

## Retraction

# Retracted: The Use of Wireless Network Combined with Artificial Intelligence Technology in the Reform of Music Online Teaching System

### Wireless Communications and Mobile Computing

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1].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.

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] F. Chen and H. Meng, "The Use of Wireless Network Combined with Artificial Intelligence Technology in the Reform of Music Online Teaching System," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 5957708, 10 pages, 2022.

## Research Article

# The Use of Wireless Network Combined with Artificial Intelligence Technology in the Reform of Music Online Teaching System

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The purpose is to respond to the call of the government on the artificial intelligence (AI) policy of music online education. First, wireless network technology and AI technology are described in detail; the application principle of AI technology in traditional music teaching mode and online teaching mode is analyzed; then, the combination model of AI technology and music online education system in 5th-generation (5G) wireless network environment is proposed. These models include music online composition teaching model, music online teaching scoring model, and music online lyric writing teaching model. Finally, the models are verified in the application of AI technology. The results show that AI technology has good application performance in the models above. Moreover, the direction of music online teaching reform and innovation along the combination of 5G network environment and AI is correct under the background of the new era. This exploration expands the application scenario of AI technology and provides ideas for the reform and innovation of music online education in the context of the new era.

## 1. Introduction

China's distance education platform appeared in the late 1990s. At first, the platform was only a tool for teachers to share and use the Internet as a communication tool [1]. Network companies began to try online education in 2010. Diversified forms and connotations made online education develop rapidly and prosperously [2]. At present, music online education has become a benchmark for the development of music education in the future. Especially driven by the huge engine of the Internet, it has swept from first-tier cities to second and third-tier cities [3].

The main function of music online teaching system is to carry out music education through online interaction based on Internet, wireless network technology, or various music recognition technologies. In this process, music recognition is the most basic and key link. If the system can identify the music output by teachers and students

through musical instruments or independent voice, it can realize music online creation, electronic score generation, and music scoring [4]. Musical instrument digital interface (MIDI) system is widely used in obtaining music rhythm, tone, and intensity information. KunYang (2020) designed a MIDI music system based on the time function of multimedia application programming interface (API), which can model and reason the music rhythm, pitch, and intensity; the experimental results show that the method is feasible [5]. However, using MIDI requires special MIDI instruments to play, and the collected music signals need to be transmitted to the computer for processing to complete the recognition of notes and generate audio or electronic music scores; then, the music evaluation function is realized by comparing with the standard documents. Although the MIDI system can also complete music creation and scoring, it still needs to manually input music and cannot obtain vocal information. There are still some

restrictions on its use in music online education systems [6]. Therefore, people begin to focus on the research on the combination of artificial intelligence (AI) and music education.

Li described the advanced online interactive teaching music intelligence system model based on music AI technology. This model can achieve music perception, music cognition, music creation, and teaching [7]. Zhang analyzed the significance of creating a music online teaching sharing platform in Anshan City and considered it necessary to build an intelligent system of music online education [8]. Lv and Luo revealed the potential of using online learning resources, namely, Smart Music, eMusic Theory, and Dolomitic Music Theory, to improve the qualitative music learning indexes of sight singing, listening training, rhythm reading, score, and performance [9]. Wu and Li proposed a deep feature extractor based on convolutional neural networks (CNN). The extractor is trained on massive time synchronized MIDI audio data pairs and can estimate the pitch level activation of real-world music audio records. CNN feature extractor and a bidirectional long-short memory conditional random field decoding model constitute the proposed hybrid system for automatic chord recognition. Experiments show that the model is suitable for conventional major/minor triad classification and large vocabulary chord recognition and is superior to other most advanced chord recognition systems [10]. In order to promote the development of an intelligent teaching system, Zhang combined AI technology with a computer-aided teaching system to produce an intelligent computer teaching system and studied the design of the system [11]. The above research results show that in the current environment, the combination of online music teaching and AI technology is the general trend. The integration of the two is bound to qualitatively change the traditional music teaching mode and greatly improve teaching efficiency.

