Artificial Intelligence Development and Music Education System Reform in the Context of 5G Network

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1. Introduction

The main research background of 5G communication technology is reflected in the following aspects. The growth rate of video streaming demand mobile data traffic keeps going higher and higher. With the use of multiple devices, many users also need the maximum number of connections at the same time [1]. The Internet of Things requires the ability to support and handle billions of new connected devices. The increase in the number of users and the demand for video streaming, mobile devices, and network functions all need to be made more energy-efficient [2]. With the above problems, network operators have entered into studies to reduce operational expenses, and these studies can mainly help users to reduce the problem of multiple costs for devices and services. According to the requirements listed above, 5G communication technology should improve operational performance and outstanding user experience. 5G technology needs to meet many of the requirements of the Internet of Things on a large scale, providing parties that can control the increase in energy consumption, reduce equipment costs, network deployment services, and services to meet user requirements [3]. 5G communication technology can bring more support in the new infinite network and app development system in the future while making services more convenient.

5G cloud-native architecture is an important solution that can be used to achieve diverse service requirements. In
the field of mobile transport-related, telecom operators have been implementing digital transformation through continuous efforts in order to create a better digital world [4]. In order to provide enterprises and individuals with real-time services, online services and DIY business social networking platforms need to implement end-to-end connectivity and intelligent operational design. This research direction has now become a specific area of research, while many international companies are starting to develop new solutions [5]. Operators can transform their networks with a data center-based network architecture. In this architecture, all functional and service applications are run on the cloud, called cloud-native architecture. Many cities and transportation use unlimited networks and IoT technologies for covering public services. With 5G technology, the consumer will get a lot of new applications that can help him deal with time requirements. The biggest advantage of 5G technology is ubiquitous wireless connectivity. The use of 5G technologies coupled with the standardization of IP as a data protocol, the availability of low-cost and powerful computing resources in the cloud—all help in shaping the vision of 5G [6]. A variety of applications can use lower-cost 5G networks. 5G communication technology will become one of the indispensable technologies for all industries. This technology will help not only normal people but also disabled people’s lives, like smart cars and smart airplanes in the future [7]. Urban traffic management and urban safety management and online and offline tracking of traffic are some areas where implementation of the 5G network has contributed significantly. The benefits of bringing together multiple datasets from a deeply connected world are becoming more and more evident. The application scenario of the 5G network is schematically shown in Figure 1.

The applications themselves are very diverse and have different requirements on the network, especially in terms of latency, peak data throughput, connection density, throughput density, and device power [8]. To maximize their potential, with 5G technology, mobile networks have more resources to allocate to different applications. This is a major technical challenge. This paper thus follows a comprehensive discussion of the development of artificial intelligence in the context of 5G networks and its contribution to the reform of the music education system and designs a method for reforming the music teaching system based on artificial intelligence algorithms in the context of 5G networks.

The unique contribution of the paper includes the following:

(i) Exhaustive and detailed discussion on the current status of 5G technology-related research highlighting the key features of the same

(ii) Review of AI implementation in 5G networking

(iii) Development of a 5G-based method for reforming the music teaching system using AI algorithms

The organization of the paper is as follows. Section 2 presents a detailed review of related work. Section 3 explains the techniques and methodologies used followed by the results in Section 4. Section 5 finally presents the conclusion.

2. Related Work

2.1. Research Status of 5G Network. As the US starts using 5G through some operators and research institutions, the country has been providing fixed 5G wireless services through new features, cybersecurity, protection of personal data, etc. since 2018. To get the development of higher 5G communication technology wireless services, Huawei of China is leading the way in downlink and uplink [9]. Huawei has shown the greatest value in uplink and downlink scenarios and has demonstrated increasingly faster performance. In the current use of IoT and other related services, Huawei’s developing technology profile helps achieve good performance [10]. These technical performances allow Huawei to gain more attention and support. While European and American countries have been the most developed countries in the world in the history of unlimited technology development, South Korea is planning to get more 5G services in the coming years by supporting all operators in the country to enter the maximum technology implementation while developing new services [11]. The communication model of 5G is shown in Figure 2.

