

Research Article

Analysis on the Application of Multimedia-Assisted Music Teaching Based on AI Technology

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In order to improve the effect of modern music teaching, this paper combines AI technology to construct a multimedia-assisted music teaching system, combines music teaching data processing requirements to improve the algorithm, proposes appropriate music data filtering algorithms, and performs appropriate data compression processing. Moreover, the functional structure analysis of the intelligent music teaching system is carried out with the support of the improved algorithm, and the three-tier framework technology that is currently more widely used is used in the music multimedia teaching system. Finally, in order to realize the complex functions of the system, the system adopts a layered approach. From the experimental research results, it can be seen that the multimedia-assisted music teaching system based on AI technology proposed in this paper can effectively improve the effect of modern music teaching.

1. Introduction

The main function of constructing a music teaching multimedia system is to realize resource sharing. In the system, a variety of teaching courseware can be provided for students to appreciate and help improve students' level. Music is a hands-on course that requires in-depth discussions between students and teachers, so as to quickly improve the level of singing or performance and personal performance. The combination of traditional teaching methods and informatization methods can help in learning from each other's strengths and can improve students' interest in learning through some video and audio [1]. Specifically, the significance of constructing a multimedia system for music teaching is mainly manifested in the following aspects. The multimedia system is a rich resource library, which can realize the fair distribution of educational resources [2]. Music majors can view the music resources shared in the multimedia system. There is no difference between good and bad conditions, so that every student has equal educational opportunities, which helps to improve students' music literacy and teaching quality [3].

It can provide a brand-new communication method and interactive platform between students and teachers. Under the traditional teaching mode, the communication between teachers and students is limited to the classroom or the phone. When students encounter problems in the music process, they often have trouble to be resolved in time. For this purpose, this topic provides an intelligent question-and-answer module, which supports automatic answering of students' questions, so that students' learning is no longer restricted by time and can ask questions at any time. If you encounter a question that the system cannot answer, you can leave it behind and solve it together when the teacher is online or in class, which can improve efficiency. Each student's learning style is different and is not the same, and the traditional teaching mode cannot meet the learning needs of different students, and under the information mode, students can develop a learning plan that meets their personal characteristics according to their needs, so that they can fully explore intrinsic potential of the individual, improving students' ability to learn independently. The music teaching system provides a wealth of music teaching resources, including multimedia courseware and teaching audiovisual. Each student can choose teaching resources that match the

progress according to their needs to learn, which can give full play to the students' learning initiative, which is the teacher's teaching and student learning. The auxiliary tools also help to improve the teaching quality of music majors in a university.

Artificial intelligence is becoming an important tool for automatic and personalized learning. The application of AI makes music education and creation easier than ever. For example, using the artificial intelligence music creation Amper Music, students can create their own music albums, and SmartMusic can also synthesize and create music. These new forms of music creation greatly stimulate students' innovation and creativity in music. The application of artificial intelligence technology can complete the extraction, processing, and storage of MIDI cloud data. The teaching quality evaluation is carried out through the music classroom teaching wisdom evaluation platform. Evaluate the knowledge points of music appreciation and investigation: singing or performance form; timbre discrimination (instrumental music, vocal); musical structure, mode discrimination, and music genre; and the characteristics of musical elements and musical styles. Turning subjective evaluation into objective evaluation to a large extent changes the existing music education system.

This article applies AI technology to music teaching and combines multimedia technology to construct a multimedia-assisted music teaching system based on AI technology to improve the scientificity and effectiveness of music teaching.

2. Related Work

The application of metadata to describe the organization and network of educational resources to improve the existing educational resource utilization structure is the GEM project. The core principle of the development of the specific element data element of GEM is the core of the project [4]. GEM reuses the 15 elements of the Dublin Core Metadata Element Set (DC) as the core element and is expanding functionally based educational resources. GEM Cat is a coding software for users' educational resource metadata. With GEM Cat users, corresponding metadata records of educational resources are generated, and metadata records are used to describe and locate network resources [5]. The design principles of the American Educational Resource System emphasize that GEM does not collect actual resources, only storage resources for metadata information. The collection of all the records assembled on the GEM constitutes the basic resource of the entire education. The acquisition module collects metadata records in order to create a simple HTML page in a record gateway abroad, and teaching resource management system has been used for many years [6]. GEM Cat is a coding software for users' educational resource metadata. With GEM Cat users, corresponding metadata records of educational resources are generated, and metadata records are used to describe and locate network resources. For example, in the card catalog library, metadata are formed in two forms, and other metadata records in which the resource is embedded can be

saved as a separate file [7]. The acquisition plan is to collect all the metadata resources about a specific website to form a local site index and a catalog list of portal websites editors to add resources [8]. The design principles of the American Educational Resource System emphasize that GEM does not collect actual resources, only storage resources for metadata information. The collection of all the records assembled on the GEM constitutes the basic resource of the entire education. The acquisition module collects metadata records in order to create a simple HTML page which is the relevant educational resource in a record gateway system [9]. BrowseBuilder is an online educational resource search engine of the project, which integrates a wide range of public and nonpublic information suppliers, educational institutions at all levels, and educational management and information resources. Users can search for the educational resources they need, or browse the web by keywords or topics [10].

GEM Cat, Harvest, and Browse Builder editing and organizing tools of GEM project metadata specification are developed to build a huge educational resource description metadata record database on this basis. The educational resource management system enables teachers and students to effectively and accurately obtain information about these organizations [11]. The goal of the project is to achieve cooperation between different education departments and many training institutions in different countries. From the development of EdNA, the system develops local information resources and metadata standards. Government and nongovernmental organizations, schools, vocational education and training, adult education, and higher education (EdNA) provide a rich resource for services [12]. EdNA provides two main services: education and training and information catalog and online education resource library. Metadata development and editing tools, EndA Toolset development, created the Australian education portal EdNA online [13]. It is developed and managed by a nonprofit organization-education Co., Ltd. It is subordinate to the Australian Ministry of Education and Training and supervises its use to ensure the quality of resources. Metadata standards follow the electronic resource specifications to ensure that education departments and training institutions discover and manage network resources to achieve the development of interconnection. EdNA online creates a complete index of course resources. It contains two structures: all education and training catalog levels [14].