To sum up, the current online music teaching system based on AI technology has not organically combined music creation, music scoring, and lyric writing, but none of them is indispensable in music teaching. Hence, it is essential to improve the existing teaching system to make it have more complete functions, so as to improve the efficiency of music teaching. Based on the above problems and the combination of the 5th-generation (5G) wireless network background and AI technology, the AI music combination model is designed and applied to the music online teaching system to help improve the existing teaching system. The system designed mainly includes three parts: music online composition teaching model, music online teaching scoring model, and music online lyric writing teaching model. Music online education has become increasingly close to public life, the market share is growing every year, and the number of audiences of music intelligent online education has increased sharply. The scientific research position of creating music online intelligent education for system innovation becomes increasingly prominent. This exploration expands the application scenario of AI technology and provides ideas for the reform and innovation of music online education in the context of the new era.

## 2. Materials and Methods

*2.1. Analysis of Wireless Network Technology.* As the name suggests, the wireless network is a network that can achieve network signal interworking of different communication equipment without wiring [12]. Wireless network technology has a relatively broad scope. It covers not only the global voice and data network created by users for long-distance wireless communication but also the evolved radio frequency radiowave technology for short-distance wireless communication. Figure 1 displays a wireless network technology model diagram.

Present wireless network communication technology is gradually developing and mature, and various countries have conducted 5G research and development. 5G network has formed an architecture system with network deployment scenario, access network, and core network as modules. 5G communication has higher energy efficiency as well as stabler and fast network connection than the 4th-generation (4G) network, greatly improving resource utilization and transmission efficiency [13]. Figure 2 is a schematic diagram of the 5G network technology model.

5G communication includes the following features: (1) good coverage and user experience, (2) low power consumption, (3) high capacity of hot spot, (4) stable and reliable network, and (5) excellent end connector.

*2.2. Analysis of AI Technology.* AI is defined as machine intelligence in the field of electronic computers, that is, the intelligence owned by machines, as opposed to the natural intelligence owned by humans or animals. As an emerging discipline, AI is mainly adopted to research, develop, and extend the methods and theories of human intelligence. AI appeared in 1956. Now, there are multiple AI-related things in people's lives, such as fingerprint recognition, intelligent search, face recognition, language translation, and automatic planning [14]. Figure 3 presents the architecture of the AI technology system.

The common practice of AI is to use rules to deal with problems from top to bottom. A neural network (NN) uses the bottom-up inverse loop to deal with problems. The main technical means of AI is NN. Its essential feature is to learn the way of information transmission among human neurons. Hence, its processing basis is the need for massive datasets for training. Nonlinear, distributed, parallel computing, adaptive, and self-organizing are the main features of NN processing programs [15].

*2.3. Analysis of the Model Principle of AI Combined with Music Education.* AI has unique advantages in music education [16]. Here, analysis is made by taking learners' learning to create music as a case. In fact, the process of music creation also needs to learn composition skills and harmony methods. Learners gradually form their own creative thinking under repeated practice and teachers' correction. This series of learning steps can be simulated and reproduced by using the NN model, which lays the foundation for the combination of AI technology and music teaching.

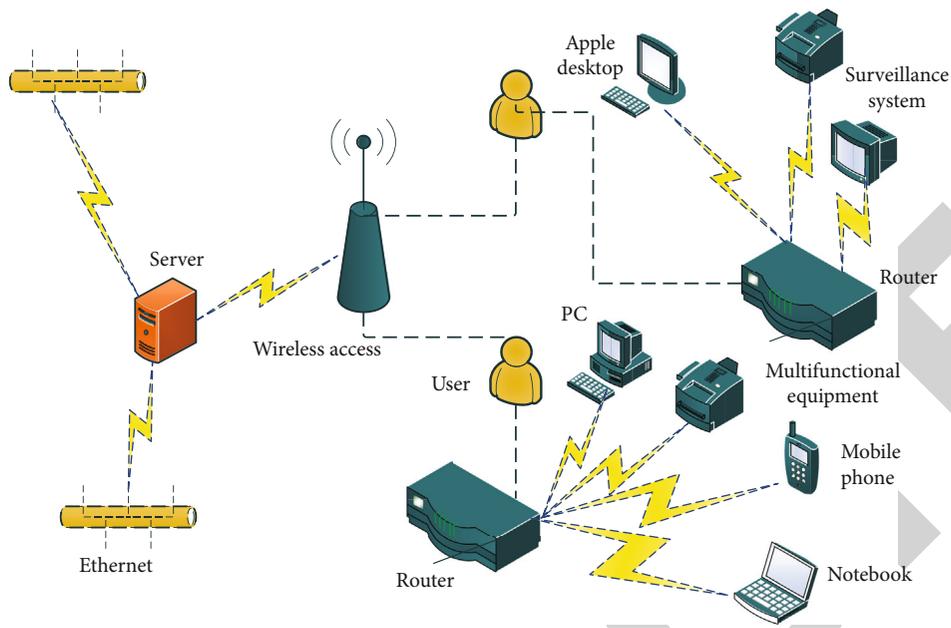


FIGURE 1: Schematic diagram of wireless network technology model.

