

# System Design and Platform Implementation for AI-Based Metaverse Music

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**Abstract**—Artificial Intelligence ( AI ) refers to the ability to simulate human intelligence through computer programs and equipment. This intelligence can process information such as language, images and sounds, and can make decisions and actions based on this information. Based on artificial intelligence-based intelligent arrangement, intelligent recommendation algorithm, intelligent mixing, virtual reality, blockchain and other technologies, Metaverse Music can carry out the design and development of intelligent arrangement system; intelligent recommendation algorithm design based on deep learning; intelligent mixing technology The innovative design; the virtual performer system design based on virtual reality technology; the copyright management system design based on blockchain technology, and the realization of the metaverse music platform construction.

**Keywords**-artificial intelligence; metaverse music; system design; platform realization

## 1 INTRODUCTION

Metaverse Music is a new form of music that combines music with Metaverse technology. It allows musicians to combine music interpretation with immersive virtual reality scenes to create a unique music experience. It uses innovative technologies such as holographic technology and virtual reality technology to provide listeners with an interactive music experience. Metaverse Music has comprehensively used various new technologies, such as intelligent arrangement technology, intelligent recommendation algorithm, intelligent mixing technology, virtual reality technology, blockchain technology and other artificial intelligence technologies, and is also a subject of digital music, virtual world, computer science, etc. Cross fusion products.

## 2 METAVERSE MUSIC

### 2.1 What is metaverse music

Metaverse music refers to music created, performed, and disseminated in the virtual metaverse environment. Metaverse refers to a digital world similar to virtual reality, which contains virtual characters, scenes, items, etc., in which users can perform various interactive activities. Metaverse music is music created in this virtual environment. Its creation method, dissemination method and audience experience method are different from traditional music.

Creators of Metaverse music can use the virtual scenes and tools of Metaverse to create colorful music and sound effects. At the same time, the interactivity of the metaverse has also brought new possibilities for music performances and performances, such as virtual concerts and virtual scenes. Listeners can enjoy music in virtual scenes in the metaverse, or get a more realistic music experience through virtual reality equipment. At present, metaverse music is becoming an emerging trend in the field of digital cultural entertainment, attracting more and more attention from musicians and music lovers.<sup>[1]</sup>

## **2.2 Metaverse Music Features**

### **2.2.1 Digitalization**

The digitization of metaverse music refers to the digitization of music, so as to realize the storage, dissemination and interaction of music in the metaverse. Metaverse music is a digital form of music. It is not only different from traditional music in the way of creation, performance and dissemination, but also integrates digital technology and music art, showing a new artistic charm. The digitization of metaverse music can be realized in a variety of ways, thereby enhancing the storage, dissemination and interactivity of metaverse music, and improving the innovation and development potential of metaverse music.

### **2.2.2 Click-and-Mortar**

Metaverse music is created in a different way than traditional music. Creators can use the virtual scenes and tools of the Metaverse to create colorful music and sound effects. The combination of virtual and real music in the metaverse refers to the combination of music in reality and music in the virtual world, so as to create richer and more complex forms of music expression. Metaverse music is the product of the combination of virtual and real, which organically combines the virtual world with the real world, making music performances and performances more diverse and flexible. The combination of virtuality and reality in metaverse music can be achieved in a variety of ways, thus creating a richer, unique and complex musical experience.

### **2.2.3 Interactivity**

The interactivity of metaverse music refers to the interactive relationship between music and the scenes and characters in the metaverse. In the metaverse, music can interact with elements such as scenes, characters, and actions, thereby enhancing the immersion and interactivity of the metaverse. The interactivity of the Metaverse brings new possibilities for music performances and performances, such as virtual concerts and virtual live performances. Listeners can enjoy music in virtual scenes in the metaverse, or get a more realistic music experience through virtual reality equipment. The interactivity of metaverse music can be achieved in a variety of ways, thereby enhancing the player's sense of immersion and interactive experience. <sup>[2]</sup> As shown in Figure 1, According to the survey, the future of metaverse development and the amount of high-tech investment are increasing significantly, with a predicted annual growth rate of more than 20% from 2020 to 2024.