3. Multimedia Music Teaching Music Processing Based on AI Technology

As per the regularity of wavelet basis, the vanishing moment order of wavelet function φ and the support of p have a greater influence on music compression; we will introduce the classification of wavelet basis and the relationship between wavelet basis and data compression.

There are many types of wavelet bases, including orthogonal, biorthogonal, and some that are approximately completely reconstructed. Below, we focus on several commonly used wavelet bases.

$\{V_j\}_{j \in \mathbb{Z}}$ is a multiresolution analysis of $L^2(\mathbb{R})$, and ϕ is the scaling function of the multiresolution analysis, which satisfies the two-scale equation [15]:

$$\phi(x) = \sum_{n \in \mathbb{Z}} h(n)\phi(2x - n). \quad (1)$$

Here,

$$h(n) = \langle \phi(x), \phi_{-1,n}(x) \rangle = \sqrt{2} \int \phi(x)\phi(2x - n)dx. \quad (2)$$

The Fourier transform of $h(n)$ is

$$H(\omega) = 2^{-1/2} \sum_n h(n)e^{-jn\omega}. \quad (3)$$

Under the regular conditions, the filter $H(\omega)$ or $h(n)$ satisfies the following two equations:

$$\begin{aligned} |H(\omega)|^2 + |H(\omega + \pi)|^2 &= 1, \\ H(0) &= 1. \end{aligned} \quad (4)$$

or

$$\begin{aligned} \sum_n h(n - 2k)\bar{h}(n - 2l) &= \delta_{kl}, \\ \sum_n h(n) &= \sqrt{2}. \end{aligned} \quad (5)$$

From the point of view of the filter, we need to find a conjugate filter $H(\omega)$ or $h(n)$ [16]:

$$H(\omega) = \left(\frac{1 + e^{-j\omega}}{2} \right) Q(e^{-j\omega}). \quad (6)$$

The scaling function is constructed by iterative filtering, and then the orthogonal wavelet basis is constructed from the scaling function $\phi(x)$:

$$\begin{aligned} \varphi(x) &= \sqrt{2} \sum_k g(k)\phi(2x - k), \\ g(x) &= (-1)^{k-1} h(1 - k). \end{aligned} \quad (7)$$

or

$$\begin{aligned} \varphi(\omega) &= G\left(\frac{\omega}{2}\right)\phi\left(\frac{\omega}{2}\right), \\ G(\omega) &= 2^{-1/2} \sum_k g(k)e^{-jk\omega}. \end{aligned} \quad (8)$$

Generally, we hope that the filter is real; that is, the coefficients of $H(\omega)$ are real, so the polynomial Q should also have real coefficients. According to the structure of $H(\omega)$, the filter H has N zeros at $z = -1$ on the unit circle, and the square of the filter's modulus is $|H(\omega)|^2 = (\cos(\omega/2))^N |Q(e^{-j\omega})|^2$. Since Q is a polynomial with real coefficients,

$$\begin{aligned} |Q(e^{-j\omega})|^2 &= Q(e^{-j\omega})Q^*(e^{-j\omega}) = Q(e^{-j\omega})Q(e^{j\omega}), \\ &= \sum_m \sum_n q_m q_n e^{-j(m-n)\omega} = \sum_{k=-\infty}^{+\infty} q_k \cdot e^{jk\omega}, \\ &= \sum_{k=-1}^{+\infty} 2q_k \cdot \cos(k\omega). \end{aligned} \quad (9)$$

Therefore, $|Q(e^{-j\omega})|^2$ can be expressed as a polynomial of $\cos(k\omega)$. If $|Q(e^{-j\omega})|^2 = P(\sin^2(\omega/2))$ and $y = \cos^2(\omega/2)$, then the conditional expression of the conjugate filter can be rewritten as [17]

$$|H(\omega)|^2 = |H(\omega + \pi)|^2 = y^N P(1 - y) + (1 - y)^N P(y). \quad (10)$$

Here, $P(y) \geq 0, y \in [0, 1]$. Solving the conjoint filter $h(n)$ is transformed into finding a polynomial $P(y)$ that satisfies the above formula.

In fact, the practical application of conjoint filters often requires a finite length, the so-called compact support, which requires the filter $h(n)$ to be nonzero only in a limited area: $h(n) = 0, n \notin [N_-, N_+]$. The scale function $|H(\omega)|^2$ and wavelet function $p(x)$ constructed by the conjoint filter of compact support also have compact support characteristics. On the other hand, since the filter $A(n)$ has only a finite number of nonzero points, the polynomials Q and P also contain only finite terms.

We can summarize the process of constructing a conjoint filter into the following five steps:

- (1) The algorithm sets a $N - 1$ order polynomial $P_N(y)$ that satisfies the following conditions: (a) $P_N(y) \geq 0$; (b) $y^N P_N(1 - y) + (1 - y)^N P_N(y) = 1$; (c) $\sup P_N(y) < 2 * 1$ [18]:

$$P_N(y) = \sum_{n=0}^{N-1} C_{N-1+n}^n y^n. \quad (11)$$

- (2) The algorithm sets $Z = e^{-j\omega}$ and finds all the zeros of the polynomial $P_N(0.5 - 0.25Z - 0.25Z^{-1}) = P_N(\sin^2(\omega/2))$:

$$\begin{aligned} r_k, r_k^{-1} (k = 1, 2, \dots, K), Z_l, (Z_l)^*, Z_l^{-1}, \\ \cdot (Z_l^{-1})^* (l = 1, 2, \dots, L). \end{aligned} \quad (12)$$