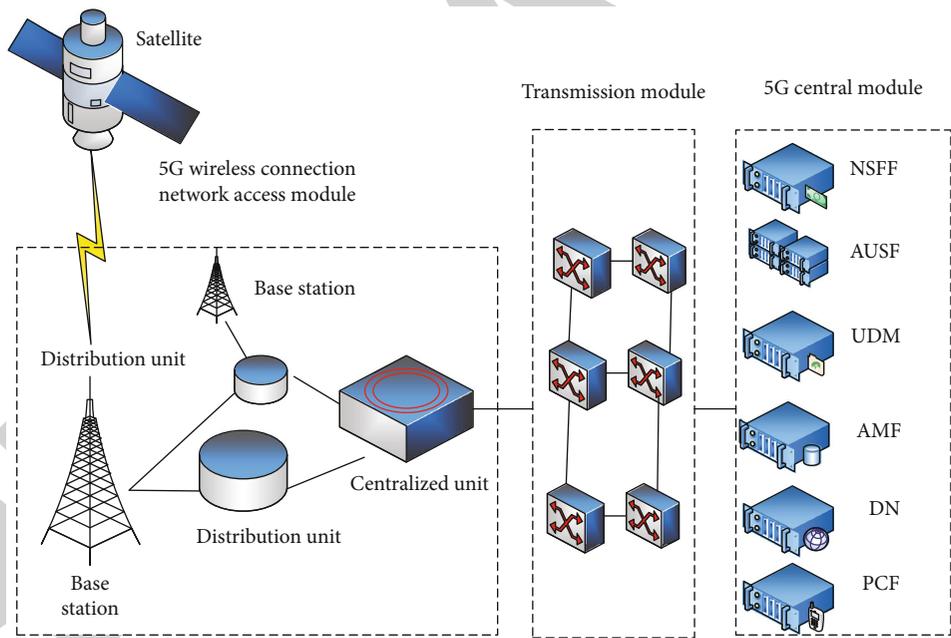


FIGURE 2: Schematic diagram of 5G network technology model (NSSF: network slice selection function; AUSF: authentication server function; UDM: unified data management; AMF: access and mobility management; DN: data network; PCF: policy control function).

Music, known as space-time art, contains the fundamental information of time. The recursive neural network (RNN) in NN can solve problems according to time series. The parameters of RNN are measured by time and information is transmitted in chronological order [17]. RNN has consistent input and output structures. The next input is the sequence output generated after the previous point in time iteration. One of the principles of AI technology combined with music teaching is the RNN model. Figure 4 displays a simplified schematic diagram of the RNN model.

There is no clear distinction between good and bad music data, which is more suitable for unsupervised learning. The completion of an unsupervised learning program can be realized by the compression and solution process of autoencoder. The essence of the model of unsupervised learning of data by autoencoder is the prototype of NN [18]. The upgraded version of the autoencoder is the variational autoencoder (VAE). The difference is that there are more constraints in the VAE program. From the perspective of composition, it is the coexistence of creation and rules,

