Scientific Programming

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Lead Guest Editor: Wang Jianxing
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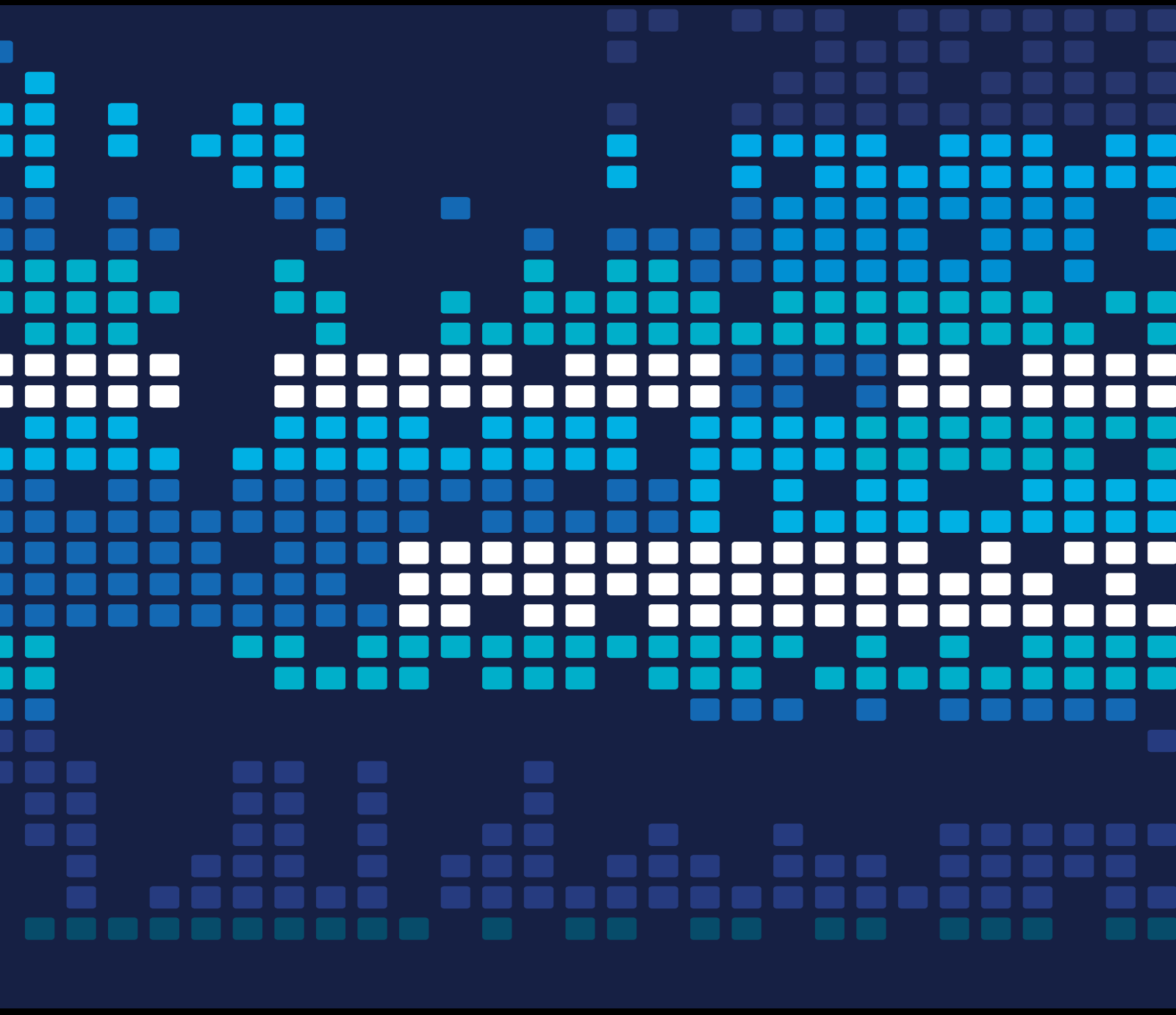

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Research Article

Inspection Technology of Power Communication Network Based on Machine Vision Graphic Recognition

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With the continuous improvement of maintenance management level and the continuous progress of fault diagnosis technology, equipment condition maintenance has also gradually entered the stage of market use. Especially, in the electric power industry, with the development of the research and production practice of condition maintenance theory, its application areas are becoming more and more extensive. In recent years, with the increasing popularity of computer network technology, the development of communication network monitoring technology has also made great progress. However, the monitoring of communication equipment in China is still in the primary stage, and the complexity of the equipment and the diversity of the equipment make the research on its condition detection a very challenging task. The study introduces the application of computer vision-based graphic recognition technology in power communication networks, which includes two modules: FasterR-CNN and RPN. The model provides real-time monitoring of various performance indicators of power communication network equipment and feedback on its working status, repairs the equipment according to the monitoring results, timely detects potential safety hazards, and makes a maintenance cycle reasonable planning, ensuring the normal operation of the communication network.

1. Introduction

Power communication network is different from general communication network; it is specially designed for power system service, and the services it carries are mainly voice, video, data signal, multimedia conference, remote control, and so on [1]. With the continuous development of power system, people's production and life are increasingly affected by the power system, and higher requirements are put forward for the stability of the power grid. In addition, the development of the power industry and the informationization process of the power industry are increasingly accelerated, and higher requirements are put forward for the emergencies in power generation, transmission, and distribution. Therefore, whether the power communication network equipment can work properly has a nonnegligible role in the reliability of the power grid [2].

