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The fusion of musical emotion recognition and artificial intelligence in music education

Yang Lijin

Krirk University, Bangkok, 10220, Thailand

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Abstract: This paper discusses the fusion and application of music emotion recognition technology and artificial intelligence (AI) in music education. With the rapid development of artificial intelligence technology, its application is increasingly widely used in the field of education, especially in music education. AI not only improves teaching efficiency, but also provides students with a more personalized and efficient learning experience. As an important branch of AI, music emotion recognition technology can accurately identify and interpret the emotion and artistic conception expressed by analyzing the melody, rhythm and harmony elements in music works, which is of great significance for students to deeply understand the connotation and essence of music works in the process of music appreciation and learning. This paper analyzes the current situation, advantages and challenges of the integration of music emotion recognition and AI in music education, and puts forward corresponding strategies and suggestions, aiming to provide theoretical reference and practical guidance for innovative practice in the field of music education.

1. Introduction

Today, with the rapid development of digitalization and intelligence, the field of education is experiencing unprecedented changes. Music, as an important carrier of human emotion expression, its educational form and content are also constantly exploring and innovating. As an important branch in the field of artificial intelligence, the music emotion recognition technology can accurately capture the emotional elements in music works through deep learning and big data analysis, bringing a new perspective and method to music education. Traditional music education often focuses on the teaching of music theory knowledge, performance skills, and other aspects, while the introduction of music emotion recognition technology can help students to further understand the emotion and artistic conception behind music works, and improve the ability of music appreciation and creation[1]. At the same time, the wide application of artificial intelligence technology also provides personalized and intelligent teaching programs for music education, which greatly improves the teaching efficiency and learning experience. This paper aims to explore the integrated application of music emotion recognition and artificial intelligence in music education, analyze its potential and challenges in improving the teaching quality and promoting the overall development of students, in order to provide useful theoretical reference and practical guidance for the innovative practice in the field of music education.

2. Overview of music emotion recognition techniques

2.1 The basic principle of musical emotion recognition

Music emotion recognition technology, in short, is the use of computer technology and algorithms to analyze and process music, in order to identify and understand the emotion expressed in music works. The core of this technology is to establish the mapping relationship between musical characteristics and emotion. Musical features usually cover multiple[2] dimensions such as melody, rhythm, harmony, timbre, and dynamics, while emotion can be described by various labels such as joy, sadness, tension, and calm. The basic principle of musical emotion recognition lies in extracting and analyzing these features in music, and using machine learning or deep learning algorithms to build models to predict and classify the emotions expressed by music.

The theoretical basis of music emotion recognition involves many disciplines such as music psychology, audio signal processing and natural language processing. Music psychology studies the internal connection between music and human emotion, which provides a theoretical basis for music emotion recognition; audio signal processing focuses on how to extract effective characteristic information from music audio; natural language processing borrows the method of text emotion analysis[3]. Although music is not language, the lyrics and texts in music can also be used as a dimension of emotion analysis.

2.2 Technical methods of music emotion recognition

The technical method of music emotion recognition mainly includes three steps: feature extraction, model training and emotion classification.

Feature extraction is one of the key steps in musical emotion recognition. It involves extracting emotion-related features from musical audio, which may include spectral features (e. g., mel frequency inversion coefficient MFCC), rhythmic features (e. g., beat, speed), harmonic features (such as chord progression, tonality), etc. In addition, if the music contains lyric text, text features can also be extracted, such as emotional vocabulary, sentence structure, etc.

Model training is to use a large amount of music data to train machine learning or deep learning models. These models can be support vector machines (SVM), random forest (RF), neural network (NNN), etc. In the field of deep learning, convolutional neural network (CNN), recurrent neural network (RNN) and its variants (such as long and short time memory network LSTM, gating loop unit GRU) have been widely used in music emotion recognition. The goal of model training is to enable the model to learn the mapping relationship between musical features and emotions[4].

Emotion classification is to input the new music data into the trained model and obtain the emotion classification results. This result can be either a discrete emotional label (e. g., joy, sadness) or a continuous emotional dimension (e. g., pleasure, excitement). The results of emotion classification can be used in various application scenarios, such as music recommendation, music therapy, music visualization, etc.