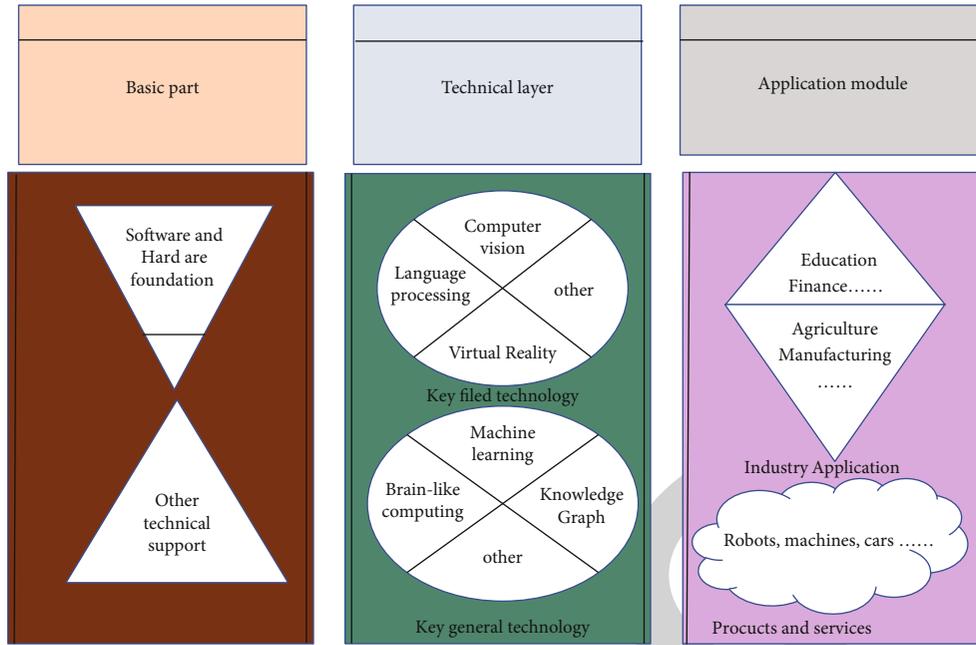


FIGURE 3: AI technology system architecture.

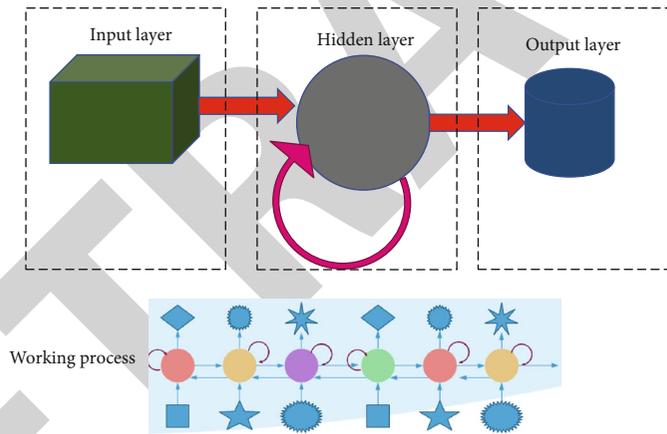


FIGURE 4: Simplified schematic diagram of RNN model.

which is just consistent with the principle and mechanism of VAE. Figure 5 displays a schematic diagram of the VAE principle.

At present, one of the means to generate high-quality content is VAE, which is particularly prominent in the production of multipart music. Sometimes, VAE will combine with long short-term memory (LSTM) to eliminate the problem of using various tones in scales with 24 tones and above.

**2.4. AI Combined with Music Online Education.** Music online education is an expansion and innovation of traditional music teaching. It is an online interactive training and learning mode using the Internet. It uses modern intelligent mobile equipment and developed network technology to achieve remote synchronous interactive teaching, learning, and training through a professional platform [19]. The AI scene of music online education includes the following

ways: online live broadcasting of famous teachers' lectures and reports, video-on-demand display of classroom videos and teaching films, video connection question and answer link, online tutorials, learning forums, and teacher-student chat rooms [20]. Figure 6 is a schematic diagram of the content combination model of AI and music online education.

**2.5. Analysis of the Application of AI in the Reform of Music Online Teaching System.** Music teaching mainly includes three parts: music creation, music scoring, and lyrics writing, which is completed by professional teachers before. However, the use of manual methods requires high personal experience. Different teachers have their own unique creation and evaluation methods and levels, and there are strong subjective shortcomings, making the level of their works and students vary greatly. AI technology can solve this problem well. The music online teaching system produced by combining AI technology and wireless network can realize the

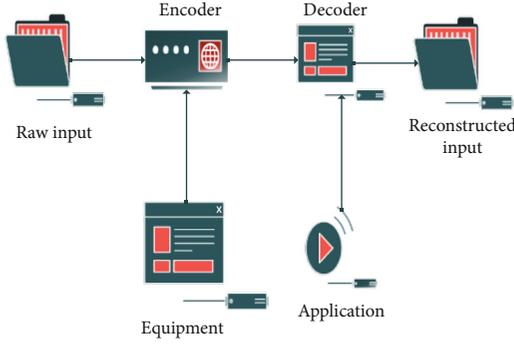


FIGURE 5: VAE schematic diagram.

automation of music creation, music scoring, and lyrics writing and provide more objective evaluation. The specific analysis is as follows:

- (1) Music creation by using the music online teaching system of AI technology algorithm

Algorithmic composition belongs to computer composition or automatic composition, which can reduce the interference of subjective thinking in music creation. Generally, the composition includes multiple aspects, such as melody, rhythm, harmony, and orchestration. A single dimension cannot fully express music, and computer technology can use these data to display through professional language, which is computer-aided composition. AI composition is slightly better from the perspective of subjective thinking intervention, not the so-called computer-aided composition. In real practice, the previous computer-aided composition, which uses rules and some information to make music, requires a harsh environment, and the whole set of programs is not much related to the components of “intelligence” and “learning” [21]. AI composition program relies on NN, which is a composition method closest to human ideas. Hence, the composition scheme combining rule and NN is the best solution for a long time.