Reasonable maintenance time is the key to ensure safe and reliable operation of the power grid. There are various methods of power communication network equipment maintenance, among which are the following:

(1). Regular inspection: this can be done to find faults in time during the inspection process and to ensure the normal operation of the equipment to a certain extent, thus avoiding or delaying the occurrence of faults. On the contrary, because this maintenance method requires an inspection of all the equipment every once in a while, so equipment that does not require maintenance is bound to be repaired, which will not only cause a waste of various resources but also the maintenance method will have a certain impact on the equipment, and even increase the chances of failure of the equipment.

(2). Reliability maintenance: the method is based on the inherent reliability of the equipment to be serviced so that the maintenance interval between various devices is reasonably allocated [3]. However, due to the current level of research on the reliability of

communication devices and their own characteristics, it is difficult to find a reasonable reliable calculation method, and it is inevitable that some sudden failures will occur in the process of use.

(3). Condition inspection: condition inspection refers to judging the current working status of communication devices, using advanced condition monitoring technology to discover the harbingers of faults and to determine the composition and severity of faults, so as to decide the maintenance time of each communication device. Offline diagnosis refers to determining whether there is a fault in the equipment by using information such as the operation records, operation time, and maintenance records of the equipment; the online monitoring system can monitor the working status of the equipment in real time and can discover the fault in the shortest possible time and deal with it according to the working conditions of equipment.

From the above analysis, it can be seen that the use of state maintenance method for power communication network devices has the following advantages:

(1). Reasonable arrangement of maintenance cycles and reduction of maintenance costs: using the state maintenance technology, the maintenance time can be reasonably arranged according to the different conditions of the equipment, thus greatly reducing the major failures of the equipment and reducing the various losses caused by equipment failures. There is no need for any maintenance of the equipment, reducing the funds and manpower required for conventional maintenance methods and reducing maintenance costs [4].

(2). Extend the service life of equipment: due to the characteristic and structural features of the communication equipment itself, there is a possibility that, in every maintenance, there will be an impact on its components, and frequent maintenance will shorten the service life of the whole equipment; in addition, the equipment failure caused by the extended maintenance cycle will also have a negative impact on the operation of the whole communication network. The use of condition maintenance mode can effectively prevent the generation of faults and extend the service life of the device.

(3). Ensure the normal operation of the power communication system: the normal operation of the power communication network is closely related to the communication equipment, and sometimes, the failure of one communication device can cause the paralysis of the entire communication system. Therefore, a condition check of communication equipment will enable the timely detection of existing safety hazards and prevent the further spread and emergence of accidents, so as to ensure the normal operation of the communication network.

The monitoring system developed in this study is the most advanced monitoring technology, which provides technical assurance to ensure the safety, stability, and long-time use of equipment [5–8]. With the continuous development of power grid construction, the maintenance of power communication network equipment is also gradually changing from the conventional maintenance mode to condition monitoring. However, China's power communication network equipment operation condition monitoring technology is still immature, so the application prospect of this project is very broad.

2. Introduction to Related Theories

2.1. Neural Network Theory. A neural network is a complex network system consisting of many simple multiple processing units, which simulates the characteristics of the animal nervous system and performs parallel data processing in a distributed manner with high memory and associative ability. Neural network is a system with learning function, which can achieve high level of knowledge to some extent [9]. It has two types of learning methods, one is supervised learning and the other is unsupervised learning. A neural network has a learning function similar to that of the human brain, and it contains a three-layer structure of input, implicit, and output layers, which is capable of fitting an arbitrary nonlinear continuous function accurately, thus providing mathematical guarantees for the application of neural networks in time-series forecasting [10]. With implicit expression of nonlinear relations, better fault tolerance, higher prediction accuracy, and better dynamic adaptability, the neural network forecasting method is suitable for intelligent prediction of complex nonlinear systems.

2.2. Machine Vision Theory. Next, machine vision will become the next development direction of artificial intelligence. Machine vision is to measure and judge objects by mechanical eyes, that is, to obtain external images by mechanical imitation of human eyes. It has a wide range of applications, including transportation, scientific research, meteorology, public security, agriculture, industry, and aerospace [11]. For example, in large-scale industrial production, using manual vision to check the quality of products, its accuracy and efficiency are very low, while using machine vision technology can greatly improve the efficiency and automation level of production, while in the sorting, it is necessary to classify products with the help of machines, which can not only save a lot of manpower and resources but also greatly improve production efficiency and reduce production costs. And in the field of transportation, automatic driving technology is based on machine vision to achieve the detection and identification of people and vehicles, so as to improve road safety. Machine vision will play an important role in all aspects of the national economy.

2.3. Image Processing Theory. There are many contents of image processing, which can be divided into three levels of image preprocessing, image analysis, and image understanding according to its abstraction level, research methods, etc.

2.3.1. Image Preprocessing. The main content of image preprocessing is the change that occurs between different images. It mainly consists of image smoothing, denoising, and edge sharpening to highlight features of interest in the image and the abatement of unnecessary features such as noise points.

2.3.2. Imaging. Image processing techniques are used to detect and measure targets in images, to obtain their objective information, and to describe them [12]. If image preprocessing is the process of conversion from image to image, image analysis is the process of conversion from image to data.

2.3.3. Image Comprehension. The core of image comprehension is to analyze the image, conduct an in-depth study of the properties of each object and their interconnection, then obtain an understanding of its connotation and interpret its original objective situation, and thus provide a basis for decision-making.

The processing of digital images can be divided into two types: spatial domain and transformation domain.

(1) Space Domain Measurement. The null-domain approach treats an image as a collection of pixels in a plane and processes it accordingly. There are two main types of null domain methods: (1) adjacency processing contains gradient operation, Laplace operator operation, smooth operator operation, and convolution operation and (2) point processing contains grayscale processing, area, perimeter, and volume operations.

(2) Transformation Domain Method. The change domain processing technique in digital image processing is to transform the image orthogonally to obtain an array of change area coefficients, then perform a variety of processing [13], and finally inverse transform it to the spatial domain to obtain the corresponding processing effect, for example, filtering and data compression.

