own characteristics. The first one is suitable for students who are very good at playing, and the second one is suitable for students who are familiar with music scores. The third kind is suitable for novices. They have an intuitive understanding of the notes played by the piano and can easily get started without any theoretical study.

After the performance practice is completed, the system will provide the overall level assessment and give the performance data that need to be improved, including wrong rhythms and notes.

5. Test and Application of Piano Intelligent Teaching System

5.1. System Test. In-depth testing of system performance is an important part of system tuning. Only when the system is exposed to a high load environment can we find some code problems, performance bottlenecks, and architecture design problems that do not exist under low load conditions. The performance test of the system is carried out by using wrk performance test tool. Wrk performance tester is a high-performance pressure tester created based on C language. Compared with ab pressure tester, wrk supports multi-threading, and the underlying layer encapsulates epoll i/o reuse model, which greatly reduces the creation and programming overhead of multiple AB tools. The basic method to use the wrk tool is to enter "wrk-t [number of threads]-c [number of connections]-d [test duration]-h [HTTP request header] URL" on the command line. Here, the number of threads is usually twice the number of cores of the test machine. At the same time, we can use Lua to write scripts for more complex tests.

Here, we first test the readability of the system. At this point, we select the interface to obtain a list of all scores of the stress test. The HTTP method of this interface is obtained, which only reads the database. Since the number of CPU cores of the test machine is 4, we use 8 threads and the test duration is 30 seconds. Because wrk uses the http/1.1 protocol, long connections are allowed by default. We will use long and short connections to send requests to the server under test for testing. The test results are shown in Table 1.

It can be concluded from the test results that if the number of connections opened by the wrk tool is 100, the processing capacity of the system will reach the peak, and the average number of requests per second will be the highest. If the number of connections exceeds 500, the system will open more connections at the fastest speed, but the average number of requests per second will decrease and the response time of the system will increase, but the system is still stable. Although the service is provided, the response is very slow, indicating that the stability of the system is sufficient. At the same time, if the requesting application is a long connection, the processing capacity of the system is much higher than that of a short connection. This is because if the application is a long connection, the wrk tool does not need to repeatedly establish and disconnect. Eliminating three TCP handshakes can greatly reduce the overall cost of establishing a connection. At present, the actual demand is between full-length connection and full-short connection, so the actual readability of the system is between the two.

The write capability of the system is tested here. The music score upload is selected as the loading pressure test. The HTTP method of this interface is posted. After receiving the music XML file and the music score diagram file, the server uploads the two files to the Alibaba cloud OSS server and writes them to the database. At the same time, you need to write a Lua script to test. The write capability test of the long connection system is shown in Table 2.

It can be seen from the test results that the writing capacity of the system is lower than the reading capacity. This is because MySQL takes longer to write data than to read data, and the file overload from the server to the Alicloud OSS server is also high. In the current business, the system will receive more get requests than postrequests, so the current write capability of the system can support the existing business.

5.2. User Feedback. The characteristics of the surveyed teachers using the piano intelligent teaching system in the six dimensions of user experience are shown in Table 3 (notes: 1 = strongly opposed, 2 = opposed, 3 = neutral, 4 = agreed, and 5 = strongly agreed). In general, the general characteristics of teachers' user experience in all dimensions of the intelligent piano teaching system are above average. Among them, the three dimensions of learning (average = 3.89, standard deviation = 0.61), attraction (average = 3.86, standard deviation = 0.64), and satisfaction (average = 3.91, standard deviation = 0.68) have a higher level of relative identity, while the three dimensions of aesthetics (average = 3.77, standard deviation = 0.70), efficiency

Table 2: System write performance under long connections.

Number of threads	Number of connections	Average requests per second	Average request processing time (MS)	Success rate (%)
8	20	3076.591	20.25	100
8	50	4927.851	23.96	100
8	200	569.5996	26.65	100
8	500	5237.436	36.60	100
8	1000	4041.313	38.46	100

Table 3: Teachers' attitudes towards piano intelligent teaching system in various dimensions of user experience ($n = 74$).

Dimension	N	Minimum value	Maximum	Mean value	Standard deviation	Median
Satisfaction	74	2.00	5.00	3.91	0.68	4.00
Reliability	74	2.00	5.00	3.81	0.66	4.00
Attractiveness	74	2.00	5.00	3.86	0.64	4.00
Efficiency	74	1.75	5.00	3.75	0.78	4.00
Learning	74	2.00	5.00	3.89	0.61	4.00
Beauty	74	1.00	5.00	3.77	0.70	4.00

Table 4: Students' attitudes towards piano intelligent teaching system in various dimensions of user experience ($n = 444$).

Dimension	N	Minimum value	Maximum	Mean value	Standard deviation	Median
Satisfaction	444	1.00	5.00	3.17	0.80	3.00
Reliability	444	1.00	5.00	3.18	0.74	3.25
Attractiveness	444	1.00	5.00	3.23	0.79	3.20
Efficiency	444	1.00	5.00	3.11	0.81	3.00
Learning	444	1.00	5.00	3.64	0.78	3.50
Beauty	444	1.00	5.00	3.31	0.78	3.25

(average = 3.75, standard deviation = 0.78), and reliability (average = 3.81, standard deviation = 0.66) have a lower level of identity.

The characteristics of the students using the piano intelligent teaching system in the nine dimensions of user experience are shown in Table 4 (Note: the same as the table above). In general, students who use the piano intelligent teaching system usually score above average in each dimension. Except that the learning dimension has a relatively high level of identity (mean value = 3.64, standard deviation = 0.78), there is no significant difference in the level of identity of other dimensions.

6. Conclusion

With the development of the Internet, online education is more developed at this stage. Nowadays, online education is essentially a video learning course based on traditional teaching, and Internet-based education has become the development trend in the industry. In the field of quality education, especially in the subfield of music education, many enterprises and institutions have also begun to build intelligent online music education products to improve teachers' teaching efficiency and impact on students' learning. Music education is an important part of human cultural heritage, and piano education is the top priority of music education. Receiving good piano education can improve one's cultural quality, cultivate one's sentiment, promote self-development, and develop one's intelligence to improve coordination. Through the in-depth study of the neural network algorithm model, piano teaching methodology, and music theory, this paper establishes the framework of the piano teaching system based on the artificial neural network model, completes the construction of the system, and carries out tests to verify its reliability, hoping to provide help to people who want to learn piano.

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 that they have no conflicts of interest.

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