When AI is applied to music creation, the type of music signals to be processed needs to be determined. Generally, the use of symbol information is relatively more common in the process of deep learning. In fact, relevant products aiming at “AI serving music” have already served the music. The application of the AI composition system, DeepBach, is taken as an example. Hadjeres and Pachet, two scientists from Sony Computer Science Laboratory in Paris, have developed a neural network that can create music with Bach’s music style. They call this AI machine “DeepBach.” They import 352 oratorios created by Bach into the database, use these oratorios to train the recognition of the neural network of the machine, and then mix them with other music. Finally, the database can distinguish Bach’s works. After the study period, the team begins to train the machine to create Bach-style harmony works.

DeepBach is mainly adopted for the creation of polyphonic music in chants. It focuses on Bach’s four-part chorus works to achieve certain results, and the systematic sampling results are efficient and flexible. In addition to

machine learning, users can add notes defined as unary constraints in the process, and the model is controlled by rhythm or information.

DeepBach can achieve coherent music phrase output, reintegrate different melodies, and achieve nonrepetitive results. This system is aimed at exploring a kind of Bach harmony, combine it with the interesting movement melody in music, and finally produce works similar to the chorus.

- (2) The use of an online music teaching system based on an AI technology algorithm to score music

In 2017, CCTV music program *Longing for the Scene* cooperated with the Chinese Academy of Sciences to introduce an AI scoring system into music programs for the first time. This program adopted the original mode of “technology + music” for the first time. AI music scoring system “Xiaoke” is based on the AI algorithm of deep learning and the scoring data of multiple experts. It automatically learns the internal relationship between the evaluation criteria of professional evaluation and the excellent elements in music from the six dimensions of pitch, range, tonality, rhythm, sense of language, and sense of music. A more objective evaluation system is formed through the analysis and learning of massive basic examples. Moreover, it can learn, update, and improve independently with the expansion of the sample size to achieve scientific scoring [22].

The reform of the music online teaching system can learn from CCTV’s innovative thinking, so as to use AI technology to score students’ creation scientifically in the evaluation of learners’ music teaching. AI technology scoring results are not the final judgment standard, but the application of this technology evaluation will greatly simplify the process of music teaching evaluation and the burden on music teachers.

First, the scoring system reads the running entrance audio, segments the features of the fundamental tone, and calculates the score according to the segmentation results. The extraction function process of the fundamental tone feature is preemphasis-framing-windowing-obtaining short-term average energy-obtaining fundamental tone. The singing score is the matching statistical result of the standard pitch and the singing pitch at the corresponding time point. The pitch value of the whole song at any time point can be obtained from the remote application control file. The first step in the calculation of singing pitch is the extraction of the fundamental frequency of the voice signal [23]. The following equation is mainly adopted to extract the fundamental frequency information.

The expression of the Fourier transform equation is as follows:

$$X(e^{j\omega}) = F|x(n)| = \sum_{n=N_1}^{N_2} x(n)e^{-j\omega n}. \quad (1)$$

In (1),  $F|x(n)|$  is the image function of  $X(e^{j\omega})$  and  $X(e^{j\omega})$  is the image primitive function of  $F|x(n)|$ .  $x(n)$  and  $e^{j\omega}$  stand for the frequency signal.