3. Application Method Design

The application method design is described as follows.

3.1. Principles of Parameter Selection for the Inspection Index System. To accurately identify the state of the equipment, it is necessary to obtain the state information of the equipment. Therefore, in the inspection, it is necessary to monitor and obtain sufficient state parameters of equipment. The first thing to know about monitoring a special instrument is what parameters indicate its status; the relationship between each parameter and the status of equipment is close [14]. Generally speaking, once the state of the device is changed, regardless of the cause, it will have an impact on the state of the device. The relationship between the change of the state of the device and the state of the device becomes the focus of this paper's research.

The change in the working condition of the device can reflect the working condition of the device, which has a certain correspondence with the working condition of the device [15]: $F = (\alpha 1, \alpha 2, \ldots)$, where F is the operating condition of the device, $\alpha 1, \alpha 2, \ldots$ are the operating parameters of the device. Equipment condition forecasting is to infer the condition of the device based on the changes of the operating parameters $\alpha 1, \alpha 2, \ldots$ There are many state parameters that can be used to describe the operating condition of a device, and it would be very complicated and inefficient if all of them were. Therefore, before establishing an efficient and accurate inspection system, the screening of condition parameters must be carried out, which requires clear screening objects and guidelines. A large number of practice have proved that the following principles must be followed when selecting equipment status parameters.

(1) High sensitivity: the selected parameters have a high sensitivity, in the case of very small changes in the state of the equipment, all lead to fluctuations in the state parameters

(2) Scientific: the meaning of the state parameters and evaluation basis should be reasonable and the selected state parameters should reflect the working state of the grid equipment, shall not omit the key parameters, and shall not contain invalid parameters

(3) Realizability: the selected parameters not only are limited to the theory but also can be obtained by certain methods

3.2. Establishment of Inspection Index System. There are many kinds of performance indicators of power communication network equipment, and some of them are listed in the following table. If all the above parameters are used for this system, it will cause the complexity, scale, and inefficiency of the system, thus making the performance of the whole system worse [16–18]. According to the above principles, only the parameters that best reflect the operating conditions of the grid equipment are predicted, and participation in the condition maintenance system not only saves resources and reduces development costs but also improves the efficiency of the system and is more practical.

After selecting the performance parameters, it is necessary to categorize them. The system is graded according to an hierarchical structure, and with the help of references and experts, the devices are divided into three main categories: optical port, electrical port, and device environment. Therefore, according to the components, the parameters are divided into three parameters: optical port parameters, electrical port parameters, and device environment parameters.

In this study, a large amount of information was consulted and the data obtained from the network management

system was compared with the data obtained, and finally, the data that needed further processing and participation in maintenance decisions were derived.

3.3. Inspection Process Architecture. After the establishment of the monitoring indicator system, this section details the structure of the monitoring model. The overall flow of the inspection model described in this study is shown in Figure 1. The core idea of the approach is that, first, the performance parameters of equipment involved in the maintenance operation are identified and classified according to their respective interfaces and types. Subsequently, machine vision technology is used to output the inspection images and apply them to the inspection images. By graphical processing of the inspection images, the performance parameter evaluation of the inspection images is finally derived. Then, according to the given weight calculation method, the weighting operation is performed for each parameter [19], and the current score of each device is calculated according to the existing state integral algorithm. Finally, the corresponding monitoring report is generated based on the evaluation results of each parameter.

3.4. Patrol Identification Structure. The inspection identification structure adopts the FasterR-CNN architecture, which is shown in Figure 2. The basic architecture of FasterR-CNN includes (1) RPN (Region Proposal Network) and (2) FastR-CNN. In the detection of electrical equipment, the original image is extracted by using the FasterR-CNN shared network, and then, it is input to RPN and FastR-CNN for processing.

3.4.1. The Image Processing Process of RPN Network in Power Communication Network. RPN network, also known as region suggestion network, mainly uses its own training trials to generate candidate regions and then sends the candidate regions as training samples to FastR-CNN for training and testing.

RPN is a fully convolutional neural network, which consists of a convolutional layer and two fully connected layers [20]; it is a convolutional layer structure, and the latter two fully connected layers have different functions; one is a cls layer, which is used to generate the object location with suggestion.

RPN processes the dataset in the following way:

(1) irst is generating about 20,000 anchors on the original image using a mapping mechanism and then obtaining anchor classification information using IoU (Intersection-over-Union) with artificial tagging (GroundTruth). The following are the main processes:

The feature map is scanned using a 3×3 sliding window, and 9 (k in Figure 2) are generated in one scan ($128, 256 \times 256, 512 \times 512$) using 3-scale relationships ($1:1$, $1:2$, $2:1$) with the center point of the window as the reference. Based on this, the feature maps generated after shared convolution by FasterR-CNN were scanned, and the 9 recommendation frames corresponding to the centroids were mapped to the original images.

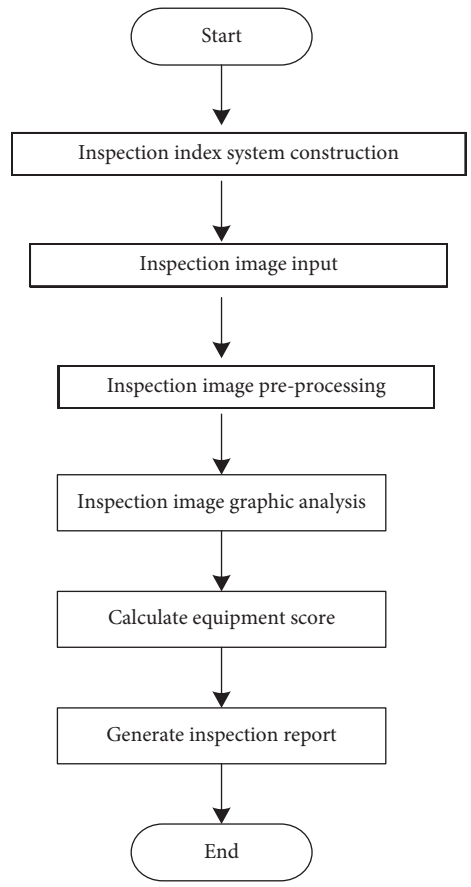

Figure 1: The overall flowchart of power communication network inspection system.