In the US, Verizon is shifting traffic to the new core in the second half of 2020 and achieving full commercialization in 2021. In contrast to Verizon and T-Mobile, AT&T is vague about its plans. The carrier said the company is currently developing and testing core technologies for next-generation 5G to enable cloud-native network capabilities and network slicing [12]. China’s experimental research on 5G technology has entered the third phase of testing, with three major carriers launching 5G pilots in more than a dozen cities across the country in 2018. The Ministry of Industry and Information Technology (MII) is also issuing 5G commercial licenses in June 2019. Over the past two decades, China has made great strides in technological advances and has considerable innovative capabilities in the field of mobile wireless integration in telecommunications, and this good influence is also reflected in many fields such as medicine and education [13]. Through the integration with technologies such as cloud computing, big data research fields, artificial intelligence, and bracketing virtual reality, 5G provides users with ultrahigh-definition video, social networking, and other virtual reality services, promoting another upgrade of human interaction. At the same time, 5G, with its excellent performance of ultrahigh reliability and ultralow latency, will detonate applications in vertical industries such as automotive networking and mobile healthcare [14]. It will promote the construction of a strong manufacturing country and a strong network country and make the new generation of mobile communications a universal technology leading the digital transformation of the country.

According to many international media reports, Samsung is one of the cell phone companies that now has officially available 5G technology that can be used to meet the needs of new customers [15]. The technology developed in
South Korea is one of the best 5G technologies in the world today, and the new system is officially available around 2020. With the development of this technology by Samsung Electronics, research on Fifth-Generation mobile communication technology will become more active in countries around the world, and the introduction and commercialization of its international standard will be accelerated [16]. With the gradual maturation and popularization of 5G technology, more and more new features will emerge in the AI and music industries. For the AI and music industries, every advance in communication technology will have a huge impact on them, especially 5G, which is a revolutionary change compared to previous generations of communication technology. For the fundamental change of communication technology, AI and the music industry will also have disruptive changes [17]. For the traditional AI and music industry, it is more necessary to actively study the evolution characteristics of the publishing industry and do the transformation layout in advance on the basis of theoretical research. Therefore, grasping the huge industry opportunities brought by 5G technology is of great significance for the thriving of enterprises and even the industry.
In recent years, China’s social economy has entered a period of rapid development, but at the same time, the country’s economic development model has been restricted by many factors. The traditional economic development model has been unable to meet the needs and promote the further development of China’s economy. Compared with the traditional infrastructure, the new infrastructure construction covers a broader scope and has a richer connotation. To promote the rapid development of the “new infrastructure,” we must take the new development concept as the leader. To provide infrastructure for the realization of digital transformation, the specific solution is the two aspects of industrial development, on the one hand, the problem of data circulation, and on the other hand, the problem of information data. In the context of the development of modern information technology, the realization of the digital transformation of the economy and society has become an important goal. And the development of 5G technology has become an important guarantee for the transformation of a digital society. At present, the development of the digital society has been more than a decade, but on the whole, the development speed is relatively slow. Through analysis, it is found that the reason is mainly for the physical and digital societies, in the process of network connection, the number of network connections is low, the time delay is too large, and the amount of data is insufficient, so it has a negative impact on the transmission of data. The arrival of the 5G era has effectively solved the above problems.

2.2. Current Status of Research on Music Education System Reform. Multimedia technology has become the most important modern high-tech means for the new century, and multimedia system with the computer as the main body is the most popular and widely applicable modern tool. As a modern teaching method, the multimedia teaching system is a specific application of multimedia technology in the field of education. It is a comprehensive information processing system based on digital technology, integrating communication technology, audio and video technology, and computer technology, and is capable of interactively processing, storing, and transmitting various media information. The multimedia teaching system built with computer music systems has shown undeniable vitality in music production, sound synthesis, music theory research, and music education teaching. It combines music score, graphics, film and television images, animation, text, language, and music sound together and takes a real-time dynamic approach to operation, which can develop teaching in all aspects of music education and expand the traditional music teaching methods and means. Therefore, from the software that has been developed so far, it can well solve some drawbacks in the traditional teaching of music in senior teachers and receive better teaching effect. The schematic diagram of the music education system in the new media era is shown in Figure 3.