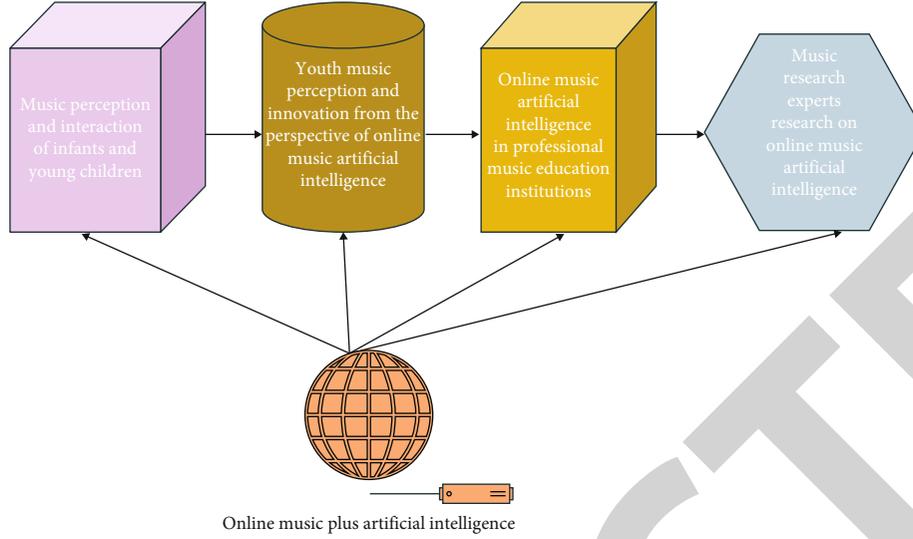


FIGURE 6: Schematic diagram of content combination model of AI and music online education.

The speech fundamental frequency signal is obtained by the cepstrum method, and the complex logarithm expression is as follows:

$$C(e^{j\omega}) = \ln [|X(e^{j\omega})|], \quad (2)$$

where  $C(e^{j\omega})$  represents the fundamental frequency signal function. The inverse function of the fundamental frequency function is expressed as follows:

$$c(n) = F^{-1}[C(e^{j\omega})] = \frac{1}{2\pi} \int_{-\pi}^{\pi} C(e^{j\omega}) e^{j\omega n} d\omega. \quad (3)$$

The operation result obtained through the above three steps is a sequence, and the sequence peak is obtained through sorting, which is the fundamental frequency. The characteristic parameters of singer audio and standard audio are extracted, respectively. The singing score is obtained by the difference of characteristic parameters.

### (3) Online music teaching system using AI technology algorithm for lyrics writing

Lyrics have the dual nature of literature and music, which combines auditory art and singing art. Exploring and researching AI intelligent creation of lyrics with complex networks not only fills the gap in the field of lyrics production but also promotes the development and innovation of contemporary pop music in China. The online music teaching system will use AI technology to automatically model the lyrics of contemporary pop songs, forming a weighted network with each morpheme as the link point and the adjacent morpheme connection edge. The method of locating rhymes first and then reverse walk is adopted. Combined with four forms: syntax rules, semantic correlation calculation, semantic similarity calculation, and emotional tone consistency calculation, a random walk algorithm based on edge weight is established. The lyrics of popular songs with

the same theme, unified emotional tone, format, and rhyme are automatically created.

The general procedure of AI technology lyrics production: (1) selecting rhymes. It is essential to search the network for nodes that match this rhyme. (2) Random walk. The weight of the edge is taken as the basis for determining the latter node. It runs randomly and reversely according to the probability. (3) Syntax constraints. The grammar of the generated lyrics is checked by using the deterministic finite perpetual machine method, and the lyrics that do not conform to the grammar rules will be filtered. (4) Emotional tone constraints. With the emotional tone of the selected song as the reference, the emotional tone consistency of the generated lyrics is calculated, and the lyrics that do not meet the requirements will be filtered. (5) Subject constraints. The semantic similarity of the generated lyrics is calculated by referring to the selected theme morphemes of the song, and the lyrics that do not meet the requirements are deleted. (6) Initial morpheme constraint. The initial morpheme is constrained by 50% probability. (7) The word number of lyrics shall be limited according to the creation requirements. (8) Work output. A complete song can constitute output only if all the above constraints are met [24].

AI lyric writing experiment is programmed on MATLAB, and the network is analyzed and processed by complex network analysis software Gephi. The experimental computer model is Intel(R) Core(TM) i7-3540M CPU@3.00 GHz. The template selects Teresa Teng's *Small Town Story* as a reference, so the songs that are automatically created and the template songs have nothing in common in content, emotional tone, theme and rhyme.

## 3. Results and Discussion

3.1. Discussion on the Influence of Wireless Network 5G Technology Combined with AI Algorithm on Music Online Teaching Composition. Figure 7 is a screenshot of a work generated by the AI composition system DeepBach.