The RPN was trained by backpropagation and stochastic gradient reduction (SGD), in which 256 were randomly selected from 2000 candidate frames, and the number of target objects and the number of backgrounds were equally distributed, but if 128 could not be reached, they were replaced with backgrounds, thus greatly improving the recognition accuracy.

3.4.2. FastR-CNN-Based Image Processing Process for Power Communication Networks. In this thesis, the main function of RPN is to propose regionality for the FasterR-CNN architecture, while FastR-CNN combines the features of the original image with the region suggestions proposed by RPN, based on which classification and boundary regression are performed. The training process of FastR-CNN includes:

(1) A shared convolutional network of FasterR-CNN is used, and a feature curve is obtained by performing a convolutional pooling operation on it.

(2) The candidate region generated by RPN and the feature curve generated by the shared convolutional network of FasterR-CNN are mapped and input to the RoI pooling layer for resizing.

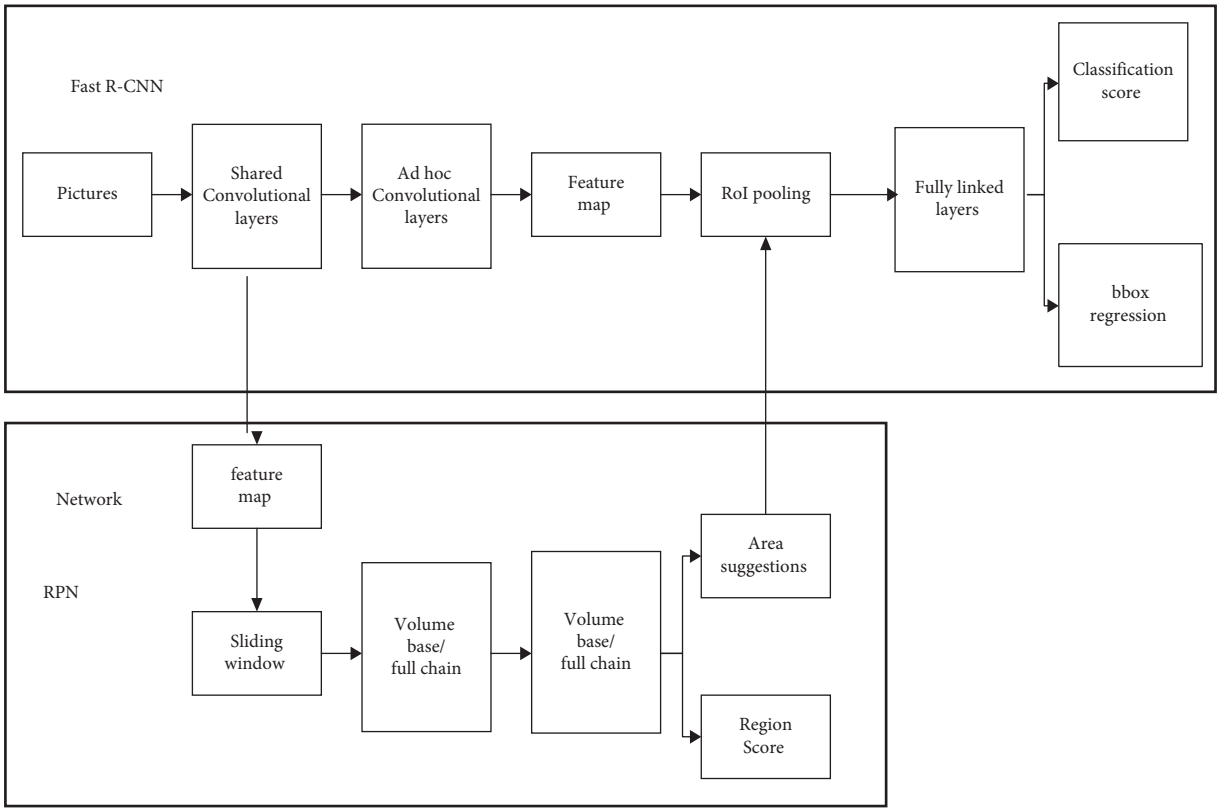

Figure 2: FasterR-CNN structure.

The RoIpooling layer adds a lot of work and a lot of time due in large part to the post fully connected layer of the network (the previous convolutional pooling was not necessary). In FastR-CNN, the RoI pooling layer can replace the full connectivity. Simply put, the RoI pooling layer is a feature map on images of different sizes [21], and a specific dimension is extracted from the feature maps of candidate regions of each size, both to improve the accuracy and to speed up the computation. The extracted fixed feature dimension representation is shown in Figure 3.

(3) The sized feature maps are sent to the fully connected layer for classification scoring and boundary regression.

In terms of algorithm, the whole linkage layer is improved to shorten the training time. Since more than 2000 sensitive regions need to be extracted during target identification and the whole connected layer is time-consuming, the SVD method is used to perform SVD decomposition on the full linked layer, and the results show an improvement of nearly 30% in processing speed.

4. Application Experiment Analysis

4.1. Experimental Setup. In FasterR-CNN, the shared convolutional network is a 5-level convolutional pooling network, which is shared by RPN and FastR-CNN, and the parameter settings of each level are shown in Table 1.