The emergence and development of computer music have transformed traditional music and are an unprecedented revolution in the history of music development. The entry of computer music into our country has brought a wide impact on our musical life; brought a new world to music creation, especially adding vitality to music education and music teaching methods; and provided technical support for modern multimedia music education. The multimedia teaching system is equipped with projection TV, video display, multimedia computer, etc. in the same classroom together to form an optimized teaching environment. In the demonstration teaching environment, teachers can directly use slides or directly use books, pictures, drawings, etc. for classroom teaching. If the multimedia computer is connected to the Internet, the teacher can call the campus or international Internet system in the classroom to explain the various materials, so that students can learn more knowledge in a limited period of time. This greatly improves the efficiency of teachers’ lectures and teaching quality and brings classroom teaching to a new level. With the expansion of contemporary information technology into the field of education, the high-tech content of educational activities is rapidly increasing. The education industry will be the world trend to complete the historical transformation from labor-intensive to capital- and technology-intensive industries so that education really steps into modernization. In the curriculum system of music and art colleges, the traditional classroom teaching puts too much emphasis on the leading role of teachers and ignores the role of teaching contents, teaching media, teaching objects, and other factors, thus affecting the teaching effect and the improvement of teaching quality. In order to meet the educational requirements of the information society, the use of modern multimedia education technology in the teaching of music majors in higher education has become a necessity to promote the transformation of...
teaching ideology, teaching concept, teaching mode, teaching content, and the expansion of teaching methods and teaching means.

3. Design of Application Model

This chapter details a method of music education reform based on artificial intelligence algorithms in the context of 5G networks, and the overall structure of the method is shown in Figure 4.

3.1. 5G Network Space Based on User Mobility Characteristics. In modern times, the widespread use of smartphones and satellite positioning systems has made users’ mobility data more readily available, and along with this, new advances and breakthroughs in related research have begun to be made. Moreover, the research and application of various types of mobility models are becoming hotter and hotter by calculating the entropy of people’s actual mobility data. In recent years, there have been a large number of mobile model-related studies and applications in the field of mobile communications such as Telematics, cellular networks, and wireless sensor networks. This chapter investigates the mobility characteristics of users in 5G superdense heterogeneous networks based on individual mobility models and the theoretical modeling and performance analysis of 5G superdense heterogeneous networks based on considering user mobility characteristics. Considering the fact that the performance of 5G superdense heterogeneous networks is very sensitive to user movement due to the high SBS density, and considering the fact that traditional mobility models such as the random path point model cannot reflect the tendency and aggregation characteristics of human beings in their daily movement, this chapter introduces the individual mobility model, which is widely recognized in human behavior research, into the theoretical model of 5G superdense heterogeneous networks.

The emission absorption model is a model used to model the movement characteristics of humans between different regions on a plane, and it can well model the nonuniform distribution characteristics of people on a plane. The probability formula for the hot spot region is shown in the following equation.

\[
\frac{m_im_j}{m_i + m_j + s_{ij}}
\]

\[r_{ij} = \frac{m_im_j}{(m_i + s_{ij})(m_j + s_{ij})}, \quad (1)
\]

The popularity of a representative hotspot among users is often determined by the number of jobs available in the hotspot. Assuming that the mobile characteristics of different users are independent of each other, the expectation of the binomial distribution is shown in the following equation.

\[
E(T_{ij}) = \zeta P_{ij} \frac{m_im_j}{(m_i + s_{ij})(m_j + s_{ij})}, \quad (2)
\]

where \(\zeta\) represents the proportion of mobile users in the total users and is usually considered to be a constant value for all nodes in the full plane. Since the model is a model built in the spatial dimension, it can only analyze the movement of users between different hotspot areas, but not the change of user density in each hotspot area over time. Therefore, in this chapter, we choose to extend the model in the time domain by using the queuing network theory. The queuing network theory is a tool for modeling and analyzing the statistical properties of all queues in a network. Unlike the much studied queueing theory model, in the time domain analysis.