- (3) On the unit circle ($Z = e^{-j\omega}$), set the algorithm

$$\begin{aligned} |Q_N(e^{-j\omega})|^2 &= P_N\left(\left(\sin^2\left(\frac{\omega}{2}\right)\right)\right) = \sum_{n=0}^{N-1} C_{N-1+n}^n \sin^{2n}\left(\frac{\omega}{2}\right) \\ &= \frac{1}{2} \prod_{k=1}^K |r_k|^{-1} \cdot \prod_{l=1}^L |Z_l|^{-2} \\ &\cdot \left| \prod_{k=1}^K (e^{-j\omega} - r_k) \prod_{l=1}^L (e^{-j\omega} - Z_l)(e^{-j\omega} - (Z_l)^*) \right|^2. \end{aligned} \quad (13)$$

(4) The algorithm writes a polynomial $Q_N(e^{-j\omega})$:

$$|Q_N(e^{-j\omega})| = \sqrt{0.5 \prod_{k=1}^K |r_k|^{-1} \cdot \prod_{l=1}^L |Z_l|^{-2} \cdot \prod_{k=1}^K (e^{-j\omega} - r_k) \cdot \prod_{l=1}^L (e^{-2j\omega} - 2\text{Re}(Z_l)e^{-j\omega} + (Z_l)^2)}. \quad (14)$$

(5) The algorithm compares the coefficients on both sides of the following equation to obtain the various parameters of the filter $A(n)$:

$$H(\omega) = \sqrt{0.5} \sum_n h(n) e^{-j\pi\omega} = \left(\frac{1 + e^{-j\omega}}{2} \right)^N Q_N(e^{-j\omega}). \quad (15)$$

For signal filtering, we all want the filter to have a linear phase, which requires the filter to have a symmetrical structure. Except for Harr bases, all available orthogonal conjugate filters with compact support characteristics and their wavelet bases do not have a symmetric structure.

In order to find a tightly supported filter bank with a symmetrical structure to realize the wavelet analysis of the signal, one approach is to appropriately relax the requirements for the orthogonality of the filter and use the biorthogonal filter. From the perspective of multiresolution analysis, we will use a pair of dual but unsystematic scale functions and wavelet functions during analysis and synthesis. $\phi, \hat{\phi}, \varphi, \hat{\varphi}$ represents analysis scale and comprehensive scale function and analysis wavelet and comprehensive wavelet function respectively. They respectively satisfy the two-scale expansion and contraction equations:

$$\begin{aligned} \phi(x) &= \sqrt{2} \sum_n h_0(n) \phi(2x - n), \\ \hat{\phi}(x) &= \sqrt{2} \sum_n h_1(n) \hat{\phi}(2x - n), \\ \varphi(x) &= \sqrt{2} \sum_n g_0(n) \varphi(2x - n), \\ \hat{\varphi}(x) &= \sqrt{2} \sum_n g_1(n) \hat{\varphi}(2x - n). \end{aligned} \quad (16)$$

The biorthogonal relationship between them is represented by the following formula [19]:

$$\left. \begin{aligned} \langle 2^{-j/2} \hat{\phi}(2^j x - l), 2^{-i/2} \hat{\phi}(2^i x - k) \rangle &= \delta_{lk} \delta_{ij} \\ \langle 2^{-j/2} \hat{\varphi}(2^j x - l), 2^{-i/2} \varphi(2^i x - k) \rangle &= \delta_{lk} \delta_{ij} \\ \langle 2^{-j/2} \hat{\phi}(2^j x - l), 2^{-i/2} \varphi(2^i x - k) \rangle &= 0 \\ \langle 2^{-j/2} \hat{\varphi}(2^j x - l), 2^{-i/2} \hat{\phi}(2^i x - k) \rangle &= 0 \end{aligned} \right\} i, j, k, l \in \mathbb{Z}. \quad (17)$$

The regularity requires $\phi, \hat{\phi}, \varphi, \hat{\varphi}$ to be a continuous function that the corresponding filter h_0, h_1, g_0, g_1 is iteratively filtered and converged. If the filter is a finite-length filter with a symmetric structure, the corresponding scale

function and wavelet function are also compactly supported and have a symmetric structure. Therefore, the construction of the biorthogonal wavelet base is the same as the construction of the orthogonal wavelet base, and it also comes down to the construction of the filter.

Here, the constructed four filters h_0, h_1, g_0, g_1 are required to have a symmetrical structure and enable the wavelet analysis synthesis system to meet the conditions of complete reconstruction. After reasoning, the relationship between them can be drawn:

$$\begin{aligned} g_0(n) &= (-1)^n h_1(-n), \\ g_1(n) &= (-1)^n h_0(-n). \end{aligned} \quad (18)$$

For the complete reconstruction analysis of the real coefficients, the comprehensive filter bank has the following orthogonality relationship:

$$\langle g_i(n - 2k), h_j(n - 2l) \rangle = \delta_{ij} \delta_{ik}. \quad (19)$$

The above formula shows that the low-pass filter of the analysis filter bank is orthogonal to the high-pass filter of the synthesis filter bank, and the high-pass filter of the analysis filter bank is orthogonal to the low-pass filter of the synthesis filter bank (biorthogonal).

For linear phase filters, Vetterli proved that they must be one of the following three structures under the condition of complete reconstruction:

- (1) The two filters $H_0(Z)$ and $H_1(Z)$ both have a symmetrical structure and have odd lengths. The difference between the lengths of the two filters is an odd multiple of 2.
- (2) Both filters are of even length, one filter is symmetric and the other is antisymmetric, and the difference between the lengths of the two filters is an even multiple of 2.
- (3) One filter has an even length, and the other filter has an odd length. The zero points of the filter all fall on the unit circle. The two filters are either symmetrical, or one is symmetrical and the other is antisymmetric. In fact, since the zero point can only be on the unit circle, this filter structure has no use value.

The so-called regularity is a description of the smoothness of a function and also a measure of the energy concentration of a function in the frequency domain. The regularity of function φ is generally described by the Holder definition:

That is, $0 < \alpha < 1$, if for any $t, \beta \in \mathbb{R}$ has [20]

$$|\varphi(t + \beta) - \varphi(t)| < c|\beta|^\alpha. \quad (20)$$

Then, the Holder regularity order of (t) is called α , where C is a constant independent of t and β . If the N -order derivative of $p(t)$ satisfies the above formula and $r = N + \alpha$, then the regularity order of Holder of $w(t)$ is called r .