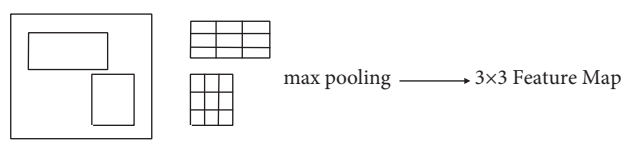

Figure 3: Schematic diagram of RoI extraction of fixed feature dimensions.

Table 1: Shared network parameter settings.

Layer	Size (kernel)	Pad	Stride	Num
CONV1	7∗7	3	2	96
POOL1	3∗3	1	2	—
CONV2	5∗5	2	2	256
POOL2	3∗3	1	2	—
CONV3	3∗3	1	1	384
CONV4	3∗3	1	1	384
CONV5	3∗3	1	1	256

The first column in Table 1 shows the names of the convolutional and pooling layers, where the size of the convolutional core (Size) , the edge padding value (Pad), and the feature vector for each layer (num) are indicated.

For the other training parameters, the settings are shown in Table 2.

The stepsize in Table 2 represents the learning rate adjusted every 2000 times, gamma is the learning rate adjustment parameter, both are a parameter in the learning rate adjustment policy (lr_policy), and the final return value is A.

Table 2: Training parameter settings.

Parameter name	Parameter value
Stepsize	2000
Gamma	0.1
Display	20
Average_loss	100
Momentum	0.9
Weight decay	0.0005
Batch size	64

4.2. Applied Model Training. The training method in this thesis is RPN cross-trained with FastR-CNN, which has the advantage that it can make full use of the information in the text to improve its accuracy significantly. Among them, the cross-training procedure consists of four main steps:

(1) First, the pretrained weighted (ImageNet) dataset [22] is used as the initial parameters of RPN. The photos containing electronic products are used to generate positive and negative samples using the RPN network and are adjusted in the process to obtain regional recommendations, which is part of the training, and it can be said that this stage is mainly about adjusting the RPN network to generate regional recommendations.

(2) As in step 1, the parameters generated from the pretrained ImageNet dataset are used as the initial parameters of the FastR-CNN, and then, the FastR-CNN is fine-tuned with the regionally recommended data generated once.

(3) Based on the fine-tuning parameters of FastR-CNN, the RPN network is initialized by fixing the shared convolutional layers together and fine-tuning only the RPN to generate the regional recommendation data.

(4) Fine-tune the FastR-CNN and implement the complete connection to the FastR-CNN based on this.

Combining FastR-CNN with RPN, cross-training, and then fixing the shared convolutional layers together separately, we realize that two networks share one convolutional layer, thus greatly improving the efficiency of use and saving a lot of time.

4.3. Experimental Analysis of Model Comparison. The monitoring structure of conventional CNN and RPN FastR-CNN was compared and analyzed by randomly selecting 200 different types of monitoring images from seven different types of monitoring images. From the experimental results, the structure is much better than the conventional CNN model. The results of the seven types of electrical devices recognition are shown in Table 3, and the mAP comparison before and after data enhancement is shown in Figure 4.

4.4. Experimental Analysis of Model Application. After the model training and comparison is the same, this section will carry out the model application experiment. Power communication network inspection is a key link in the security of power communication network, and it undertakes every operation in the whole monitoring process. First, the performance parameters of each device are obtained through data collection of the power grid and then through graphical recognition and data processing. Then, according to the actual data in the parameter graph, the status of equipment is scored according to the current data and performance index, and the corresponding equipment operation is derived. Its parameter curves are shown in Figure 5. Its actual parameter graph is shown in Figure 5.

Table 3: Seven types of electrical equipment identification results.

Category	Accuracy rate (%)	False detection rate (%)
CNN	76	6
RPN + Fast R-CNN	85.5	1.5

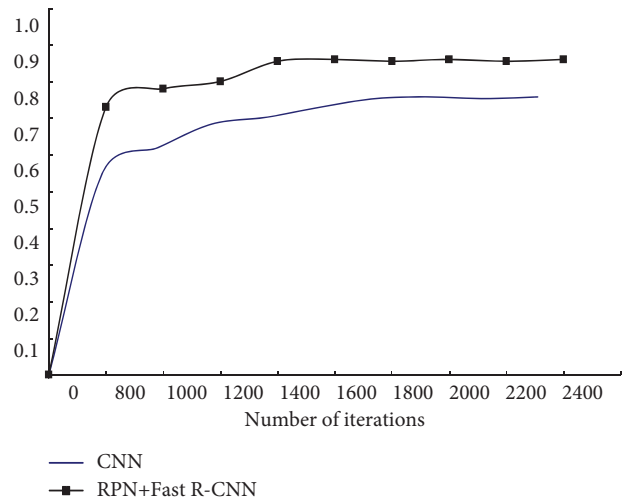

Figure 4: Comparison of mAP before and after data enhancement.

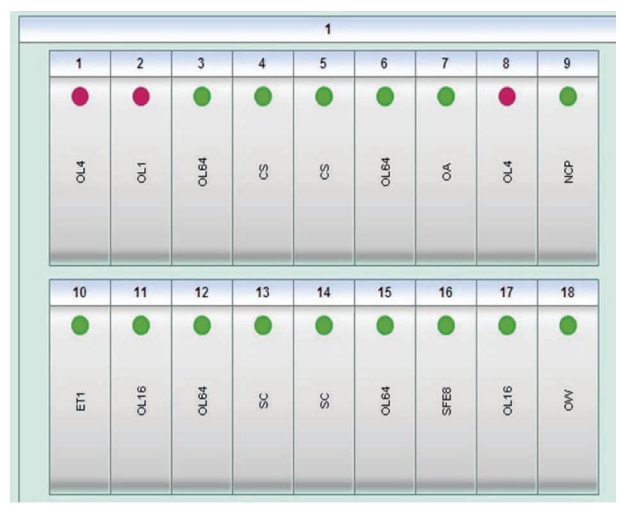

Figure 5: Device parameter map.