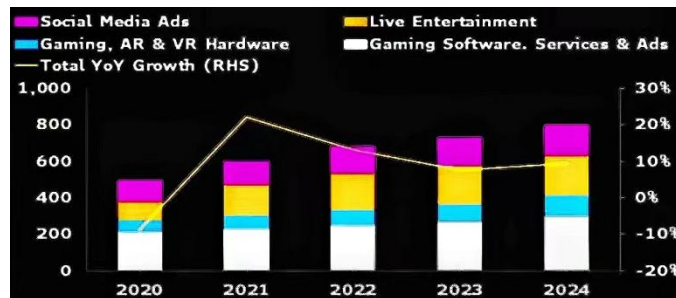


Figure 1. The Future of Metaverse Development and New Trends in High tech Investment

### 3 ARTIFICIAL INTELLIGENCE TECHNOLOGY RELATED TO METaverse MUSIC

Artificial intelligence is one of the important technologies in the music field of Metaverse, which plays an important role in music creation, sound mixing, arrangement and recommendation. Here are five AI technologies relevant to Metaverse music:

#### 3.1 Intelligent orchestration technology

Intelligent arrangement technology is a technology that uses artificial intelligence technology to complete the arrangement and creation of music content. It analyzes and learns a large amount of historical data of music creation and music theory knowledge, as well as an in-depth understanding of the user's music playback behavior and preferences, to automatically generate more personalized music works that meet the user's taste. Intelligent orchestration technology can be divided into two types: one is rule-based orchestration technology. The rule-based intelligent arrangement technology automatically generates music based on pre-set rules and music creation theory. For example, according to appropriate music theory rules and melody structure, combined with artificial intelligence algorithm data processing technology, intelligently generate musical works with personalized characteristics and in line with music creation theory. The second is machine learning-based orchestration technology. The intelligent arrangement technology based on machine learning analyzes historical data, music theory, and user listening behavior data, uses machine learning algorithms to establish intelligent models, predicts the types of music that users may be interested in, and automatically generates information based on the user's past interest characteristics Music content in line with user preferences. Intelligent recommendation algorithm

The intelligent recommendation algorithm is an artificial intelligence technology that can analyze the user's historical data in the application to recommend content that matches their interests to the user. Such recommended content may be music, movies, news, magazines, merchandise, and the like. The intelligent recommendation algorithm first establishes the user's "portrait" based on the user's interests, behavior patterns, preferences, historical records and other data, and then through the analysis of the user's portrait and the data of the supplier (such as music streaming media or e-commerce platform), Find the best matching content and recommend it to users. Intelligent recommendation algorithms can be divided into the following types :

1) *Based on collaborative filtering.* The algorithm based on collaborative filtering is the most widely used algorithm in the intelligent recommendation system. It uses the historical data of user behavior to predict the target user's interest in the specified item by finding other users with similar interests to the target user, so as to recommend items that the target user has not known or is not interested in.<sup>[3]</sup>

2) *Filter based on content.* The algorithm based on content filtering is a recommendation algorithm that infers user preferences according to the attributes of items (such as text, color, style, type, keywords, etc.). It provides users with content that matches their interests by analyzing their behavior.

3) *Hybrid recommendation .* Hybrid recommendation is an algorithm based on two algorithms, collaborative filtering and content filtering. Its advantage is that it can make full use of the advantages of the two algorithms to improve the accuracy of intelligent recommendation and user reputation.

4) *Based on social media analysis.* The intelligent recommendation algorithm based on social media analysis is to predict the user's interest in a certain content through the user's behavior and interaction in social media. The development and application of intelligent recommendation algorithms should be based on specific business scenarios. On the premise of preserving user privacy, data analysis and proper use of recommendation results can achieve better results.

### **3.2 Intelligent mixing technology**

Intelligent mixing technology is a technology that applies artificial intelligence technology to realize audio mixing. It uses machine learning algorithms to automatically complete audio editing during the mixing process, and uses artificial intelligence algorithms to imitate human auditory perception and quality judgment, so as to better improve sound effects and save mixing time.

Intelligent sound mixing technology can be divided into three types :

1) *Intelligent sound mixing technology with preset effects.* The intelligent mixing technology with preset effects is based on the pre-set mixing effects and mixing process, and uses machine learning and rule engines to automatically complete the mixing process, thereby improving work efficiency and saving the precious time of mixing personnel. For example, for a song, set the volume ratio, balance, reverb and other sound effects of each track, and then let the computer automatically complete the mixing process, thereby improving the quality and efficiency of mixing.