Obviously, if $r > N$ (N is a positive integer), then $o(t)$ has an N -order continuous derivative, and the greater the regularity order r . It means that the smoother $p(t)$, the more concentrated the energy in the frequency domain from the

relationship between the frequency domain and the time domain of the signal.

From the relationship between the wavelet function and the filter $H(\omega)$, $G(\omega)$, the regularity of $\varphi(t)$ can be controlled by $H(\omega)$. If $H(\omega) \in C^q$, there must be $\varphi \in C^q$, where q is an integer, and C^q represents the q -th consecutive differentiable function class on the set of real numbers \mathbb{R} . If the regularity order r of $\varphi(t)$ is larger, the regularity of the time domain form of $H(\omega)$ and $G(\omega)$ is also stronger. Generally speaking, the effect of reconstruction after data compression is also better.

In the process of wavelet transform, when a smooth part of the input signal passes through filters $H(\omega)$, $G(\omega)$ with poor regularity, its output will quickly show discontinuity as the number of transformation stages increases. This nonsignal discontinuity will also be reflected in the transform coefficients of the discrete wavelet transform (DWT). When compressing music data, these coefficients must be quantized before inverse transformation, resulting in errors in these coefficients, and the higher the compression ratio, the greater the error. The errors of these coefficients appear as distortions of the reconstructed music after the reconstruction filter. The magnitude of the distortion is proportional to the error of the transform coefficient.

For the case where $H(\omega)$ is an FIR filter, the length of h is L . For the case of length $L \leq 10$, the effect of music compression and reconstruction will improve faster with the increase of r . When $L > 10$, the effect of increasing r and L on the peak signal-to-noise ratio (PSNR) after music compression and reconstruction is not obvious. At the same time, the greater the length L of the filter h , the greater the calculation complexity and the longer the calculation time, which is not conducive to real-time processing. Therefore, looking for a filter with the largest regularity order r designed from a smaller L will be beneficial to the processing of music data and improvement of the quality of music processing.

At the same time, it should be noted that the higher the regularity order is, the better the music compression effect is only for most cases. In some cases, there is also a wavelet basis with a small regularity order that is better than a wavelet with a high regularity order on music compression. This is mainly because there are many factors that affect the effect of music compression. In addition to regularity, wavelet basis functions and specially coded music may affect the quality of reconstructed music.

Definition. The function $\varphi(t)$ is said to have a vanishing moment of order m ($m \in \mathbb{N}$), if

$$\int_{-\infty}^{+\infty} t^p \varphi(t) dt = 0 \quad p = 0, 1, \dots, m-1. \quad (21)$$

We can easily introduce it according to the above formula:

$$\frac{d^p}{d\omega^p} \widehat{\varphi}|_{\omega=0} = 0, \quad p = 0, 1, \dots, m-1. \quad (22)$$

That is, $\omega = 0$ is the m -th order zero of $\widehat{\varphi}$. If the wavelet function $\varphi(t)$ has m -th order vanishing moments, according to the two-scale relationship and $\widehat{\varphi}(t) = 0$, we can get

$$\frac{d^p}{dz^p} G_1(z)|_{z=0} = 0, \quad p = 0, 1, \dots, m-1. \quad (23)$$

Here,

$$G_1(z) = \sum_n g_1(n) z^n, \quad z = e^{-j\omega}. \quad (24)$$

It can be deduced that the high-pass decomposition filter and the low-pass reconstruction filter have the same order zeros at $\omega = 0$ and $\omega = \pi$ respectively, but their order is determined by the vanishing moment of the dual wavelet of φ .

Obviously, the vanishing moment of the wavelet function characterizes the flatness of the high-pass filter at $\omega = 0$ and the low-pass filter at $\omega = \pi$. The larger the vanishing moment is, the closer the performance of the filter is to an ideal filter. Since the energy of music is concentrated in low frequencies, the larger the vanishing moment of the filter, the less low-frequency energy leaks into the high-frequency subimages during wavelet decomposition, and the smaller the high-frequency coefficients located in the smooth area of the music. Therefore, it is more conducive to music compression. Similarly, because the high-frequency energy leaks to the low-frequency relatively less, there may be more high-amplitude coefficients in the edge or texture area of the music in the high-frequency submap.

In order to minimize the number of high-amplitude coefficients, the frequency band of the signal of infinite length is strictly limited. According to the sampling theorem, strict sampling of the subband signal can satisfy these two conditions. However, for a signal of finite length, after the signal is linearly filtered by wavelet transform, the data size of the subband signal will be larger than that of the original signal, which will cause the boundary extension.

The support length and vanishing moment of the function are a priori independent. But the vanishing moment order and the length of the support are related. Taking orthogonal wavelets as an example, if φ has p -th order vanishing moments, then its support length is at least $2p-1$. For a given vanishing moment order, Daubechies wavelet has the smallest support. In this sense, Daubechies wavelet is optimal. Therefore, when we choose specific wavelets, we are faced with the trade-off between vanishing moment order and support length. If the music is very smooth between the edge points, then we must choose a wavelet with high-order vanishing moments to generate a large number of small-value wavelet coefficients. If the density of edge points increases, the support length should be reduced at the cost of reducing the vanishing moment order. This is because the wavelet whose support includes edge points produces large-scale coefficients. However, for mobile multimedia music, the support cannot be too long, because the support is too long, the calculation amount is too large, and there is no use

value, and the increase in the calculation complexity in exchange for not significantly increasing the PSNR value is not worth the loss.

In the wavelet analysis of the signal, the analysis and reconstruction system must meet the following two conditions. 1. Complete reconstruction: the original signal can be completely reconstructed from its subband signal. 2. The sum of the data size of the subband signal is not much as the data size of the original signal; otherwise, the compression efficiency of the encoding will be reduced.