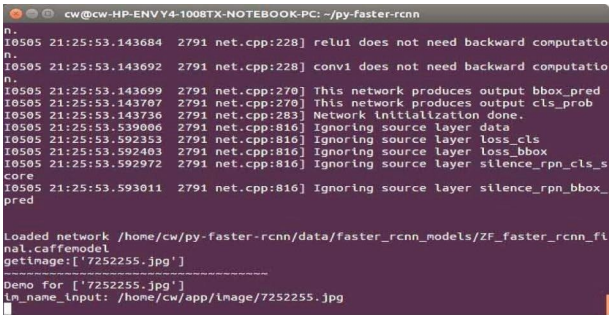

Figure 6: Server-side detection of images.

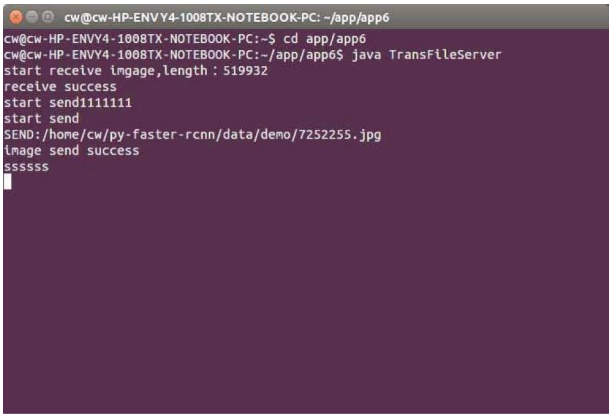

Figure 7: Image sent to the client.

Table 4: Identification results' table.

Equipment number	Equipment name	Equipment status
1	OL4	NO
2	OL1	NO
3	OL64	YES
4	CS	YES
5	CS	YES
6	OL64	YES
7	OA	YES
8	OL4	NO
9	NCP	YES
10	ET1	YES
11	OL16	YES
12	OL64	YES
13	SC	YES
14	SC	YES
15	OL64	YES
16	SFE8	YES
17	OL16	YES
18	OW	YES

After the model network receives the device parameter image, a detected image will appear in the specified folder of the model network. At this time, the terminal responsible for the graphic recognition will directly call the RPN + FasterR-CNN framework, use the trained model in this study for the target recognition task, and then recognize the model according to that model. The detection process is shown in Figure 6.

After recognition by FasterR-CNN, the model network automatically feeds the detected images and sends them to the server. The result is shown in Figure 7.

After the image is detected, the server side sends the image to the client side, which receives it, and then the information of the detected image parameters is identified and fed back, and the identification results are shown in Table 4. From the table, we can see that the device numbers 1, 2, and 6 are the ones with problems, and the rest are normal.

5. Conclusion

In China, the research on grid monitoring technology is relatively lagging behind and is still in the primary stage, but there have been many achievements. In the past ten years or so, domestic equipment condition monitoring and diagnosis technology has been exchanged with international standardization organizations, international equipment condition monitoring and diagnosis technology seminars, equipment condition monitoring, fault diagnosis, artificial intelligence and expert systems, and other advanced technologies, which have rapidly developed China's equipment overhaul technology. At present, China's equipment reliable operation and overhaul system have made great development and are close to or near the international advanced level.

This study proposes a computer vision-based graphic recognition technology for power communication network inspection system, which includes two major parts: (1) RPN (Region Proposal Network) and (2) FastR-CNN. The research contents of the paper include the following. (1) The background of power communication network monitoring technology is introduced. (2) The relevant theories involved in this study are discussed. (3) The indicators, monitoring process, and structure of the monitoring model are introduced in detail. (4) Through comparative tests and application tests of the model, it is concluded that the model is very good and has achieved good results in practical applications.

The inspection model of power communication network developed in this study has reached the basic needs of daily inspection, and to make the model more perfect and the inspection scheme more complete, in-depth research and exploration are needed on.

(1) ot many performance parameters can be obtained at present; if more performance parameters can be obtained, it can better reflect the working state of the whole system

(2) The performance index evaluation table is segmented rather than continuous; if a continuous model can be established, it can better reflect the characteristics of each performance index and thus improve the accuracy of the evaluation

Data Availability

The dataset used in this study can be obtained from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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Research Article

New Paths for the Development of National Sports Intangible Cultural Heritage Based on Computer Nonlinear 3D Model Modeling Technology from the Perspective of Scene Theory

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Purpose. The AI era has brought rapid progress and many changes in life, which challenge the survival of cultural heritage. One of the topics that has attracted much attention at the moment is how to better inherit and develop the intangible cultural heritage of national sports. In order to improve the development level of national sports intangible cultural heritage, this article explores a new path for its development. *Methodology*. Through the analysis and research of scene theory and computer nonlinear three-dimensional (3D) model modeling technology, it can be applied to the development of national sports intangible cultural heritage. This article analyzes the scene theory, three-dimensional modeling, and intangible cultural heritage of national sports, conducts experimental analysis on its functions, and uses relevant theoretical formulas to explain. *Research Findings*. The results show that this development path is more effective than the traditional development path. It has a lower error rate than the traditional model, which differs by 0.124. The public satisfaction increased by 56.7% before and after. *Research Implications*: The new method proposed in this article provides a new path reference for the development of national sports intangible cultural heritage in the future. *Practical Implications*. This method can meet the needs of the development of intangible cultural heritage of national sports culture, and the satisfaction and development level of the masses have been greatly improved.