2) *Intelligent mixing technology with optimal mixing effect.* The intelligent mixing technology for the optimal mixing effect is based on the model established by the computer program and the artificial intelligence algorithm. By analyzing the frequency spectrum, time axis, level, space and other factors of all audio tracks, a set of optimal mixing effects is automatically generated. In order to achieve better sound effect. For example, in a song, use the optimal reverb and equalizer to automatically optimize the surround sound effect, so as to better meet the auditory needs of the listener and present a more natural, three-dimensional, clear and comfortable audio effect. Optimize audio quality.

3) *Intelligent mixing technology with personalized mixing effect.* Intelligent mixing technology for personalized mixing effects By learning the user's individual preferences and tastes, the deep learning technology based on music emotion and musical instrument style can generate a personalized mixing that is more in line with the user's taste and music style. The application of intelligent sound mixing technology can not only help music producers improve production efficiency and sound mixing quality, but also bring better audio experience to ordinary users, so that music can better benefit the public and meet the audio needs of users.<sup>[4]</sup>

## **4 SYSTEM DESIGN OF METAVERSE MUSIC BASED ON ARTIFICIAL INTELLIGENCE**

### **4.1 The Design and Development of the Metaverse Music Intelligent Arrangement System**

The design of the Metaverse music intelligent arrangement system needs to combine the characteristics of the Metaverse to match traditional music with the virtual space. Therefore, the core of the design is to achieve music customization and a new music playback experience. It will use artificial intelligence technology to understand and learn from users' individual needs, past listening habits, and music theory knowledge of this type of music. At the same time, it also requires in-depth research and analysis of the characteristics and format of the Metaverse . The design and development of the metaverse music intelligent arrangement system needs to follow the following three main steps:

#### **4.1.1 Data Collection**

Data is the key to the success of Metaverse Music Intelligent Arrangement System. Through the collection and integration of data, the system can have a deeper understanding of users, and then recommend the types of music and music arrangements that different users like. In the process of data collection, the data that needs to be collected includes the user's music playing history, the user's favorite music style, music theory knowledge, etc. In order to collect these data, it is necessary to use some technologies, such as crawlers, API , etc., to provide support for data annotation and data processing; at the same time, data quality control is performed to ensure the accuracy and integrity of the data.<sup>[5]</sup>

#### **4.1.2 Music arrangement and generation algorithm**

Movies, games, and social history experience show that each user has different needs, which can be analyzed and predicted by computer algorithms. In the process of algorithm design, it is necessary to combine music theory, machine learning, deep learning and other technologies to continuously explore. Machine learning models need to be trained to learn users' listening preferences or emotional responses, and on this basis, provide the most suitable music content for different users. At the same time, the understanding and application of artificial sound mixing is also required to ensure the quality of the generated music.

#### **4.1.3 UI Design and Technology Development**

UI design is the user's first contact, which directly determines whether users can intuitively understand the basic functions of the system, especially in a highly virtualized environment

like Metaverse, more attention should be paid to UI design. The interface design needs to conform to the characteristics and format of the metaverse, so that users can experience the music in the metaverse space more easily. In addition, the process of technology development also needs to focus on scalability and openness to ensure that the system can be easily integrated with other applications, and can be continuously upgraded and improved to adapt to changes in the metaverse.

## **4.2 Design of intelligent recommendation algorithm based on deep learning**

The intelligent recommendation algorithm based on deep learning mainly uses the deep neural network to process a large amount of data and model, so as to mine the user's interest characteristics and behavior habits, provide users with the recommendation service that best meets their needs, and improve user experience and satisfaction. Next, we will discuss the implementation and application of intelligent recommendation algorithms based on deep learning from several aspects. The core of the intelligent recommendation algorithm is to obtain effective feature representation through automatic learning of deep neural network, mine the complex nonlinear relationship between user behavior patterns and product features, and then predict the potential needs of users and provide recommendation services that best meet their needs.

### **4.2.1 Algorithm Implementation Based on Natural Language Processing**

Natural language processing techniques can help recommender systems better understand users' needs and accurately predict their behavior. The recommendation system using this technology can convert the user's search keywords, demand expressions, etc. into vectors, matrices, etc., and then use deep learning technology to build models, train and predict recommendation results. In the training of the model, deep learning techniques such as multi-task learning and transfer learning can also be used to make better use of data in different fields and provide more accurate recommendation results.

