Hindawi
Wireless Communications and Mobile Computing
Volume 2021, Article ID 5999152, 9 pages
https://doi.org/10.1155/2021/5999152

Research Article

Online Education and Wireless Network Coordination of Electronic Music Creation and Performance under Artificial Intelligence

Ning Xu [1] **and Yuanyuan Zhao** [2]

[1] *School of Music and Drama, Zhengzhou SIAS University, Henan, China*
[2] *School of Marxism, Zhengzhou SIAS University, Henan, China*

Correspondence should be addressed to Ning Xu; 11222@sias.edu.cn

Received 21 September 2021; Accepted 23 October 2021; Published 18 November 2021

Academic Editor: Narasimhan Venkateswaran

This paper is aimed at studying the online education and wireless network collaboration on electronic music creation and performance under artificial intelligence (AI). This paper uses a fuzzy clustering algorithm (FCA), designs the sensor network-related equipment, and uses AI to design an electronic music creation system. The analysis of simulation experiments suggests that under the premise of increasing the number of neighbors, the Mean Absolute Error (MAE) and Mean Squared Error (MSE) of collaborative filtering and fuzzy C-means clustering algorithms show a downward trend. However, with the same number of neighbors, the filtering matching algorithm is greater than FCA regarding the mean values of MAE and MSE. Meanwhile, on the electronic music performance system of AI, the digital module is designed and the sound data are imaged on the oscilloscope, and the collaboration of electronic music online education and wireless network is completed. The following conclusion is drawn: modularizing the creative mode of intelligent electronic music has achieved higher computational efficiency. Through the oscilloscope, the sound feature is converted into the image structure, and the corresponding sound and image mode is formed, which realizes the purpose of online electronic music intelligent matching and optimizes the effect of online education. In the AI environment, the matching degree of verification electronic music curriculum resources is better than traditional matching algorithms, and the accuracy is higher.

1. Introduction

With the progress of science and technology, various new technologies emerge endlessly. Artificial intelligence (AI) is booming, leading the trend of the times to a certain extent. With the growing development of AI, it is possible for the creation and performance of electronic music to collaborate online education and wireless network [1]. The emergence of digital art by AI enriches the current media form. Meantime, the sensing technology of AI and the intelligent matching algorithm of online education of electronic 5music have become a new direction of current research. At present, the previous teaching mode is limited by time and space, and it is difficult to meet the needs of different personality. With the gradual improvement and maturity of online education, many advantageous educational platforms begin to seek new optimization methods to adapt to the needs of people for educational resources and content in the new era of continuous development [2]. Yan et al. [3] believed that for the low utilization of online education resources and online teaching logic, electronic music curriculum resources matching the fuzzy clustering algorithm (FCA) can optimize these problems. Ma and Feng [4] pointed out that the use of modern network technology and education technology to establish an efficient, fast, and user-friendly educational application information system has become an important trend. The "digital campus" using modern information network technology and communication technology is a new teaching method. In particular with the development of wireless networks, these technologies provide technical support

for strengthening the functions of educational application information systems and improving system experience.

Whether curriculum resources can be accurately matched has always been a difficult problem faced by online education. In view of this situation, relevant researchers have once studied it, and they put forward some effective ideas. Singular value decomposition technology can be applied to a collaborative filtering algorithm (CFA) [5], and the advantage is that the dimensionality of the vector is reduced and the accuracy of the matching algorithm is improved. Some scholars adjusted the matching of resources and the weight of users, which could improve the matching effect of the algorithm. Some scholars classified teaching resources and users through the Bayesian network and obtained a stable and efficient matching algorithm [6]. For the above-mentioned algorithms, there are also some shortcomings. Although these algorithms can optimize the traditional matching algorithm, its poor practicability makes it difficult to effectively apply on the online education platform. Mahdiuon et al. [7] suggested that social media has a certain influence on academic participation and performance in the higher education environment. Therefore, social networks in online education can improve students' academic performance using joint analysis and mapping social media functions according to students' preferences. Mapping the radiation function of the wireless network to online education and establishing the intimacy and immediacy of the social learning system can improve the effectiveness of the AI electronic music creation learning process. The representative online learning platform is analyzed by scholars. They emphasized the problems of online learning platforms and tried to build models using the structure of personalized learning systems and online learning content. The improved optimization strategy is used to build a personalized learning system. Tang et al. [8] proposed that anyone with a personal computer can automatically arrange learning sequences through a data-driven recommendation system to achieve personalized learning. They explored methods and strategies to effectively improve students' comprehensive quality and cultivate creative awareness in electronic music creation and performance training, to promote the reform of electronic music online education. The research shows that there are many researches on the application of electronic music creation technology in teaching systems. However, there are few researches on the online exhibition and education direction of AI electronic music creation. Faced with this problem, the research on online education and wireless network collaboration by AI electronic music can change this situation [9].

Aimed at the collaboration of online education and AI electronic music creation and performance wireless network, intelligent wireless sensor network (WSN), AI and CFA are used to design an electronic music creation system. A fuzzy C-means clustering algorithm is used to realize intelligent matching suitable for online electronic music and optimize the effect of online education. Meanwhile, the simulation experiment is used to verify the matching degree of AI electronic music curriculum resources, which is better than the traditional matching algorithm and has high accuracy. The innovation lies in the multidimensional optimization of intelligent online electronic music by using intelligent WSN and the design of electronic music creation system by AI and CFA. These provide a theoretical basis for subsequent relevant researchers and have very important practical significance.