If the complete reconstruction condition is satisfied, the data size of the subband signal during strict sampling will increase, and condition two cannot be satisfied. However, if condition two is met, information will be lost, the reconstructed signal will change, and complete reconstruction cannot be achieved. In order to meet the above two conditions at the same time, the signal must be extended to form an infinite signal to reduce the loss of information.

The length of the original signal $f(n)$, $n \in [0, N - 1]$ is N , and the length of the filter is L . The original signal is extended by $[L - 2]/2$ points to form the extended signal $\hat{f}(n)$. There are four commonly used extension methods as follows:

(1) Zero continuation is

$$\hat{f}(n) = \begin{cases} f(n), 0 \leq n < N, \\ 0, 1 - \frac{L}{2} \leq n < 0, N \leq n < N + \frac{L}{2} - 1. \end{cases} \quad (25)$$

(2) Period continuation is

$$\hat{f}(n) = \begin{cases} f((n + N) \bmod N), -\frac{L}{2} + 1 \leq n < 0, \\ f(n), 0 \leq n < N, \\ x(n \bmod N)N \leq n < N + \frac{L}{2} - 1. \end{cases} \quad (26)$$

(3) The zero continuation of the boundary is

$$\hat{f}(n) = \begin{cases} f(0), -\frac{L}{2} + 1 \leq n < 0, \\ f(n), 0 \leq n < N, \\ x(N - 1), N \leq n < N + \frac{L}{2} - 1. \end{cases} \quad (27)$$

(4) The continuation of the symmetry point is

$$\hat{f}(n) = \begin{cases} f(-n), -\frac{L}{2} + 1 \leq n < 0, \\ f(n), 0 \leq n < N, \\ x(2N - N - 2), N \leq n < N + \frac{L}{2} - 1. \end{cases} \quad (28)$$

The boundary distortion is not only related to the correlation of the signal itself near the boundary and sub-sampling of the transformation result but also related to the nonlinear phase characteristics of the filter. When the filter does not have a linear phase, the weaker the correlation of the signal near the boundary, the greater the distortion of the reconstructed signal at the boundary. In actual music data compression, the more commonly used wavelet bases are the tightly supported orthogonal wavelet bases and the bi-orthogonal wavelet bases. Except for the Harr wavelet (Harr wavelet has poor regularity), the compactly supported orthogonal wavelet base has no symmetry. The symmetry of the tightly supported orthogonal wavelet function is equivalent to the linear phase characteristic of its filter. Whether the filter has a linear phase is great for eliminating the distortion near the boundary.

4. Multimedia-Assisted Music Teaching System Based on AI Technology

This article combines AI technology and multimedia technology to construct an auxiliary music teaching system. The intelligent music teaching system constructed in this paper is shown in Figure 1.

The music multimedia teaching system must be designed and developed based on the B/S model, so that users can complete the above work online. According to the above requirements, a local area network system can be established first, and then the local area network can be connected through the Internet network to form a music multimedia teaching system. According to the above analysis, the physical structure of the system can be drawn, as shown in Figure 2.

In order to improve the development efficiency and system performance, this paper uses the three-tier framework technology that is currently used in the music multimedia teaching system, which divides the entire music multimedia teaching system into user interface layer, business logic layer, and data storage layer. The combination of the above technologies lays the foundation for the efficient implementation and operation of the system, and its working principle is shown in Figure 3.

The music multimedia teaching system is composed of five parts: music resource management, system management, homework management, interactive management, and basic data setting, as shown in Figure 4.

The timing diagram of the text resource classification adding function is shown in Figure 5.

The timing diagram of the text file playback function in the music resource viewing module is shown in Figure 6.

Based on the analysis of system functions and three-tier structure, the system establishes multiple database storage tables. The relationship between the tables is shown in Figure 7.

The system structure can be divided into three steps: data access, business logic, and system UI design according to the application of logic functions. In order to realize the complex functions of the system, the system adopts a layered approach. The so-called layering means that the system is divided into different modules, and the modules directly

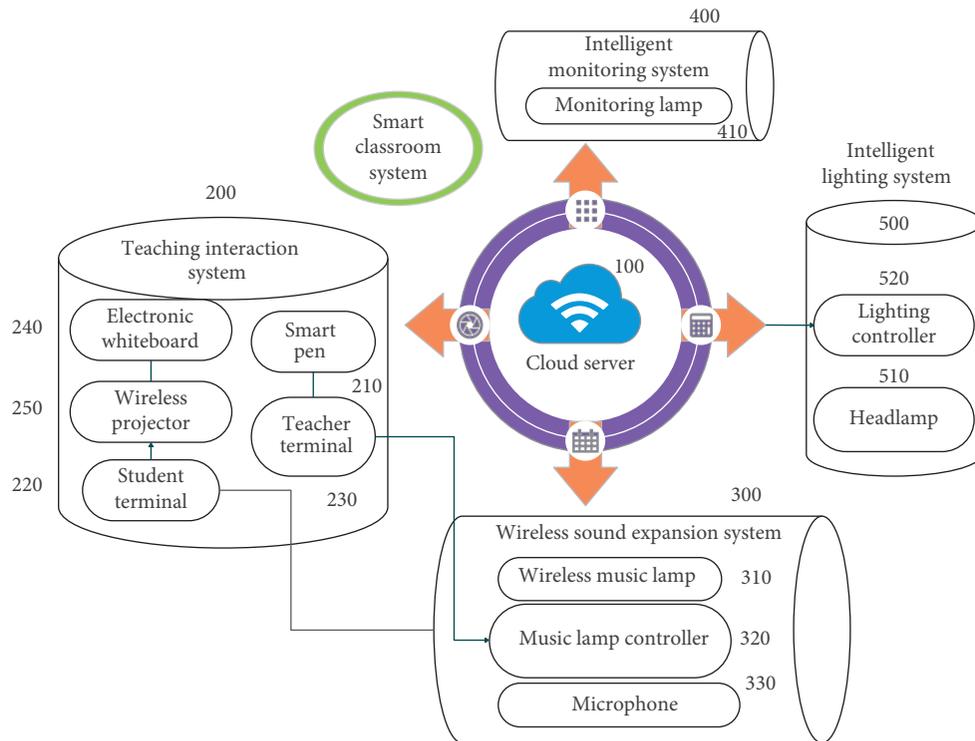


FIGURE 1: Multimedia-assisted music teaching system based on AI technology.