### **4.2.2 Algorithm Implementation Based on Reinforcement Learning**

Reinforcement learning is a learning method based on trial and error, which can help establish an adaptive personalized recommendation model, and continuously adjust model parameters according to user feedback information, and improve recommendation accuracy.<sup>[6]</sup>In this way, the recommendation system uses user feedback as a reward signal, and builds a more accurate recommendation model through continuous experimentation and improvement, thereby improving user satisfaction.

Intelligent recommendation algorithms based on deep learning have been widely used in various application scenarios. For example, in the music recommendation system, in the music listening application, the intelligent recommendation algorithm based on deep learning can provide more personalized and user-friendly music recommendations by analyzing data such as the user's personal emotion, music style, and listening habits, and improve the user experience.

### **4.3 Innovative Design of Metaverse Music Intelligent Mixing Technology**

Metaverse music intelligent mixing technology refers to the use of deep learning and other related technologies to synthesize the audio data of different musical instruments into an overall sound effect, and apply the sound effect to the music environment in the Metaverse. This technology can enable users to obtain a more immersive music experience in the Metaverse and feel more realistic sound effects.

#### **4.3.1 Data processing**

First, collect audio data of different musical instruments, and preprocess the data, such as data cleaning, feature extraction, etc.<sup>[7]</sup> After processing, the audio characteristics of each instrument, such as frequency and amplitude, can be obtained. In the metaverse music intelligent mixing technology, different musical instruments can be selected for mixing, and users can also choose different combinations of musical instruments according to their own preferences.

#### **4.3.2 Data analysis**

According to the characteristics of different musical instruments, algorithms such as deep learning can be used to analyze data, build models, and predict the interaction and composition relationship between different musical instruments. Among them, deep learning technology can use models such as neural networks to predict the time and frequency characteristics of audio, as well as the mutual influence relationship between the characteristics of each instrument. In addition, statistical analysis and other methods can be used to further dig out the expressive ability and collaboration ability of each instrument to improve the mixing effect between instruments.

#### **4.3.3 Mixing processing**

According to the results of the data analysis, the instrument data can be mixed using digital signal processing technology. In this processing step, the synthesizing effect between different musical instruments can be achieved by adding and subtracting audio signals of musical instruments, adjusting the volume and timbre of musical instruments, and so on. In addition, real-time adjustment and interaction can be realized through algorithms, and the role of different musical instruments in music can be adjusted in real time according to user input.

### **4.4 Design of Metaverse Music Virtual Player System Based on Virtual Reality Technology**

Metaverse Music Virtual Player System is a music performance system based on virtual reality technology. The system has a variety of built-in virtual instruments, and users can create and perform music by selecting instruments, playing instruments, and selecting scores. At the same time, users can also upload their own music works for music sharing and discussion in Metaverse.

#### **4.4.1 Modules of virtual player system design**

The modules designed by the virtual player system include five modules:

a) *Virtual instrument module.* In the virtual musical instrument module, users can select corresponding virtual musical instruments, such as piano, guitar, violin, etc., to realize music performance. The virtual instrument module needs to use virtual reality technology to simulate the performance process in real time and output corresponding sound effects. At the same time, the virtual instrument module needs to be compatible with various input devices, such as keyboards and mice, so that users can choose the most convenient way to perform music.

b) *Score module.* In the music score module, users can choose an existing standard score, or upload and edit the score by themselves to realize the performance of the music. The score module needs to follow the basic rules of music performance, such as rhythm change, frequency conversion, etc., and output corresponding sound effects in the system.

c) *Sensor module.* The sensor module records the relevant data information in real time according to the input of the user's hand movement, and simulates the corresponding performance effect through the algorithm. Through the use of this module, users can play some more complex musical instruments more realistically, such as guitars, violins, drums, etc.

d) *Sound effect processing module.* In the sound effect processing module, the system needs to process the sound effect of the virtual performance music to make the performance more immersive and real. At the same time, the sound effect processing module also needs to be intelligently adjusted according to the preferences and needs of different users to improve user experience.

e) *Sharing modules.* The sharing module is an important function of the metaverse music virtual player system. Users can upload their own music works to the system, and share and communicate with other users. The sharing module needs to implement multiple sharing and evaluation methods according to user needs, such as music sharing, music reviews, music voting, etc.