2. Materials and Methods

2.1. Fuzzy Clustering Algorithm. The basis of fuzzy theory is the set of fuzziness, which brings together descriptions of fuzziness. The traditional set has a clear description of an object, but the fuzzy set has an unclear description of an object. Therefore, the elements in the fuzzy set can be attributed to different subsets. In fact, simple yes or no should not be the answer to all questions. For complex nonlinear problems, it is necessary to go beyond yes or no answers, and the degree of freedom of the elements of fuzzy theory solves this problem well. Since the emergence of fuzzy theory, it has been applied in various fields for decades. Fuzzy theory has signs of use in many advanced fields such as industrial control, analysis systems, and sensor systems. The essence of fuzzy theory is the calculation process of mapping one target space to another target space through fuzzy logic analysis, which is similar to the principle of Support Vector Machine (SVM). The general fuzzy inference system includes the process of input and output, fuzzification, rule base, synthesis algorithm, and defuzzification.

The fuzzy C-means (FCM) algorithm and CFA are used. On these two algorithms, an intelligent matching algorithm for online electronic music creation and performance is proposed [10].

The FCM algorithm can solve the difficulty of classification with unclear membership [11]. If the number of users is n and the number of items is m, p_{ij} represents the score of the i user to the j item. Let $1 \le i \le n$ and $1 \le j \le m$, and its evaluation matrix is expressed as

$$P = \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1m} \\ p_{21} & p_{22} & \cdots & p_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ p_{n1} & p_{n2} & \cdots & p_{nm} \end{bmatrix}. \tag{1}$$

On the above evaluation matrix [12], a membership matrix X can be used to classify its very similar users into c clusters as

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{c1} & x_{c2} & \cdots & x_{cn} \end{bmatrix}. \tag{2}$$

It is assumed that l is a fuzzy index [13], then d_{ij} means the Euclidean distance between the i user and the j cluster center [14]. In order to calculate the objective function of

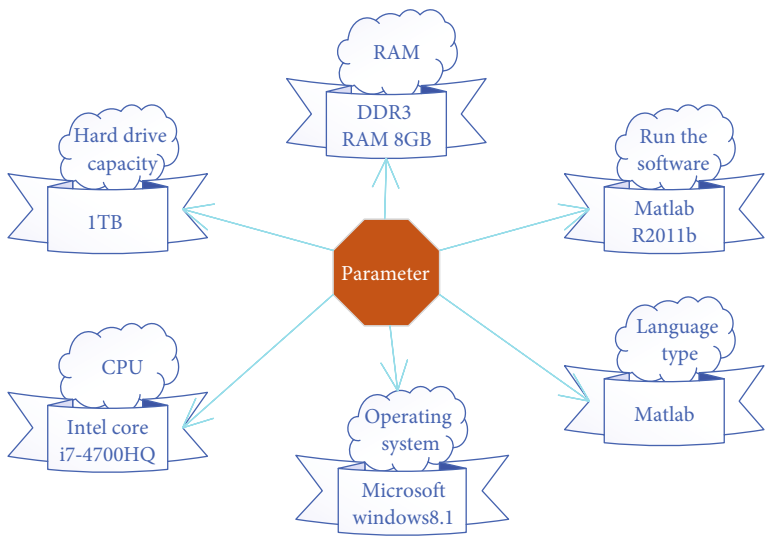

Figure 1: Parameters of the simulation platform.

the FCM clustering algorithm, this paper uses the data of matrix X according to n users and c users as

$$J_l(X, c) = \sum_{i=1}^{n} \sum_{j=1}^{c} x_{ji}^{l} d_{ij}^{2}. \tag{3}$$

In order to optimize the objective function of the algorithm [15], this paper needs to derive its implementation conditions. Assuming that there are $j\,(1 \le j \le c)$ cluster centers c_j, the conditions it needs to achieve are shown in

$$c_j = \frac{\sum_{i=1}^{n} x_{ji}^{l} p_{ij}}{\sum_{i=1}^{n} x_{ji}^{l}}, \tag{4}$$

$$x_{ji} = \frac{1}{\sum_{j=1}^{c} \left[d_{ji}/d_{ki}\right]^{2/(l-1)}}. \tag{5}$$

During the execution of the algorithm, it is often necessary to calculate the distance between the user and its cluster center, compare matrix data, and reduce similarity, to optimize the objective function [16]. The specific steps of the algorithm are as follows. (a) Initialize. (b) Select the initial clustering center with the maximum density. (c) Implement the membership matrix. (d) If the $t+1$st and t-th iteration results satisfy

$$\left|J_l^{t+1} - J_l^{t}\right| < \varepsilon, \tag{6}$$

when iteration is stopped, its membership matrix and scoring matrix are the final solutions. Then, (e) if the result is opposite, execute again from step b. (f) According to the membership matrix and the rating matrix, users are grouped to establish user clusters to realize the classification of other users.

Select the initial cluster center [17]. In order to prevent errors in selecting the initial clustering center and failure to complete the classification, this paper selects the initial clustering center according to the following steps in the implementation process [18].