![Figure 4: The overall structure of the method.](image-url)
model based on the queueing network theory, users will face two choices after a queue is served: they can choose to enter another queue or simply leave the whole system. The Jackson network is characterized by the assumption that there exist users from outside the system who enter the system; i.e., the entire network is completely open. First, define the occurrence function of the random variable as shown in the following expression.

$$f_{i_{\text{arr}}}(x) = \frac{4x}{\pi l_i^2} \left( \arccos \frac{x}{2l_i} - \frac{x}{2l_i} \sqrt{1 - \frac{x^2}{4l_i^2}} \right).$$  \hspace{1cm} (3)

The Rayleigh channel model is chosen as a theoretical tool to model the wireless channel fading; then, the probability of coverage is shown in the following expression.

$$P_{\text{cover}} = \Pr \left( \frac{p_i G_i R_{i_{\text{avg}}}}{\sigma^2 + \sum_{j=0}^{N_{\text{cell}}} p_j G_j R_{j_{\text{avg}}}} \geq y_0 \right).$$  \hspace{1cm} (4)

Considering that the base station in the actual system is limited in carrying capacity, it often does not serve all the users covered. The blocking situation in the network will be more prominent because the model itself has a weaker service-bearing capacity than the traditional MBS. The number of call request users can be viewed as some series of random variables obeying Poisson distribution with the following mathematical expressions.

$$\Pr \{ AP(t + \Delta t) - AP(t) = n \} = e^{-\lambda(t)} \frac{(\lambda(t) \Delta t)^n}{n!}. \hspace{1cm} (5)$$

Assume that the call arrival process is both an independent incremental process and a smooth incremental process at the same time. Then, according to the definition of the Poisson process, it is known that the call arrival process is a Poisson process. The mathematical expression for the call arrival rate is as follows.

$$\lambda_{i_{\text{arr}}} = \frac{\tilde{a}}{P_i \cdot p_i \cdot N_{\text{cover}}} N_i(t). \hspace{1cm} (6)$$

Using a two-dimensional Markov chain, we can analyze the channel occupancy in the network, as well as the variation of parameters such as call blocking rate. One of the most important and primary outcomes of computational probability is the development of algorithmic models which are also known as matrix geometric methods and matrix analytic methods. The matric geometric method helps in efficient analysis of the Markov chain on a state space that is finite in one dimension and infinite in another dimension considering the fact that the Markov chain has a certain structure. The timing effect of 5G communication in the scenario of nonuniform user distribution is shown in Figure 5.

3.2. An Artificial Intelligence Algorithm-Based Approach to Music Education Reform. In recent years, kernel methods have become a hot issue in data mining and pattern recognition research. Kernel methods are solved by mapping nonlinear problems onto a high-dimensional feature space and transforming them into linear problems through the kernel technique. This approach is also able to avoid the extra computational overhead caused by the elevated dimensionality. Kernel methods are extremely efficient in performing supervised classification tasks. It provides a structured mechanism to implement linear algorithm in a transformed feature space [31]. The core idea of the kernel function is to use the kernel trick. Assuming that a point in the input space is mapped to the feature space by a nonlinear mapping function, the core advantage of the “kernel trick” is that the dimensionality of the data brings about the transformation from a nonlinear to a linear problem without the computational complexity that comes from the dimensionality increase. The new kernel function proposed in this chapter is used to optimize the classification accuracy of support vector machines. The schematic diagram of SVM optimization using kernel functions is shown in Figure 6.