1. Introduction

In the era of rapid change, people are more and more alienated from national sports culture, and the traditional development methods of intangible cultural heritage cannot meet its increasing requirements in terms of breadth and integrity. 3D modeling is a computer nonlinear vision method that can construct and display stereoscopic images. Due to its advantages in image processing, it has been applied to various fields to successfully solve various image display problems. Images can give people an intuitive feeling, and it is of far-reaching significance for the inheritance and development of the national sports intangible cultural heritage to be better and more accurately displayed to people through 3D modeling. Generally speaking, 3D modeling is the use of 3D production software, through virtual 3D space. In the computer, it looks like the real world. Scenes have become an important driving force for contemporary urban innovation. The combination of technology and scene theory can better develop the national sports intangible cultural heritage. The scene is based on the traditional physical space, adding cultural and aesthetic elements, making it a social space with cultural value, emphasizing cultural quality, and displaying cultural characteristics. In recent years, scholars have used 3D modeling for cultural heritage inheritance, but there are relatively few applications and research studies combining the scene theory and 3D modeling. Therefore, it is of great significance to apply 3D modeling based on the perspective of scene theory to the research on the new development path of national sports intangible cultural heritage.

Technology has changed life, and cultural inheritance and development have received increasing attention. More and more scholars have explored the intangible cultural heritage of national sports. Among them, in order to study the cultural compatibility between tradition and modernity,

He et al. revealed the local differences in dealing with the conflict between folk sports-related cultural heritage and modernity, and showed how to use folk sports culture in village governance to activate sports culture [1]. Liu and Zhao believed that Wushu carries the traditional sports culture. He expounded the difficulties and breakthrough strategies of effective Wushu teaching in colleges and universities from many aspects, in order to provide theoretical reference for the effective teaching of Wushu in colleges and universities [2]. The value of intangible cultural heritage is well worth exploring, and Kogiso considered traditions and indigenous movements to be powerful specific aspects of intangible cultural heritage and studied the process of the spread of Pelota Mixteca to the United States [3]. Ming explored the dissemination mode of national sports intangible cultural heritage to provide a reference for its wide dissemination to obtain an effective dissemination path [4]. In order to improve the cultural resilience and contribution of the intangible cultural heritage of national sports, Ode et al. inventoried and formulated a strategy to protect the cultural progress objects of the Baubau city area [5]. However, these studies have theoretical significance for the inheritance and development of national sports cultural heritage, and have made contributions to the protection of heritage and the inheritance and development of culture, but they do not provide practical methodological guidance.

Scene theory and 3D modeling can help in the development of national sports intangible cultural heritage, and have good results in actual display. Among them, Martino et al. proposed a method based on the scene theory to identify and classify objects in the scene for better 3D modeling [6]. In order to improve the 3D modeling quality of cultural heritage development and reduce the complexity of deep video interframe coding, Chen et al. proposed a fast coding unit (CU) size and mode decision algorithm [7]. Chao and Guo proposed a novel feature-based RGB-D camera pose optimization algorithm for real-time scene 3D modeling systems [8]. To model cultural heritage with 3D modeling, Kotsiubivska and Baranskyi created 3D models of historical heritage elements with the help of digitized word counts and developed 3D printing software [9]. These methods promote the development of national sports intangible cultural heritage to a certain extent, but their effects show low mass satisfaction.

In order to solve the abovementioned problems of improving the development level of national sports intangible cultural heritage, this article uses the scene theory and 3D modeling to analyze the development method of cultural heritage and simulates the 3D modeling method to achieve fast and high-quality results. The innovation of this article is as follows: using the scene theory and 3D modeling, it analyzes how the scene theory and 3D modeling technology play a role in the research on the new development path of national sports intangible cultural heritage based on computer nonlinear 3D model modeling technology from the perspective of scene theory. The proposed method is expounded, and it is found through experiments that the method is simple to use, has high modeling quality, and improves the satisfaction of the masses and the level of cultural heritage development.

2. Methods of Developing a New Path for the Intangible Cultural Heritage of National Sports

2.1. Research Content and Organization of the article. The development path of the intangible cultural heritage of national sports should be updated with the progress of technology. If the traditional method is still used to develop it, there will be many problems. For example, traditional methods cannot properly display traditional cultural heritage in a true and complete way, and the scope of dissemination and the target audience are affected. Therefore, it is very important to innovate its development path and improve the development level [10]. The traditional way of cultural heritage development is shown in Figure 1.

Through the investigation, it is found that the current research on the development path of ethnic sports intangible cultural heritage is still insufficient, and a lot of research studies have focused on the analysis and summary of the characteristics of the communication theory and experience and propose specific method paths for effective implementation, so this article proposes a new path research on the development of ethnic sports intangible cultural heritage [11, 12]. This article analyzes and applies the scene theory and 3D modeling method to the new development path of national sports intangible cultural heritage and evaluates it. The experimental analysis shows that the three-dimensional modeling based on the scene theory perspective has a better effect on the development of the intangible culture of national sports than the traditional development method. The organizational structure of the full text is shown in Figure 2.

As shown in Figure 2, the full text consists of five parts. The first part mainly introduces the research background of the development of the intangible cultural heritage of ethnic sports and leads to the problems to be solved to illustrate the purpose and significance of this research. The second part describes the organization structure and methods of the full text of this article and analyzes the content of related methods of national sports intangible cultural heritage, scene theory, and 3D modeling, and evaluates the effect of the proposed new development path. The third part describes the data source of this article in detail; the fourth part analyzes the comprehensive performance of environmental transmission and computing time in different scenarios, the corner detection and matching performance of different methods, the effect of different 3D modeling methods, and the result data of the satisfaction evaluation before and after the experiment; the fifth part is the conclusion.