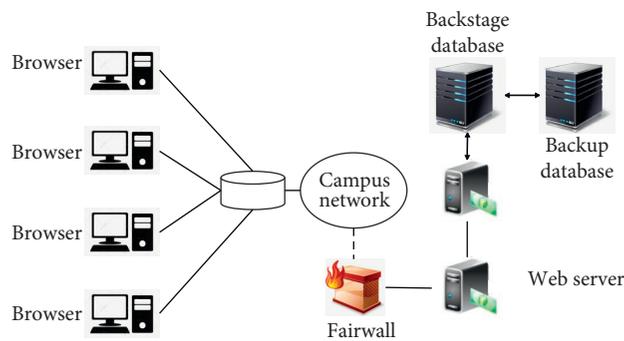


FIGURE 2: System topology diagram.

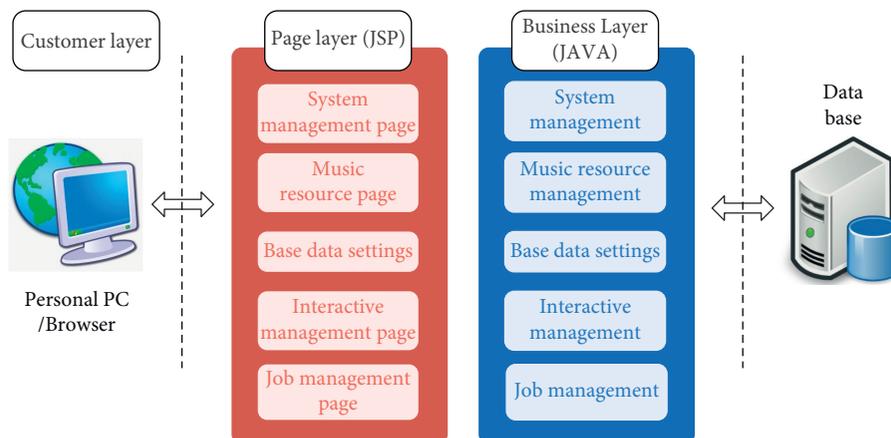


FIGURE 3: Architecture diagram.

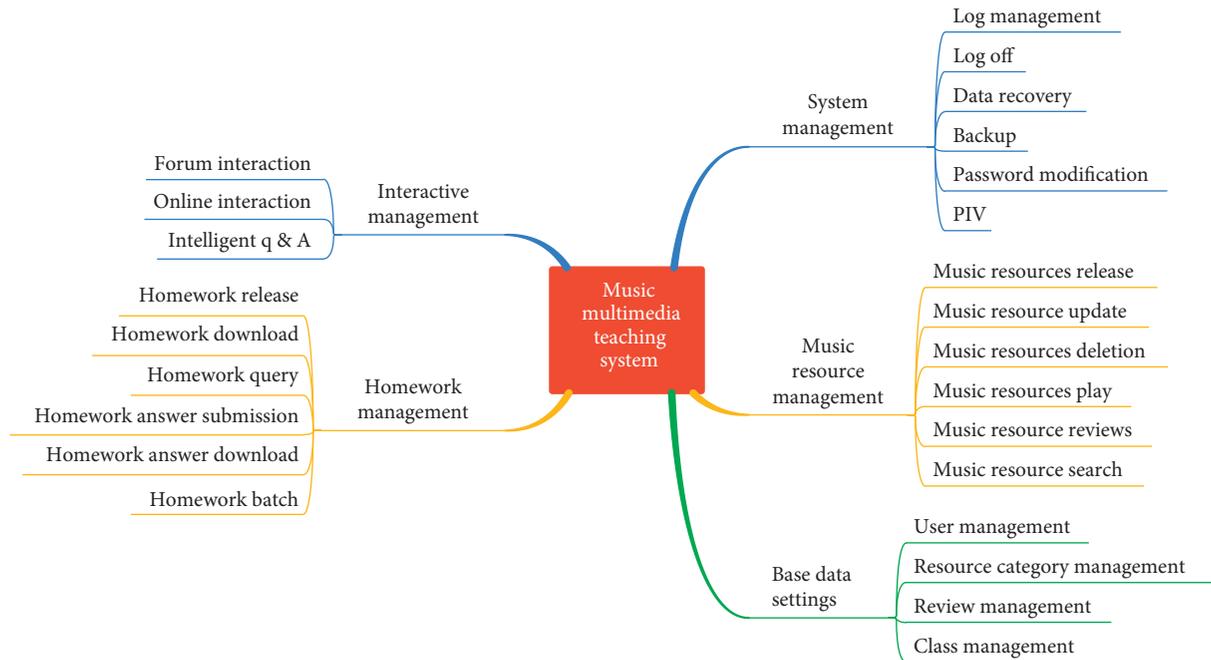


FIGURE 4: Functional structure diagram.