#### **4.4.2 Steps to realize the virtual player system**

The realization of the virtual performer system needs 6 major steps:

a) *System architecture design.* According to the requirements and functions of the system, draw the overall architecture diagram of the system. The system architecture design needs to take into account the functions and mutual cooperation of each module of the system, and determine the interface and data transmission mode between each module according to the design principles.

b) *Implementation of the virtual instrument module.* In the virtual instrument module, it is necessary to select the sound source, and realize virtual sound source switching and synthesis in the system. At the same time, corresponding trigger logic needs to be set so that the user can interact with the musical instrument through the input device.

c) *Music score module implementation.* In the score module, it is necessary to import the corresponding score file, process the arrangement of the song in real time, and perform sound effect synthesis and other processing according to time and frequency.

d) *Sensor module realization.* In the sensor module, it is necessary to combine technologies such as sensors to realize the function of recording the user's hand movement, and simulate the corresponding performance effect based on the data.



## **4.5 Design of metaverse music copyright management system based on blockchain technology**

Metaverse music copyright management system based on blockchain technology guarantees the authenticity, legality, transparency and security of music copyright information through data storage and data verification, data transmission and smart contracts, and data supervision. .

### **4.5.1 Data Storage and Data Validation**

Data storage is the first step in the realization of the metaverse music copyright management system based on blockchain technology. All music copyright information needs to be stored. In this step, blockchain technology is used to store music copyright information as blockchain data on distributed nodes. This distributed storage method can realize the maximum sharing and protection of information.

After the storage is completed, the data needs to be verified through the blockchain verification mechanism to ensure the accuracy and security of copyright information. In the data verification stage, each node in the system needs to use the private key for digital signature verification to ensure the authenticity and confidentiality of the information. In the process of digital signature verification using the private key, each node can verify the correctness of the digital signature and the specific original data, thereby ensuring the security of music copyright information.

### **4.5.2 Data transmission and smart contract**

In the case of ensuring data security and accuracy, it is necessary to use blockchain technology to realize the transmission and sharing of music copyright information. Adopting a decentralized data transmission method can improve the circulation and sharing of copyright information. This transmission method can also improve the credibility and stability of music copyright, and can prevent information leakage and tampering. After data transmission is realized through blockchain technology, the source of each information and whether it is authorized can be effectively controlled. At the same time, the information can also be traced back to the source to ensure the integrity and authenticity of the information.

Smart contracts are the core of the Metaverse music copyright management system based on blockchain technology. After ensuring the safe and reliable storage of copyright information, it is necessary to use smart contracts to manage the rights and interests transactions of copyright parties to realize the automation and programming of copyright management. When writing smart contract rules, it is necessary to put the management of copyright transactions into the program, thereby reducing the labor cost of copyright management and the risk of errors.<sup>[8]</sup>

### **4.5.3 Data governance**

Data supervision is another core of the metaverse music copyright management system based on blockchain technology. Using data monitoring mechanisms, copyright enforcement agencies can track the use of copyright and impose corresponding legal penalties on users who violate copyright. It is necessary to design a powerful data supervision mechanism to ensure the stability of copyright management and the legitimacy of rights and interests. In the process

of data supervision, each transaction data needs to be supervised and tracked to ensure the transparency and stability of copyright information. The use of blockchain technology can achieve accurate and complete supervision on a global scale, and improve the accuracy and reliability of copyright management.

## 5 AI-BASED PLATFORM IMPLEMENTATION OF METAVERSE MUSIC: CASE ANALYSIS

The entire business model is driven by both "content" and "social" at Metaverse manufacturer. As developers, we understand the importance of creating engaging and immersive content that resonates with our players. Our team of skilled developers work tirelessly to create cutting-edge games, virtual experiences, and other digital content that meets the ever-changing needs of our players. Moreover, we believe that "social" is just as paramount. Our focus is on creating a community of players who can interact and explore together in a way that reflects their passions and interests. Whether gathering with friends to go on quests or participating in group activities, our platform fosters valuable social connections that are integral to the metaverse experience. Additionally, we recognize the value of the friend component in our business model. We provide players with a variety of tools to stay connected with their friends and share their experiences in the metaverse. We foster a safe and inclusive environment that encourages players to build meaningful relationships, both in and out of the game. Overall, our content and social business model has become a cornerstone of the metaverse industry. By offering engaging and immersive experiences and fostering a strong, supportive community, we are dedicated to bringing the exciting future of metaverse technology to life. The model is shown in Figure 2 below.