(1) The rating matrix of n users is P, so the density value of each user can be expressed by

$$r_d = \frac{\sqrt{1/n(n-1)\sum_{j=1}^{n}\sum_{i=1}^{n}\left\|p_i - p_j\right\|^2}}{2}, \tag{7}$$

$$V_i = \sum_{j=1}^{n} \frac{1}{1 + 4/\left(r_d^2\left\|p_i - p_j\right\|^2\right)}. \tag{8}$$

(2) According to equations (7) and (8), the initial clustering center is obtained by calculation. The user's density value is expressed as

$$V_i^* = V_i^* - V^* \exp\left(\frac{-\left\|p_i - p_j\right\|^2}{0.25\delta_a}\right). \tag{9}$$

(3) The initial clustering center after correction is judged. If the initial clustering center conforms to equation (10), the calculation is terminated. Otherwise, continue to calculate in accordance with step (1):

$$\frac{V_i^*}{V^* < \varepsilon}. \tag{10}$$

(4) Output the initial clustering center results [19]

This paper verifies the effectiveness of the fuzzy C-means clustering algorithm through simulation experiments. The performance test of the clustering algorithm is carried out through the simulation environment of multiple computers,

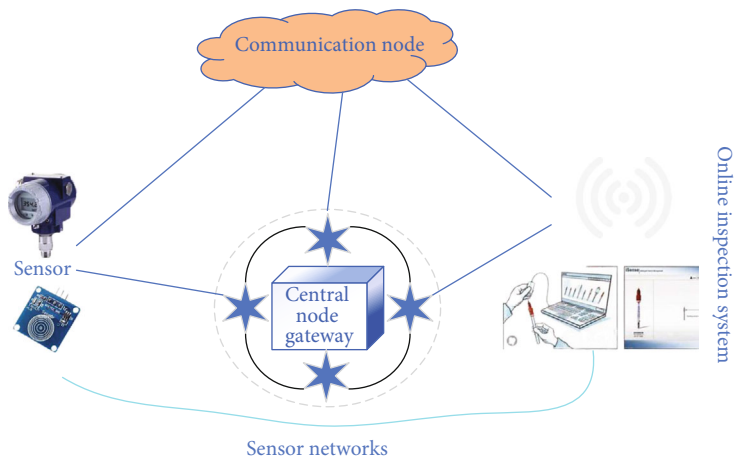

Figure 2: Collaborative frame diagram of an online platform and wireless network under a sensor network.

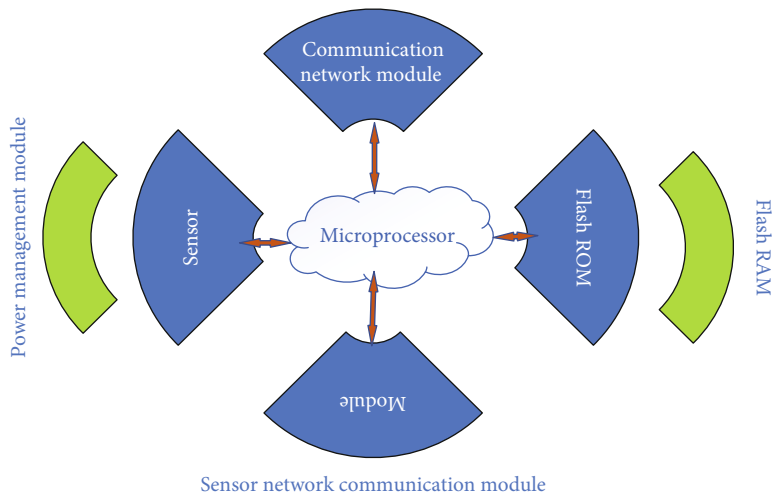

Figure 3: Structure diagram of WSN-integrated controller.

and then, the most suitable platform is selected for the simulation experiment. Figure 1 is the detailed parameters of the simulation platform.

Mean Absolute Error (MAE) and Mean Squared Error (MSE) are used to measure the algorithm. The purpose is to achieve good performance of the intelligent matching algorithm. p_i means the clustering score, q_i means the actual score of the test set, and equations (11) and (12) are the calculation method of the MAE index and MSE index, respectively.

$$\mathrm{MAE} = \frac{\sum_{i=1}^{n} |p_i - q_i|}{n}, \tag{11}$$

$$\mathrm{MSE} = \frac{\sum_{i=1}^{n} (p_i - q_i)^2}{n}. \tag{12}$$

2.2. Design and Implementation of Sensor Network-Related Equipment. People mainly obtain external information through observation. However, the ability of the human eye is limited, and the human eye is easily affected by the external environment. First, the photo element and the image forming device capture image data from the external environment. Then, the vision sensor converts the two-

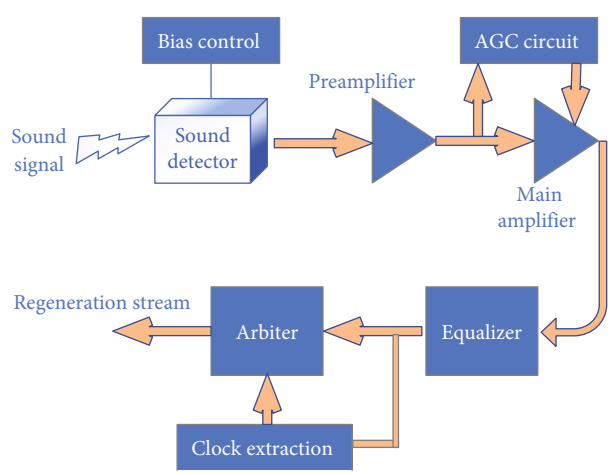

Figure 4: Frame diagram of a digital stabilized sound receiver.