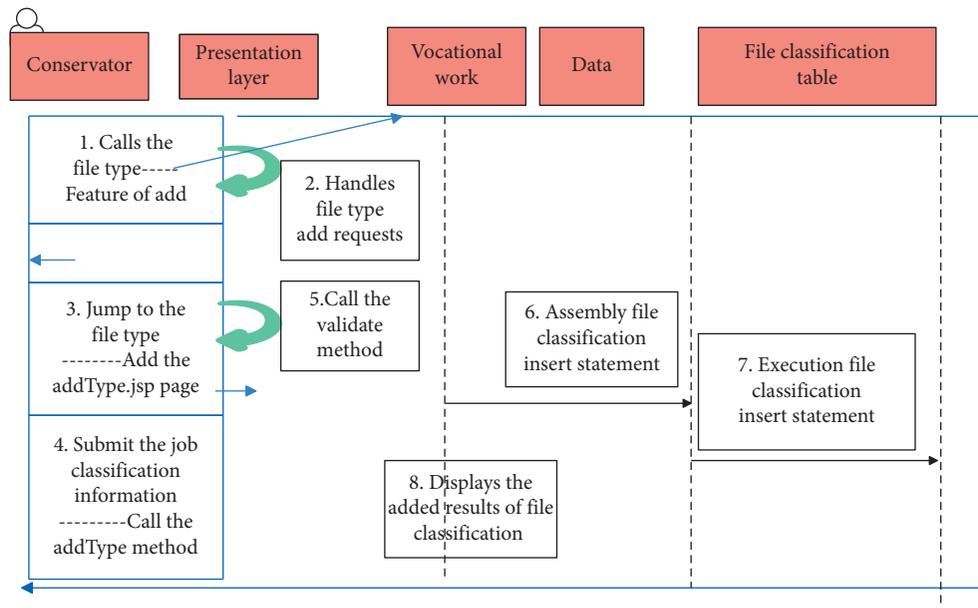


FIGURE 5: Timing diagram of category adding.

adopt loose coupling methods to realize logic calls. Through mutual calls between various modules, a system application architecture is formed, and a complex functional application model is constructed. The system consists of six projects, including one website project and five class library projects, as shown in Figure 8.

After constructing the above system, perform performance test on the system. The system proposed in this paper is applied to music-assisted teaching through AI technology

and multimedia technology. Therefore, in the experiment, the music processing effect of the system proposed in this paper is mainly evaluated, the teaching effect is evaluated, and the results shown in Tables 1 and 2 and Figures 9 and 10 are obtained.

From the above experimental research, the multimedia-assisted music teaching system based on AI technology proposed in this paper can effectively improve the effect of modern music teaching.

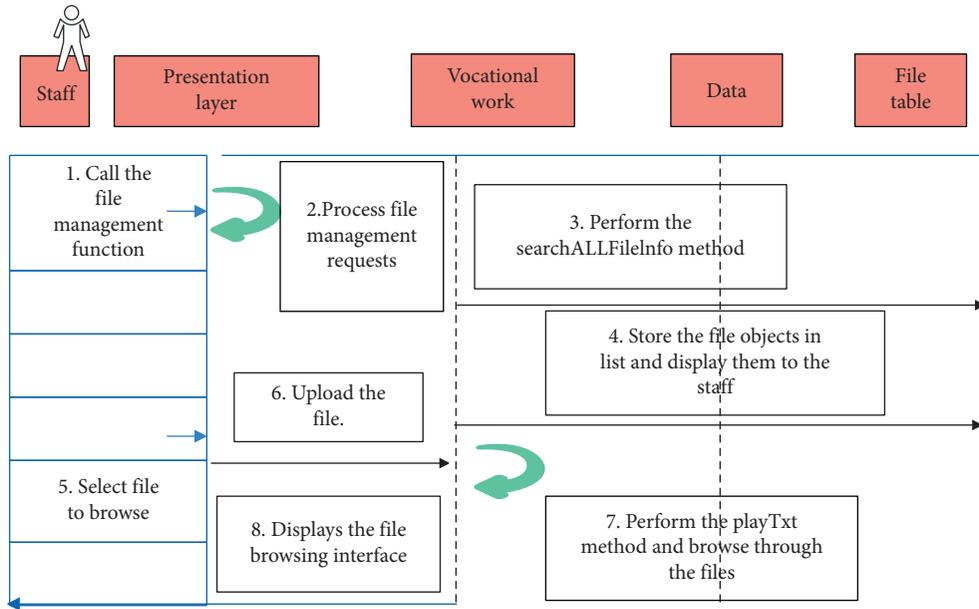


FIGURE 6: Sequence diagram of music resource file browsing function.

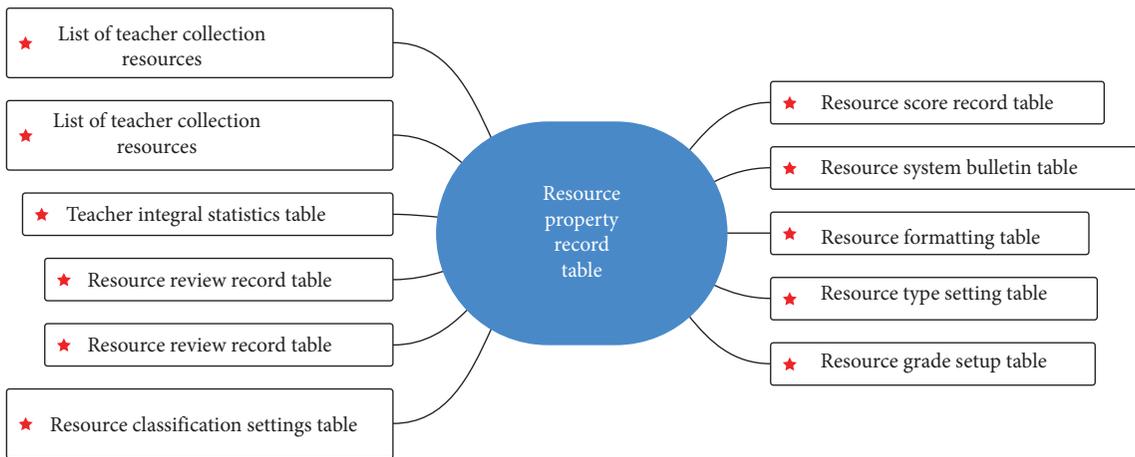


FIGURE 7: Data table relationship diagram.