The above application shows that using the combination of rules and relevant AI algorithm models to realize music creation is one of the relatively reasonable schemes. When AI participates in music creation, besides melody and lyrics, audience user data will become its goal. AI is fully participating in and changing the music production process, from harmony, arrangement to final sound synthesis, assisting the creation of music online teaching system and improving efficiency. It shows that the scheme of AI technology music creation can be popularized as a pilot scheme for the reform of the online teaching system. In this regard, through an online questionnaire, more than 1000 people (including music professionals and amateurs) are tested. The results show that it is difficult for almost everyone to distinguish whether these works are created by Bach or DeepBach. This method can be applied to Bach's oratorio and Bach's polyphonic hymn music in the future.

The application results show that the sampling of DeepBach is not carried out from left to right. When a certain direction is determined, DeepBach will use two cyclic networks, that is, the forward and backward two-way architecture in time will be considered at the same time. In this way, the past information and the information from the future can be summarized and even used for the nonrecursive NN of simultaneous notes.

**3.2. Analysis of Music Online Teaching Scoring Results Based on Wireless Network 5G Technology and AI Algorithm.** AI evaluates the achievements of online music education students in music learning and creation according to the internal process of pre-emphasis, framing, windowing, and obtaining short-term average energy. Some students in a music organization are selected for the music creation scoring test, and the sound data of the process of a student's creation is collected through 5G application equipment and AI intelligent scoring online music collection equipment. The AI score is based on the matching between the creator's pitch (sound energy value) and the pitch point of the system standard. The high matching degree indicates a high score. Figure 8 is an AI processing image display of short-time energy.

Figure 8 shows the energy value of the creator's voice directly. The truncation of short-time energy in the figure will lead to energy leakage in the frequency domain, and the system can reduce the impact by adding a window function. Figure 9 presents the short-term energy collection of a student after windowing.

The crucial foundation of the AI music scoring system is the collection and recognition of music speech. As a crucial index in sound collection, the frequency of fundamental tone will exert a great impact on the scoring results. Figure 10 is a schematic diagram of the collection of fundamental tone frequencies.

**3.3. Music Online Teaching Lyrics Creation Based on Wireless Network 5G Technology and AI Algorithm.** Through the experiment of AI application software MATLAB and analysis software Gethin, AI creation is conducted with the



FIGURE 7: Online music score generated by AI (intercepted part).

reference to the lyrics of *Small Town Story*. Table 1 displays the lyrics produced by the AI system.

Teresa Teng's *Small Town Story* is a song with a relaxed and sweet style, which praises the beautiful scenery of the small town, while the AI system creates a sad song that misses the lost love. The lyrics creation algorithm designed by the AI system can generate lyrics with changeable content, rich emotion, different themes, and flexible rhymes, which stimulates people's inspiration for lyrics and makes the process of lyrics fun. Of course, computer creation also has certain limitations. When the number of words in the lyrics of the template song is small and most of them are simple sentences or repeated sentences, the AI system can easily and quickly compose the lyrics; on the contrary, if the number of words of the template song is large and most of them are compound sentences, the AI system will be limited by the number of samples and algorithms, and it needs to iterate multiple times to compose the lyrics.

To sum up, each model of AI technology in music online teaching can be applied according to the internal AI algorithm. The music online teaching system based on the wireless network and AI technology can create music by learning a specific music style; it can also score by collecting the sound data of students in the process of music creation; it can recreate according to the existing lyrics based on the simulation software. The system also has the functions of music recognition and analysis, music creation, and music teaching. With the continuous improvement of computer computing ability and the development and research of deep learning of robots under the background of big data, a new music ecosystem of music AI + database + music teaching and application + social interaction will be an inevitable trend in the future.

## 4. Conclusions

In the future, the music online education industry will inevitably bear a more serious impact from the western developed music education system and industrial system. In this environment, long-term insistence on deep excavation and innovation has always been the core driving force to improve the quality of music online teaching. The application combination model of AI technology and music online education system in 5G wireless network environment is

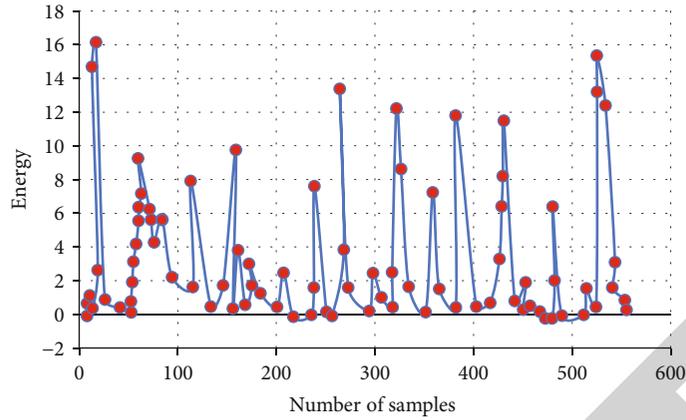


FIGURE 8: Schematic diagram of short-term energy collection of AI music scoring system of a student.