Support vector machine or SVM is one of the most predominantly used supervised learning algorithms capable of resolving classification and regression problems. There are numerous applications and case studies where SVM has been implemented. As an example, the study in [32] analyzed the effect of feature selection on music genre classification using the SVM classifier. The Spotify music dataset was used, and the classification results yielded promising accuracy. Similarly, the study in [33, 34] developed an SVM-based framework that helped listeners create a music playlist automatically based on their mood or emotional state of behavior. The system captured facial images and analyzed expressions in real-time. The SVM technique helped in recognizing of the emotions which would initiate playing of songs from predefined music files. The classification model of support vector machine can be built as the following expression.

$$\min : \frac{1}{2} w w^T + C \sum_{i=1}^{n} \xi_i, \hspace{1cm} (7)$$

subject to: $$y_i (w^T x_i + b) \geq 1 - \xi_i, \xi_i \geq 0, \hspace{0.5cm} \forall i.$$  \hspace{1cm} (8)

The reason why holding vector machines are known as the classical application of kernel methods typically is that nonlinear problems in most cases cannot be solved using classifiers and need to be transformed into linear problems by mapping the original problem into a high-dimensional kernel space through kernel techniques. Equation (7) can be rewritten as the following expression.

$$\min : \frac{1}{2} w w^T + C \sum_{i=1}^{n} \xi_i,$$

subject to: $$y_i (w^T x_i + b) \geq 1 - \xi_i, \xi_i \geq 0, \hspace{0.5cm} i = 1, 2, \ldots, n.$$
Subsequently, Equation (8) was changed to the pairwise form.

$$\max : \sum_{i=1}^{n} \alpha_i - \frac{1}{2} \sum_{i,j=1}^{n} \alpha_i \cdot \alpha_j \cdot y_i \cdot y_j \cdot k(x_i, x_j),$$  \hspace{1cm} (9)

Thus, the mathematical expression of the classifier can be obtained as follows.

$$Y = \text{sign} \left( \sum \alpha_j \cdot y_j \cdot k(x, x_j) + b \right).$$  \hspace{1cm} (10)

According to the definition of Equation (10), the smaller the difference between the kernel space selected by the support vector machine and the original space for the classification of low-dimensional embeddings after dimensionality reduction of the stream shape learning, the higher the correct classification rate of the support vector machine. The difference between the kernel space and the original space can be described by distance. The difference function $L$ between the kernel spaces can be defined as the following expression.

$$L = \frac{\sum_i \sum_j \left( k(y_i, y_j) - d(\varphi(y_i), \varphi(y_j)) \right)^2}{\sum_i \sum_j k(y_i, y_j)^2},$$  \hspace{1cm} (11)

The smaller the difference between the original space and the kernel space of the low-dimensional embedding, the smaller the value of the function $L$, and vice versa the larger the value of $L$. Since the ISOMAP method is a streamwise extension of the multidimensional coordinate method, the difference in distance between these two spaces is known from the multidimensional coordinate method. ISOMAP is a nonlinear dimensionality reduction technique which works on the basis of spectral theory. The technique helps in preserving the geodesic orders functioning in the lower dimension. The difference between the geodesic distance space created by the stream shape learning and the reduced dimensional low-dimensional embedding space is the smallest. Therefore, from the above proof, it is known that the data structure between the original space and the low-dimensional embedding is the most similar, and the distance error is the smallest. Firstly, the requirement of mapping low-dimensional nonlinear data onto a high-dimensional kernel space for conversion to a linear problem in the kernel trick is satisfied. Secondly, when mapping to a kernel space that is closer to the original space at the time of classification, the purpose of improving the classification accuracy is achieved due to the small difference between the spaces. The theorem illustrates that the selection of a suitable kernel function on a low-dimensional embedding can improve the classification accuracy of support vector machines and outperforms the effect of common kernel functions.