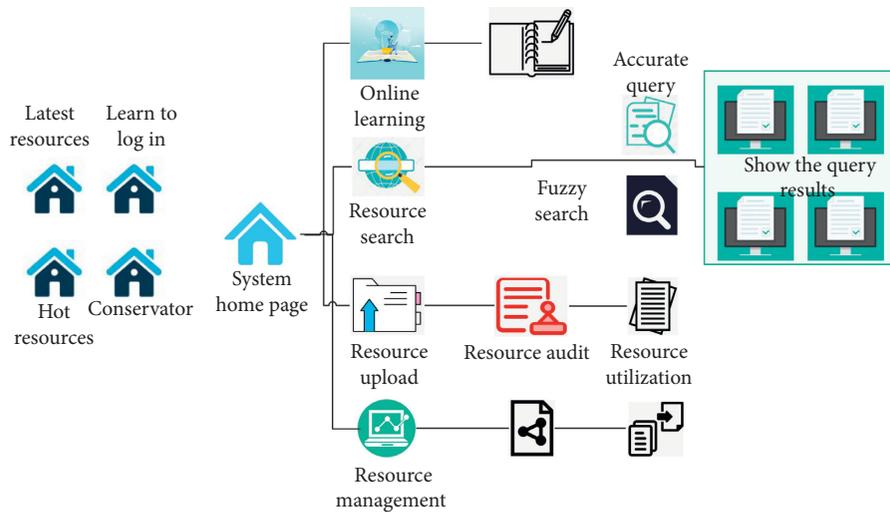


FIGURE 8: System module structure.

TABLE 1: Evaluation of the music processing effect of the multimedia-assisted music teaching system based on AI and multimedia technology.

Number	Music processing effect	Number	Music processing effect	Number	Music processing effect
1	85.8	21	94.9	41	89.6
2	81.8	22	81.9	42	87.7
3	92.4	23	90.0	43	89.9
4	94.9	24	85.7	44	81.4
5	82.7	25	92.5	45	92.9
6	85.4	26	92.4	46	87.0
7	89.7	27	82.0	47	90.6
8	91.2	28	80.9	48	91.3
9	90.5	29	80.8	49	88.7
10	89.1	30	80.1	50	90.0
11	81.5	31	82.3	51	84.2
12	87.6	32	90.0	52	86.3
13	87.4	33	81.6	53	91.3
14	83.7	34	92.3	54	80.6
15	89.1	35	86.7	55	90.7
16	81.4	36	90.3	56	80.4
17	90.5	37	95.0	57	94.3
18	85.7	38	94.4	58	94.3
19	90.3	39	91.0	59	86.0
20	94.3	40	90.6	60	94.5

TABLE 2: Evaluation of the teaching effect of the system.

Number	Teaching effect	Number	Teaching effect	Number	Teaching effect
1	85.0	21	84.4	41	83.1
2	84.8	22	83.1	42	75.5
3	85.5	23	77.1	43	86.2
4	85.5	24	77.1	44	72.8
5	73.6	25	72.9	45	76.9
6	87.7	26	73.6	46	81.5
7	86.9	27	82.5	47	75.9
8	86.6	28	70.5	48	76.7
9	83.1	29	80.4	49	80.9
10	85.2	30	86.0	50	89.6
11	76.4	31	82.2	51	75.9
12	84.1	32	71.3	52	85.5
13	78.7	33	82.0	53	83.1
14	73.1	34	89.2	54	88.6
15	89.1	35	76.1	55	87.1
16	85.2	36	85.1	56	76.1
17	87.9	37	77.9	57	85.8
18	81.4	38	88.9	58	72.9
19	78.5	39	86.7	59	87.1
20	75.3	40	76.0	60	78.3

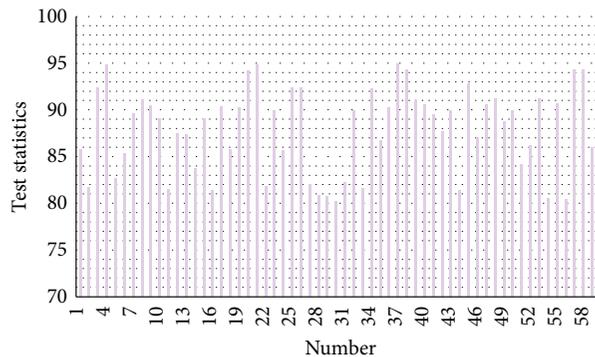


FIGURE 9: Statistical diagram of the music processing effect of the system.

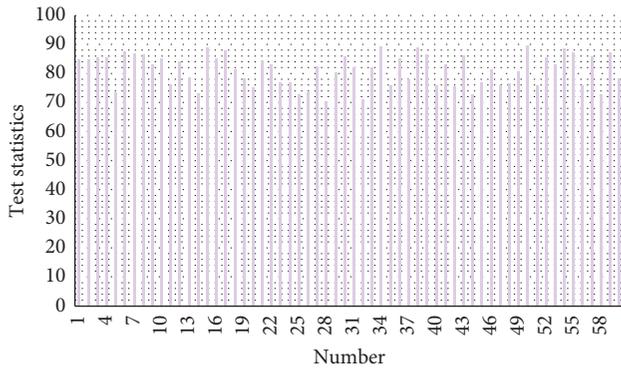


FIGURE 10: Statistical diagram of the music teaching effect of the multimedia-assisted music teaching system based on AI technology.

5. Conclusion

For AI to be combined with real music teaching guidance and become a usable tool, more understanding of this art form is still needed. To integrate artificial intelligence technology into music classrooms, we first start with the construction of smart classrooms, making musical instruments and auxiliary teaching programs. Moreover, it is connected with digital functions and platforms to analyze the data on the activities and performance of students in music classes provided on the platform and provide feedback information. At the same time, it is necessary to explore the teaching design and implementation of the independent form of AI music courses, learning methods, and learning discussions. It includes teaching resources, course objectives, course content, course activities, course organization and implementation, course design and skills, and basic operation plans for teaching practice. This article applies AI technology to music teaching and combines multimedia technology to construct a multimedia-assisted music teaching system based on AI technology to improve the scientificity and effectiveness of music teaching.

Data Availability

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

Conflicts of Interest

The author declares no conflicts of interest.

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