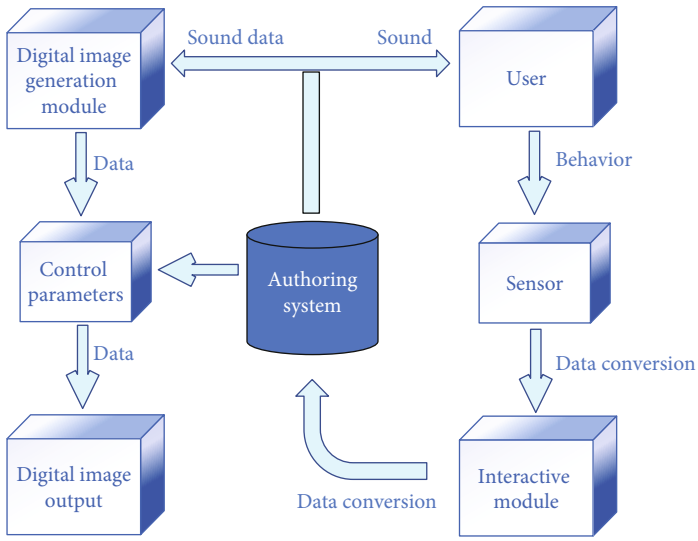

Figure 5: System working principle diagram.

dimensional image into a one-dimensional electrical signal. The essence of the visual sensor is image processing technology, which is to capture the signal on the surface of the object and present the image to the relevant researchers. According to different chips, vision sensors can generally be divided into Charge-Coupled Device (CCD) sensors and Complementary Metal Oxide Semiconductor (CMOS) sensors. CCD uses the amount of charge in the coupling mode to indicate the amount of signal and the amount of transmitted signal. The functions of CDD include photoelectric conversion and information storage and transmission. CCD has many advantages such as automatic scanning, strong spectral sensitivity, low distortion, small size, light weight, low system noise, low power loss, high durability, and high reliability. It can be integrated with other elements. Linear CCD can capture one-dimensional images, while planar CCD can capture two-dimensional images, so CCD sensors have been used in the production industry. According to whether the light source can be used, vision can be divided into two types: passive light vision and active light vision. The rapid development of CMOS is mainly due to its small size, low power consumption, and low cost, but its image quality is slightly lower than that of CCD. Digital products often seen in the market mainly use CCD or CMOS. Low-end cameras mainly use CMOS, and high-end cameras use CCD.

A sensor network [20] is an indispensable part of AI, and the collaborative framework of online education and wireless network on it is shown in Figure 2.

The intelligent system by sensors includes online platforms, wireless networks, and sensor networks [21]. Communication nodes and central gateway nodes integrate the communication function well, to realize the intelligent integration of the online platform, wireless network, and sensor network. It lays the foundation for networks and communications [22].

Sensor network equipment includes two types. One is a WSN [23] gateway (central node), and the other is ordinary nodes. The WSN gateway is actually the sensor network-integrated controller. Its structure is shown in Figure 3.

The dual-microprocessor [24] structure can coordinate each module and carry out accurate discriminant data and fast algorithm processing of intelligent information. The function of the sensor network node communication module is to connect the communication between the integrated controller and the sensor network nodes [25]. The role of an extended Read-Only Memory (ROM) is to ensure that data remains valid when power is off. Temporary data are stored in Random Access Memory (RAM). The energy of the system is provided by the power supply and its management module.

The integrated controller used can timely and effectively obtain the relevant information of the network environment and users through information interaction with sensor network nodes and online education platforms. This can ensure the synergy between the wireless network [26] and electronic music creation and performance.

A sound detector [27] is in front of the sound receiving circuit, and this arrangement is mainly to be able to easily turn optical pulse signals into electrical pulse signals. They are also set to meet the requirements of Signal-Noise Ratio (SNR) [28]. The main amplifier circuit outputs analog quantity and obtains digital signal through a series of processes such as an equalizer, a clock extraction circuit, and a decision circuit. The frame of the digital stabilized sound receiver is shown in Figure 4.

2.3. Design of the Electronic Music Creation System by AI. The creation process of electronic music is a very difficult process. It requires creators to mobilize all-round thinking and to examine and investigate from different perspectives. Different creators will have different opinions on different professional issues. The creation of electronic music is a kind of artistic activity. The experiment combines computer intelligence technology to create electronic music and design its system. Computer technology by AI is divided into two

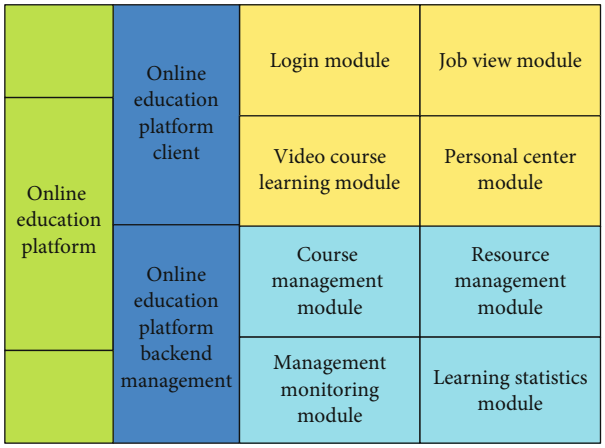

Figure 6: The specific framework of the functions of the online education platform.