4. Experiments and Results

Considering the facts revealed in the preliminary investigation, the research-based music online course application model based on an artificial intelligence algorithm in the context of 5G was designed. This model was applied to the actual teaching process. At the end of the course, we need
to evaluate the implementation effect of the blended music learning models and compare and analyze the advantages and shortcomings of various blended music learning models. At the end of the music course, we evaluated the course performance of each of the three categories of learners according to the evaluation index of the blended learning-based research-based music online course in the context of 5G. The evaluation metrics include “online learning based on online courses,” “self-directed learning,” and “project-based group learning” for graduate and other undergraduate students. The mean scores of each of the music learner evaluation indicators are shown in Table 1 and Figure 7.

The “online learning” score reflects the highest level of participation in research-based online courses by graduate students in teaching technology, followed by undergraduate students in teaching technology. The performance of “group work” was comparable between undergraduate teaching technology students and other undergraduate students. In terms of “independent learning,” we found that the ability to teach technology graduate students to complete individual assignments on their own was slightly higher than that of teaching technology undergraduates and other undergraduates, which might be related to their existing knowledge and skills. The analysis of the “overall score” showed that although the lowest score of the teaching technology undergraduates was slightly higher than that of the other undergraduates, the percentage of other undergraduates who scored above 80 was higher than that of the teaching technology undergraduates.

In the data file, “very many, many, average, few, and very few” are set as “1, 2, 3, 4, and 5” in order, so the smaller the value, the higher the learners’ usage, and the data in the table represents the average value. The number of times these three types of learners used the “study notes” to summarize and reflect on their learning, the number of times they used the “results showcase” to browse and evaluate other groups’ work, and the number of times they used the online course to preview new knowledge all ranged between “average” and “little.” Among them, the use of the Result Display Platform to browse and evaluate the work of other groups was slightly better. The number of times they used online courses to review new knowledge tended to be “average,” which

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<th>Table 1: The mean scores of each of the music learner evaluation indicators.</th>
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<td>Lower level music students</td>
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<td>Middle-grade music students</td>
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<td>Senior music students</td>
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<th>Figure 7: The mean scores of each of the music learner evaluation indicators.</th>
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<th>Table 2: The mean values of functional usage of music online courses.</th>
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<td>AUOLN</td>
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<td>Lower level music students</td>
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shows that these three types of learners used online courses to review after class more than to prereview before class. The mean values of functional usage of music online courses are shown in Table 2 and Figure 8.

This comparative dataset reflects the difference in the use of online course features by undergraduate teaching technology students, graduate teaching technology students, and other undergraduate students, with the graduate teaching technology students utilizing the online courses the most, relatively speaking.

5. Conclusion

Based on the research of online music education, the article summarizes the current situation of online music education at home and abroad after a lot of literature research and practical teaching, analyzes the difference between online music education and traditional music education, and studies the embodiment of online music education supporting independent learning in school music education and social music education. The development trend of online music education supporting self-directed learning is summarized and reflected upon. The knowledge of musical arts is vast, the content and learning methods of online music education are flexible and diverse, and the utilization of music education resources and the development of teaching materials are advancing with the times, all of which can contribute to the vigorous development of music education. Therefore, the development of online music education is crucial to improve students’ independent learning ability. This paper then follows a comprehensive discussion of the development of artificial intelligence in the context of 5G networks and its contribution to the reform of the music education system and designs a method for reforming the music teaching system based on artificial intelligence algorithms in the context of 5G networks. The experimental results show that the algorithm of this paper has a good promotion effect on the music education system reform.

Although the article is innovative in terms of theory and content, the research in this paper leaves something to be desired. The systematicity and height of the research theory are lacking, and there are few references to the relevant literature in this paper, so we can only draw on the research of other disciplines in this field for analysis and discussion. There is a lack of mathematical tools and measurement instruments to support the study. With the deepening reform of music education, with the rapid development of Internet technology, and with the in-depth study of music instructional design theory, there is no end to the research on online music education that supports independent learning.

Data Availability

The datasets used during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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