2.3 Application prospect of music emotion recognition in music education

The application prospect of music emotion recognition technology in music education is broad. First, it can help students to have a deeper understanding of the music work. By identifying the emotional elements in the music, students can better understand the composer;s creative intention and the emotional connotation expressed by the work, so as to enhance the ability of music appreciation. Secondly, music emotion recognition technology can assist music teaching. Teachers can use this technology to design more targeted teaching activities, such as recommending suitable

music works according to students; learning progress and emotional needs, or evaluating students; performance or creation works through emotional analysis, giving more personalized feedback. In addition, music emotion recognition technology can also be applied to the field of music therapy. Music therapy is a method that uses music to improve and promote the physical and mental health of individuals. By identifying the patient's emotional state, a music therapist can provide patients with music therapy programs that meet their emotional needs, thus achieving the therapeutic purpose[5].

In short, the application of music emotion recognition technology in music education is broad. It can not only improve students; music appreciation and creation ability, but also assist teachers in teaching, and bring more innovation and possibilities for music education.

3. The application status of artificial intelligence in music education

3.1 The auxiliary role of artificial intelligence in music teaching

Artificial intelligence technology is playing an increasingly important auxiliary role in music teaching. Through intelligent teaching tools and platforms, music education becomes more efficient, personalized and interactive.

First, AI can provide personalized learning pathways and resource recommendations. Based on students learning progress, interest preferences, and emotional needs, AI systems can intelligently recommend suitable music tracks, teaching videos, and practice materials to meet students personalized learning needs. This personalized teaching method helps to stimulate students interest in learning and improve their learning effect. Secondly, artificial intelligence also plays the role of interactive partner in music teaching. Through virtual instruments, intelligent accompaniment, and real-time feedback systems, the AI can interact with students to provide instant performance guidance and feedback. This interaction not only enhances the students learning experience, but also helps them to better master playing skills and understand music theory. In addition, artificial intelligence can also support remote music teaching. Using video conferencing, online collaboration tools and AI assisted systems, teachers and students can interact and teach in real time in different locations in real time, breaking the geographical constraints of traditional music education. This distance teaching method makes music education more flexible and convenient, and provides opportunities for more people to receive high-quality music education.

3.2 The application of artificial intelligence in music creation and music arrangement

Artificial intelligence technology has also shown great potential in the field of music creation and music arrangement. Through algorithms and models, AI can generate creative and personalized music works, bringing new inspiration and possibilities to music creation.

In terms of music creation, AI can assist composers in their melody, harmony and rhythm creation. The AI system can generate music fragments according to the composer's style and needs for the composer's reference and modification. This way of creation not only improves the efficiency of composition, but also inspires the composer[6].

In terms of music arrangement, AI can adapt and rearrange it based on existing musical works. The AI system can analyze features such as melody, harmony and rhythm of musical works, and then generate arranged versions that meet a specific style or demand. This way of arrangement not only enriches the diversity of music works, but also provides more choices and possibilities for music performance and production.

3.3 Advantages of artificial intelligence in music evaluation and feedback

AI has significant advantages in music evaluation and feedback. Through the intelligent evaluation system and algorithm, AI can make an objective, accurate and immediate evaluation of students; performance, creation and theoretical knowledge, providing valuable teaching reference for teachers.

First, AI can accurately evaluate students; playing skills. The AI system can analyze the audio or video of students playing, identify the errors and deficiencies in the performance, and give specific suggestions for improvement. This evaluation method not only improves the accuracy and objectivity of the evaluation, but also helps students to better understand their own performance level and make targeted learning plans. Second, AI has also performed well in music creation and theoretical knowledge evaluation. The AI system can conduct emotion analysis, harmony analysis and rhythm analysis of students; music works, to evaluate the creativity, integrity and accuracy of the works. At the same time, AI can also test and evaluate students; knowledge of music theory, to help them consolidate and expand their knowledge. In addition, AI can provide immediate feedback and interaction. Through intelligent teaching platforms and tools, AI can provide real-time feedback on students; performance and creation, point out the problems and provide suggestions for improvement. This immediate feedback mechanism helps students to correct their mistakes in time and improve their learning efficiency.

To sum up, AI is playing an increasingly important role in music education. Through intelligent teaching tools, creation platforms and evaluation systems, AI has brought more innovation and possibilities to music education, and promoted the development and progress of music education.