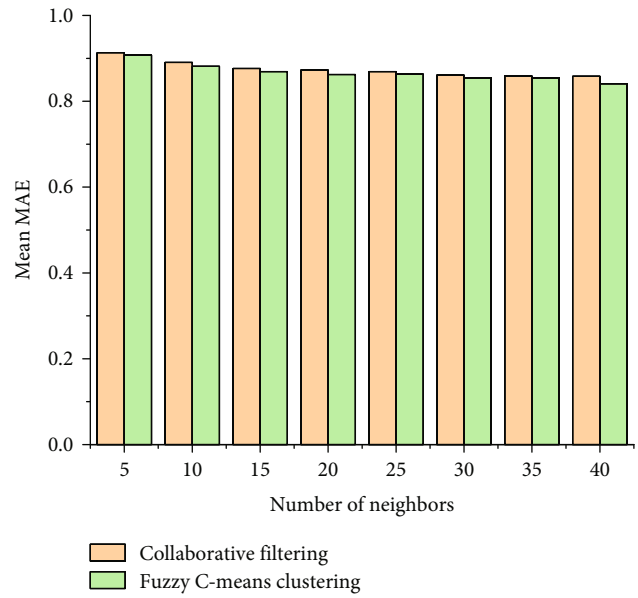

Figure 7: Mean value of MAE with different numbers of neighbors.

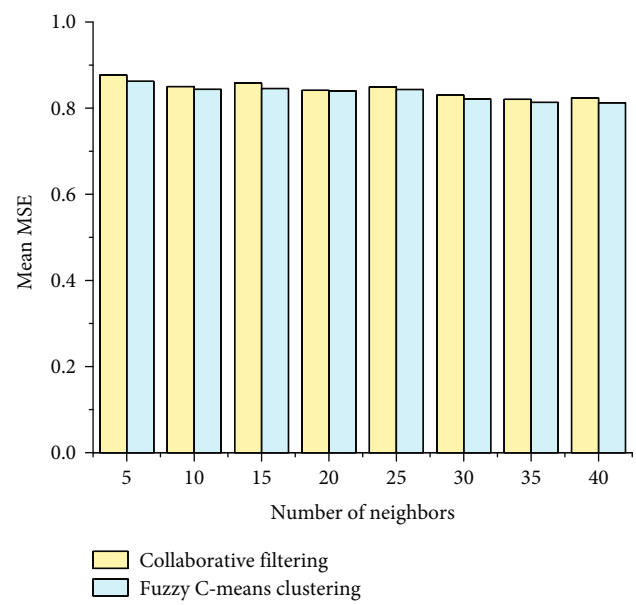

Figure 8: Mean MSE of the algorithm with different numbers of neighbors.

parts: the first part is computational intelligence and the second part is AI. Computational intelligence is obviously to use mathematical models as a basis for calculations and reflect its ability to solve problems in specific problems. For high-level computers, computational intelligence is its key capability. Computational intelligence can analyze and solve the problems encountered by users during use. This method essentially recognizes electronic music, that is, recognizing the process of electronic music creation or artistic creation, which is the embodiment of its computational intelligence. In this case, the creator's aesthetic quality and artistic sense can be fully utilized, for example, imagination and creativity, a strong spirit of innovation, keen insight, and rich emotions. These are the artistic skills that music creators must master. However, the source of computer algorithms is AI, and AI can give full play to the computer's algorithm logic and problem-solving ability. The basis of the research is the structure of computer intelligent electronic music. On this basis, the experimenter will design electronic music creation by a variety of mathematical algorithm models and AI simulation learning capabilities, combined with electronic music and real-time generation of electronic music-related theory of the music model. In this process, the experimenter must be able to master the artistic language of electronic music and its professional skills. The experimenter needs to be fully committed, listen carefully, and then express the true feelings in his heart. This is the presentation process of artistic creation. The presentation process of artistic creation is very difficult, and the experimenter needs a certain amount of time to adapt. With the background of electronic music creation, the electronic music creation system is designed.

The system design goal is "online performance of electronic music." In other words, performance is to show electronic music and real-time creation and display in the absence of people, and the decisive factor of this AI electronic music is the computer. Electronic music is music made using electronic musical instruments and electronic music technology. Musicians who create or perform electronic music are called electronic musicians. It can be distinguished by sound produced by electromechanical technology and electronic technology. Pure electronic sound manufacturing equipment includes Thereminorgan, a sound synthesizer, and a computer. The creation and performance of electronic music on the online platform are studied. According to the design objectives, design requirements have four points: (1) visualization conversion of sound signals of electronic music, (2) data visualization conversion of electronic music, (3) online electronic music performance coordination with the wireless network, and (4) optimization of data stability and fluency. The schematic diagram of this system is shown in Figure 5.