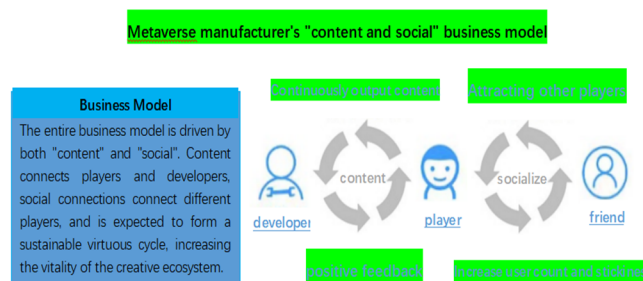


Figure 2. Metaverse Operation Business Model

### 5.1 Cryptovoxels

Cryptovoxels is a virtual reality platform based on the Ethereum blockchain. It is a completely decentralized world composed of a series of unique and scarce 3D cubes. Each square has its own address and ownership, can be bought, sold and traded, and can also be used to build virtual houses, shops and artworks. The world of Cryptovoxels is self-constructed by users, who can build anything they want on their own land, from simple houses to complex buildings and landscapes, and even interactive games and applications.<sup>[9]</sup> Users can use the built-in 3D modeling tools to create their own buildings and objects, buy ready-made land and objects, or

visit other users' creations. Cryptovoxels also offers social and business features where users can interact with other users, attend meetups and events, showcase their artwork or sell their products. All transactions and interactions are carried out through Ethereum smart contracts, ensuring the security and transparency of ownership and value.

## **5.2 Decentralization**

Decentraland is a virtual reality platform based on the Ethereum blockchain, on which users can create, experience and interact with content in the virtual reality world. The world of Decentraland is self-built by users. Users can buy virtual land and then build their own virtual houses, stores, games and other applications on it. In Decentraland, users use MANA tokens to buy and trade virtual land and items. The MANA token is an ERC-20 token that can be traded on several cryptocurrency exchanges. By holding and using MANA tokens, users can obtain more rights and interests and participate in the governance of the platform. Decentraland also offers social and business features where users can interact with other users, attend meetups and events, showcase their artwork or sell their products. The governance of the platform is jointly decided by community members, and all decisions and changes are voted and made through DAO (Decentralized Autonomous Organization).

## **5.3 Ujo Music**

Ujo Music is a music platform based on the Ethereum blockchain, aiming to bring more fair, transparent and decentralized solutions to the music industry. Ujo Music allows musicians and creators to use blockchain technology to distribute and manage their own music, while also providing music lovers with a better music experience. On the Ujo Music platform, musicians can upload their own musical compositions and use smart contracts to manage copyright and revenue distribution. All transactions and income distribution are carried out through blockchain technology, which ensures the fairness and transparency of copyright and income. In addition, Ujo Music also provides some tools and functions to help musicians and creators better manage and promote their music, such as social network, music market and data analysis, etc. The token of the Ujo Music platform is ETH (Ether currency), which is a token of an autonomous blockchain network, which can be used to pay for service fees and conduct transactions on the platform. In addition, Ujo Music has also developed an identity verification system called "Creative Passport" to help musicians and creators establish their own identity and reputation on the platform, so as to better protect their copyright and income.

## **6 CONCLUSION**

The application scenarios of artificial intelligence technology in metaverse music are very extensive, but there are also challenges. On the one hand, music generated by AI systems may lack that natural, unique, emotional element that humans create. This can lead to generated music that is less resonant to human listeners and less commercially and culturally successful. On the other hand, artificial intelligence technology may face data privacy and security issues in metaverse music applications. With the extensive development of artificial intelligence technology applications, the leakage and abuse of music data will also increase, and may involve users' privacy and personal information. In response to these problems, we need to continuously strengthen technological innovation, and at the same time, we need to improve

laws, regulations and rules and regulations to ensure the sustainable and orderly development of artificial intelligence technology in the application of metaverse music.

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