3.4 The fusion practice of music emotion recognition and artificial intelligence in music education

With the continuous progress of technology, the integration practice of music emotion recognition and artificial intelligence in music education is gradually deepening, providing learners with a more personalized, efficient and immersive learning experience. The following is a detailed discussion of this convergence practice.

4. The formulation of personalized learning path

Music emotion recognition technology can analyze the emotional characteristics of music works, combine the learners; personal preferences and learning progress, and customize the personalized learning path for each learner. By collecting and analyzing the learners; behavioral data during the learning process, such as repertoire selection, practice time and completion degree, the AI system can intelligently recommend music works and teaching resources that meet the learners; emotional needs and skill level. This personalized learning path can not only help stimulate learners; interest in learning, but also ensure that they can gradually master music knowledge and skills at their right pace.

In addition, music emotion recognition technology can also adjust the teaching strategies according to the emotional state of learners. For example, when learners show exhaustion or anxiety, the AI system can recommend some relaxed and pleasant music works to ease their mood, and when learners are in an excited and positive state, it can recommend more challenging and deep music works to promote their further development.

4.1 The construction of an efficient music evaluation and feedback mechanism

In music education, evaluation and feedback are the key link to improve the learning effect. The integration of music emotion recognition technology and artificial intelligence provides the possibility to build an efficient music evaluation and feedback mechanism. The AI system can analyze the audio or video of learners; performance in real time, identify the problems of emotional expression, skill application and rhythm mastery in the performance, and give specific suggestions for improvement. This immediate feedback not only helps learners to correct their mistakes in time, but also helps them to better understand the emotional connotation and playing skills of musical works. In addition, AI systems can also conduct emotion analysis of learners; performance to assess the accuracy and depth of their EE. This emotional level assessment helps learners to enhance the expression and appeal of the music and make their performance more vivid and moving.

4.2 The creation of an immersive music learning environment

The integration of musical emotion recognition and artificial intelligence also helps to create an immersive music learning environment. Through advanced technologies such as virtual reality (VR) and augmented reality (AR), the AI system can create virtual scenes that match the emotions of music works, so that learners can seem to feel in music works and feel and understand the emotional connotation of music more deeply. At the same time, the AI system can also adjust the atmosphere and color of the virtual scene according to the emotional state of the learners, so as to enhance the sense of immersion and substitution of learning. For example, when the learner is learning a sad piece of music, the AI system can adjust the virtual scene to a dim tone and a gloomy atmosphere to better convey the emotional tone of the work.

4.3 The exploration of innovative music teaching mode

The integration of music emotion recognition and artificial intelligence provides a new idea for the innovation of music teaching mode. Through intelligent teaching platforms and tools, teachers can adopt more flexible and diverse teaching methods, such as flipped classroom, project-based learning and gamified learning, to stimulate learners learning motivation and creativity. In addition, AI systems can also support distance learning and collaborative learning. Learners can connect to the teaching platform at home through smart devices to interact and communicate with teachers and classmates in real time. This distance teaching method not only breaks the geographical restrictions, but also enables learners to receive high-quality music education anytime and anywhere.

To sum up, the integration practice of music emotion recognition and artificial intelligence in music education provides learners with a more personalized, efficient and immersive learning experience. With the continuous progress of technology and the expansion of application scenarios, this integration practice will play a more important role in the future and promote the development and progress of music education.

5. Challenges and countermeasures of the integration of Music emotion recognition and artificial intelligence in music education

Although the integration of music emotion recognition and artificial intelligence has brought unprecedented opportunities for music education, it also faces many challenges in practical application. The following is a detailed discussion of these challenges and its solutions.

5.1 Technical challenges and solutions

The application of music emotion recognition technology in music education faces two major technical challenges: one is the accuracy of emotion recognition, especially when dealing with complex and changeable music works, the technology still has errors; the other is data privacy and security, personal learning data in music education involves personal privacy, how to ensure the security and privacy protection of data has become a difficult problem in the implementation of technology. To solve these problems, it is necessary to continuously optimize the algorithm and increase the training data to improve the accuracy and generalization ability of emotion recognition, while adopt advanced encryption technology and privacy protection mechanism to ensure the security and privacy of learner data.