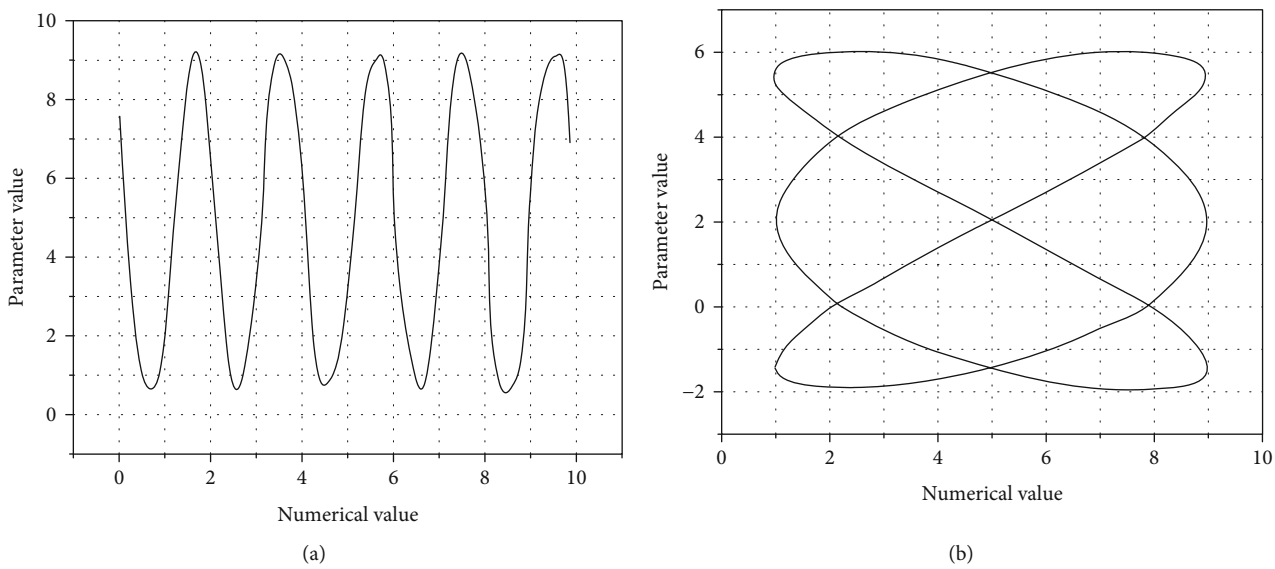

Figure 9: (a, b) Waveform graphs with sound frequencies of 100 Hz and 50 Hz, respectively.

2.4. AI Technology. The model studied is an online education system model for AI electronic music creation and performance. The functions of the electronic music creation and performance online education platform are mainly divided into two parts. One part is the client of the online education platform, and the other part is the background management of the online education platform. The first part is divided into four modules: login module, electronic music homework viewing module, video course learning module, and personal center module. The second part is also divided into four modules: course management module, resource management module, online monitoring module, and viewing data analysis module. Figure 6 is a detailed framework diagram of the functions of the online education platform.

3. Results

3.1. Simulation Analysis. Simulation results are analyzed. In the simulation experiment, the mean values of MAE and MSE are calculated according to the number of different neighbors and the performance of the two algorithms is further analyzed. Figures 7 and 8 are the running results of the two algorithms.

Figures 7 and 8 suggest that the MAE and MSE of collaborative filtering and fuzzy C-means clustering algorithms show a slow downward trend, which is premised on the increase in the number of neighbors. The above results reveal that the accuracy of algorithm matching is closely related to the number of user neighbors. Additionally, the collaborative filtering matching algorithm is greater than the fuzzy C-means clustering algorithm in the mean values of MAE and MSE, which is on the same number of neighbors. The superiority of the algorithm is reflected in the high matching accuracy of the fuzzy C-means clustering algorithm. The test results on the electronic music teaching platform also confirm that the proposed algorithm can improve the matching degree of resource push of users for electronic music, which greatly improves the quality of online education.

3.2. Function Analysis of the Electronic Music Performance System on AI. With regard to the digital sampling sound and the digital synthetic sound, their data information will form continuous waveforms. Under the action of time, these waveforms show the shape of the sampling point in the oscilloscope. The use of digital oscilloscope, according to the sound frequency, amplitude and waveform of these physical characteristics can be continuous line real-time display data changes. The image in Figure 9 is displayed by two oscilloscopes. These two function curves are on a two-axis oscilloscope and x-axis curve. Turn the sound into electronic music on a biaxial oscilloscope.

The X, Y coordinate data biaxial oscilloscope output in the form of image can objectively reflect the source of sound data, to further reflect the characteristics of electronic music. In order to make the user more convenient to use the system, the sound vision module is designed. There are five different functional parameters in this module, namely, mode, button, line width parameter, point size parameter, and drawing mode menu. Among them, there are different image generation modes in the drawing mode menu. The mode selection function is shown in Figure 10.

The drop-down button of the drawing mode is clicked for the drawing test, and the corresponding data and waveforms are relatively complete and true. Figure 11 is the generated effect diagram.

Through simulation experiments, the combination of intelligent WSN, electronic music creation system design, and CFA has a better effect on the creation and performance of intelligent online electronic music. Compared with each individual method, the former has a better effect.

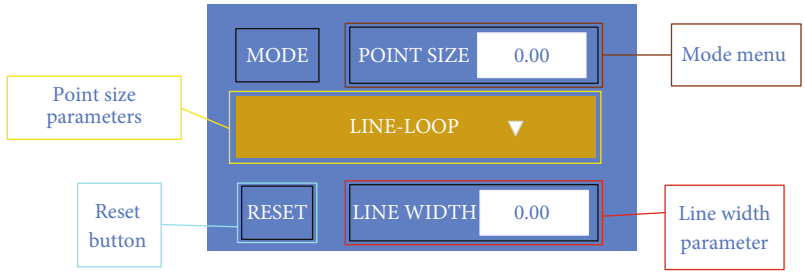

Figure 10: Pattern selection function area.