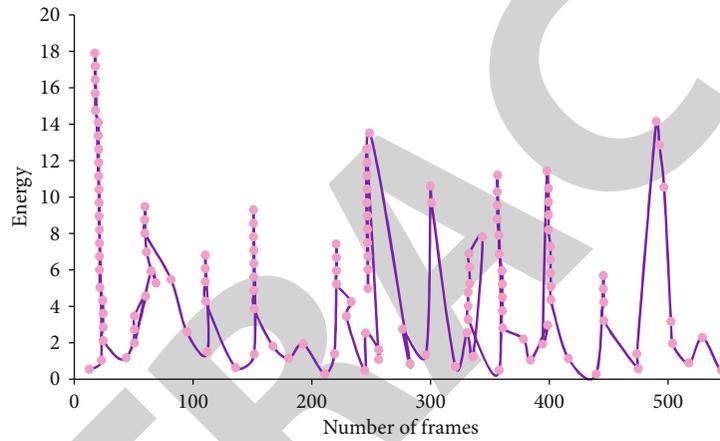


FIGURE 9: Schematic diagram of short-term energy collection after windowing of AI music scoring system of a student.

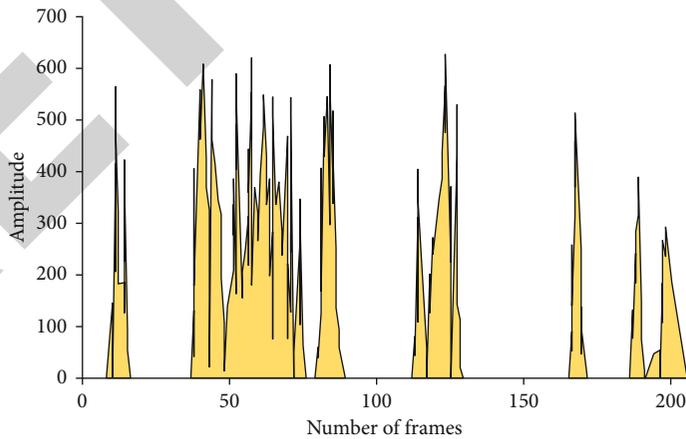


FIGURE 10: Schematic diagram of the collection of fundamental tone frequency in a student's AI music scoring system.

studied. The results show that AI technology has good application performance in the music composition teaching system, music teaching scoring system, and music lyrics writing system. Under the background of the new era, the direction of music online teaching reform and innovation along with the combination of 5G network environment

and AI is correct. The research deficiency is that the sample size of application models is too small, and there is no support from big data samples. Thereby, the following expectations are also put forward. In the follow-up research, the scope and quantity of sample collection need to be expanded to further improve the model designed and improve its

TABLE 1: Lyrics created by AI system based on the song of Teresa Teng's *Small Town Story* as a template.

Lyrics created by AI system	Lyrics of <i>Small Town Story</i>
Sorrow is in my heart	There are many stories in small towns
Thinking day and night	Full of joy and joy
Unforgettable past seasons	If you come to the small town
Sorrow cannot go away	The harvest will be particularly rich
Since I lost you	It looks like a picture
I use wine to relieve my worries	And sounds like a song
Your whisper rings in my ear	The state of life is true, good and beautiful
And turns into love to drift.	Already included here
Without end	Talking and talking
How long	Specking and speaking
Pity your youth	The story in small town is really good
And the deep wound in your heart	Invite your friends to
My heart trembled	Come to the town together
Without end	Talking and talking
How long	Specking and speaking
Pity your youth	The story in small town is really good
And the deep wound in your heart	Invite your friends to
My heart trembled	Come to the town together

adaptability in various application scenarios. It is hoped that more researchers can apply AI technology to the existing music online teaching practice and form a large database of AI application models, so as to contribute to the music online teaching system.

## 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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