5.2 The innovation of educational concept and teaching mode

In the field of music education, the bondage of traditional educational concepts has become a major challenge that hinders the application of new technologies and new ideas. Many educators and learners still tend to rely on traditional teaching models and have limited acceptance of cutting-edge technologies such as musical emotion recognition and artificial intelligence. At the same time, how to effectively integrate these new technologies with the existing teaching mode is also an urgent problem for educators and researchers to solve. To address these challenges, we need to actively promote the application of advanced educational concepts and technologies. By holding activities such as training and seminars, to popularize the teaching changes brought about by the new technology to educators and learners, and improve their acceptance and application ability. In addition, we should also combine the characteristics of music emotion recognition and artificial intelligence technology to explore new teaching modes suitable for music education, such as personalized learning, flipped classroom, etc., to stimulate learners learning interest and creativity, and promote the development of music education to a more modern and intelligent direction.

5.3 Improvement of teachers roles and quality

The field of music education is facing the dual challenge of technical ability and educational concept renewal. On the one hand, some teachers may be difficult to make full use of the potential of musical emotion recognition and artificial intelligence technology due to the lack of the ability to understand and apply new technologies, thus limiting the improvement of teaching effect. On the other hand, with the continuous progress of technology, teachers need to constantly learn and update their educational ideas, so as to adapt to the teaching changes brought about by the new technology, and to ensure the era and effectiveness of the teaching content and methods.

In order to cope with these challenges, we should strengthen teacher training, and improve teachers technical ability and educational literacy through regular technical training and educational concept renewal courses. At the same time, teachers are encouraged to actively participate in the research of relevant technologies and educational modes, which not only helps them to deeply understand the application scenarios of new technologies, but also promotes the deep integration of technological innovation and teaching innovation, and injects new vitality into music education. Through these measures, we can better cope with the challenges and promote the sustainable development of music education.

To sum up, the challenges of the integration of music emotion recognition and artificial intelligence in music education mainly come from three aspects: technology, educational concept and teacher role. By optimizing algorithms, strengthening data encryption, promoting advanced educational concepts, innovating teaching models and strengthening teacher training, we can

effectively respond to these challenges and promote the development of music education to a more personalized, efficient and intelligent direction.

6. Conclusion

The integration of music emotion recognition and artificial intelligence has brought revolutionary changes to music education, which not only improves the personalization and efficiency of teaching, but also enriches the learning experience of learners. Despite the challenges of technical accuracy, data privacy protection, educational concept innovation and teacher ability improvement in the implementation process, these challenges are being gradually overcome through algorithm optimization, the application of data encryption technology, the popularization and update of educational concepts, and the strengthening of teacher training. In the future, with the continuous progress of technology and the continuous innovation of education mode, music emotion recognition and artificial intelligence will play a more important role in music education, laying a solid foundation for the cultivation of talents with profound music literacy and innovation ability. This integration practice not only promotes the modernization process of music education, but also provides a useful reference for the educational reform in other fields.

References

[1] Yin Lanqing. Research on multimodal music emotion recognition based on deep learning [D]. And Donghua University, 2023.DOI:10.27012/d.cnki.gdhuu. 2023.001350.

[2] Ye Long, Duan Danting, Zhong Wei, et al. Modeling and application of emotion-intelligence information [J]. Journal of the Communication University of China (Natural Science Edition), 2022, 29(02):1-8.DOI: 10.16196/j. cnki.issn. 1673-4793.2022.02.001.

[3] Tang Xia, Zhang Chenxi, Li Jiangfeng. Deep learning-based musical emotion recognition [J]. Computer Knowledge and Technology, 2019, 15(11):232-237.DOI:10.14004/j.cnki.ckt. 2019.1170.

[4] Raboy M J L, Taparugssanagorn A .Verse1-Chorus-Verse2 Structure: A Stacked Ensemble Approach for Enhanced Music Emotion Recognition [J]. Applied Sciences, 2024, 14(13):5761-5768.

[5] Singh S, Singh P N, Chaudhary D .A Survey on Autonomous Techniques for Music Classification based on Human Emotions Recognition[J].International Journal of Computing and Digital Systems, 2020, 9(3):433-447.

[6] Sarkar R, Choudhury S, Dutta S, et al.Recognition of emotion in music based on deep convolutional neural network [J].Multimedia Tools and Applications, 2020, 79(1):765-783.