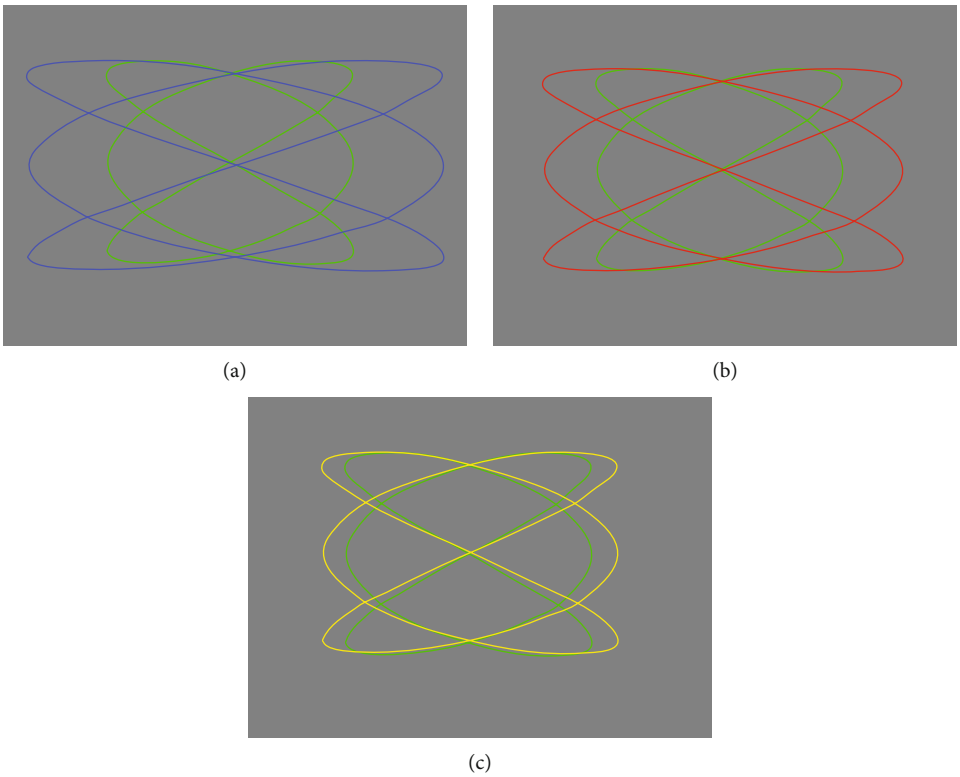

Figure 11: (a–c) Waveforms of different sound effects at frequencies of 30 Hz, 60 Hz, and 90 Hz.

4. Conclusion

In today's rapid development of science and technology, AI technology continues to progress, and the development of digital technology, electronic music online performance, and wireless network collaborative research is more important. By the research of AI, this paper combines online education and wireless network collaboration of electronic music creation and performance, takes electronic music as the research object, and studies the concept and technology of the computer sensor network and intelligent algorithm and wireless network. Finally, the following research results are obtained: this paper modularizes the creation mode of intelligent electronic music, to enable users to use it conveniently, in addition to obtaining higher computational efficiency. The sound characteristics are transformed into image structure by an oscilloscope, and the corresponding mode of the sound and image is formed. By the sensor network and fuzzy C-means clustering algorithm, this paper achieves the purpose of online electronic music intelligent matching and optimizes the effect of online education. This paper uses simulation experiments to verify the matching degree of AI electronic music curriculum resources, which is better than the traditional matching algorithm, and the accuracy is also high. The limitation is that the simulation experiment of the proposed algorithm has not been verified on a large scale, resulting in some deficiencies in the stability of this algorithm. In-depth exploration will be made in the follow-up study, and large-scale verification will be conducted to solve this problem.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

All the authors do not have any possible conflicts of interest.

References

[1] H. M. Lu, Y. J. Li, M. Chen, H. Kim, and S. Serikawa, "Brain intelligence: go beyond artificial intelligence," *Mobile Networks and Applications*, vol. 23, no. 2, pp. 368–375, 2018.

[2] R. F. Kizilcec, J. Reich, M. Yeomans et al., "Scaling up behavioral science interventions in online education," *Proceedings of the National Academy of Sciences*, vol. 117, no. 26, pp. 14900–14905, 2020.

[3] J. Yan, J. Y. Sun, and D. Y. Yang, "Application of unsupervised TSK fuzzy algorithm in large-scale online culture courses," *Personal and Ubiquitous Computing*, vol. 24, no. 3, pp. 377–391, 2020.

[4] J. Ma and B. Feng, "Integrated design of graduate education information system of universities in digital campus environment," *Wireless Communications and Mobile Computing*, vol. 2021, 12 pages, 2021.

[5] Y. Xu, J. G. Feng, J. W. Du, and D. W. Gong, "A cross-domain collaborative filtering algorithm with expanding user and item features via the latent factor space of auxiliary domains," *Pattern Recognition*, vol. 94, pp. 96–109, 2019.

[6] B. G. Marcot and T. D. Penman, "Advances in Bayesian network modelling: integration of modelling technologies," *Environmental Modelling & Software*, vol. 111, pp. 386–393, 2019.

[7] R. Mahdiuon, G. Salimi, and L. Raeisy, "Effect of social media on academic engagement and performance: perspective of graduate students," *Education and Information technologies*, vol. 25, no. 4, pp. 2427–2446, 2020.

[8] X. Tang, Y. Chen, X. Li, J. Liu, and Z. Ying, "A reinforcement learning approach to personalized learning recommendation systems," *British Journal of Mathematical and Statistical Psychology*, vol. 72, no. 1, pp. 108–135, 2019.

[9] M. Rath and B. Pati, "Appraisal of soft computing methods in collaboration with smart city applications and wireless network," *International Journal of e-Collaboration (IJeC)*, vol. 14, no. 1, pp. 27–42, 2018.

[10] A. K. Dubey, U. Gupta, and S. Jain, "Comparative study of K-means and fuzzy C-means algorithms on the breast cancer data," *International Journal on Advanced Science, Engineering and Information Technology*, vol. 8, no. 1, pp. 18–29, 2018.

[11] A. Rajput and V. B. Kumaravelu, "Scalable and sustainable wireless sensor networks for agricultural application of Internet of things using fuzzy c-means algorithm," *Sustainable Computing: Informatics and Systems*, vol. 22, pp. 62–74, 2019.

[12] K. S. Chen and C. M. Yu, "Fuzzy test model for performance evaluation matrix of service operating systems," *Computers & Industrial Engineering*, vol. 140, article 106240, 2020.

[13] T. A. K. Nihat, "Meta fuzzy index functions," *Communications Faculty of Sciences University of Ankara Series A1 Mathematics and Statistics*, vol. 69, no. 1, pp. 654–667, 2020.

[14] G. C. Cardarilli, L. Di Nunzio, R. Fazzolari, A. Nannarelli, M. Re, and S. Spanò, "*N*-dimensional approximation of Euclidean distance," *IEEE Transactions on Circuits and Systems II: Express Briefs*, vol. 67, no. 3, pp. 565–569, 2020.

[15] S. Rusinkiewicz, "A symmetric objective function for ICP," *ACM Transactions on Graphics (TOG)*, vol. 38, no. 4, pp. 1–7, 2019.

[16] Y. Nesterov, "Complexity bounds for primal-dual methods minimizing the model of objective function," *Mathematical Programming*, vol. 171, no. 1, pp. 311–330, 2018.

[17] D. T. Dinh and V. N. Huynh, "K-PbC: an improved cluster center initialization for categorical data clustering," *Applied Intelligence*, vol. 50, no. 8, pp. 2610–2632, 2020.

[18] M. Klett, N. Wentzell, T. Schäfer et al., "Real-space cluster dynamical mean-field theory: center-focused extrapolation on the one- and two particle-levels," *Physical Review Research*, vol. 2, no. 3, article 033476, 2020.

[19] Z. Zhu, Z. Li, and M. R. Morris, "An ultradeep Chandra catalog of X-ray point sources in the galactic center star cluster," *The Astrophysical Journal Supplement Series*, vol. 235, no. 2, p. 26, 2018.

[20] D. Kandris, C. Nakas, D. Vomvas, and G. Koulouras, "Applications of wireless sensor networks: an up-to-date survey," *Applied System Innovation*, vol. 3, no. 1, p. 14, 2020.

[21] W. Elsayed, M. Elhoseny, S. Sabbeh, and A. Riad, "Self-maintenance model for wireless sensor networks," *Computers & Electrical Engineering*, vol. 70, pp. 799–812, 2018.

[22] S. D. Wohwe, B. O. Yenke, A. Förster, and D. Y. Paul, "Optimized clustering algorithms for large wireless sensor networks: a review," *Sensors*, vol. 19, no. 2, p. 322, 2019.

[23] T. M. Behera, S. K. Mohapatra, U. C. Samal, M. S. Khan, M. Daneshmand, and A. H. Gandomi, "Residual energy-based cluster-head selection in WSNs for IoT application," *IEEE Internet of Things Journal*, vol. 6, no. 3, pp. 5132–5139, 2019.

[24] M. Schoeberl, W. Puffitsch, S. Hepp, B. Huber, and D. Prokesch, "Patmos: a time-predictable microprocessor," *Real-Time Systems*, vol. 54, no. 2, pp. 389–423, 2018.

[25] E. H. Alami and A. Najid, "ECH: an enhanced clustering hierarchy approach to maximize lifetime of wireless sensor networks," *IEEE Access*, vol. 7, pp. 107142–107153, 2019.

[26] Q. Wu, L. Liu, and R. Zhang, "Fundamental trade-offs in communication and trajectory design for UAV-enabled wireless network," *IEEE Wireless Communications*, vol. 26, no. 1, pp. 36–44, 2019.

[27] M. Chen and G. H. Von, "How to build a fast and highly sensitive sound detector that remains robust to temperature shifts," *Journal of Neuroscience*, vol. 39, no. 37, pp. 7260–7276, 2019.

[28] C. M. Vander Weele, C. A. Siciliano, G. A. Matthews et al., "Dopamine enhances signal-to-noise ratio in cortical-brainstem encoding of aversive stimuli," *Nature*, vol. 563, no. 7731, pp. 397–401, 2018.