2.2. 3D Modeling of National Sports Intangible Cultural Heritage. The development of national sports intangible cultural heritage can have a very significant effect on the inheritance and development of a country's national culture. Cultural heritage is the result of thousands of years of cultural transmission and is the crystallization of the common excellent culture of the whole nation [13]. This article proposes to promote the new development of national

(a)

(b)

Figure 1: Traditional way of development. (a) Graphic works and (b) live performance.

sports intangible cultural heritage through the perspective of the scene theory and 3D modeling technology, so as to achieve the effect of improving the quality level of the development of national traditional sports culture.

Scenario theory: what a scenario must contain is a geographically conceptual community. The second is the obvious physical building; the third is the concentration of various groups of people in a specific group (such as race, social class, gender, education, occupation, and age); and the fourth is the characteristic activity connecting these elements. These all these elements come together to form the symbolism of the scene, the shared values. Regardless of who can participate, this is due to the public nature of the scene [14]. The aesthetic dimensions selected in the scene theory are shown in Table 1:

Table 1 clearly illustrates how more complex scenarios can be created and interpreted through the combination and empowerment of several different dimensions. The rows in the table represent the dimension of the scene, the columns represent the composite scene model, the numbers represent the weights, 5 is the highest score, and the features of various models are defined and distinguished by assigning various numbers. For example, the Disneyland model has a somewhat conventional and nonconventional nature of the scene from a weight distribution point of view.

Scenes include not only time and space in the physical sense, but also people's personal activities and personal emotions when receiving information. These elements combine to form scenes in the communicative sense, and these elements are summarized as scene 5 forces [15]. The scene 5 force, namely wearable devices, big data, sensors, social media and positioning systems, it is. The popularization of scientific and technological smart devices

Figure 2: Full-text organization.

Table 1: Aesthetic dimensions.

Project	Disneyland	Bohemia	Legal Samurai Gathering	Los Angeles flashy landmark	Reano box
Traditionalism	4.21	2.11	3.31	4.24	2.21
Self-expression	2.33	4.96	3.64	3.14	4.87
Utilitarianism	3.14	1.07	2.64	3.36	1.12
Race	3.67	2.64	4.36	2.64	3.24
Indigenous	4.17	3.65	3.17	4.12	3.37
Violations and crimes	1.23	4.13	2.24	3.27	3.68

has laid the foundation for the application of the scenario theory. It is almost impossible to achieve the effect of public awareness through a single communication method as before. Today's masses tend to be influenced by multiple media. In order to realize the accurate dissemination of national sports intangible cultural heritage for each user in a specific scenario and improve the development level of national sports intangible cultural heritage, it is necessary to use big data, 3D modeling, and other technologies to achieve this in the scenario.

Computer nonlinear vision: Before 3D modeling of cultural heritage, it is necessary to obtain the relevant element parameters of the modeled object, and this process can

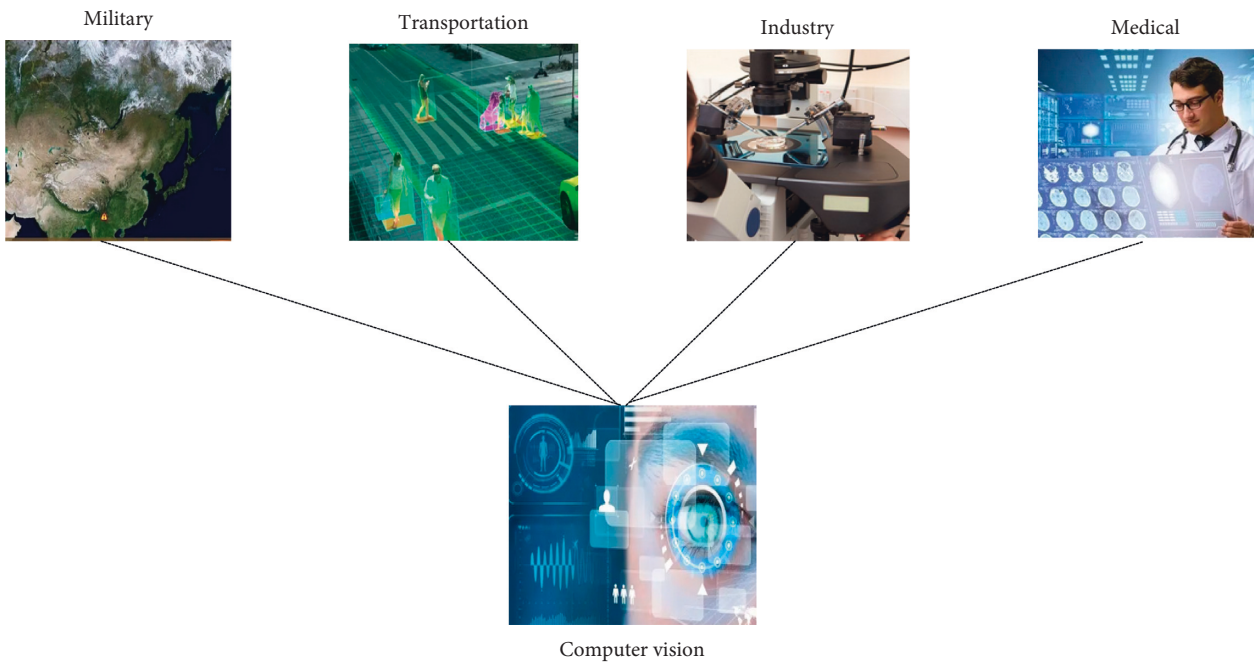


Figure 3: Computer nonlinear vision application areas.

be achieved through computer nonlinear vision. It is widely used in the fields of military defense, infrastructure construction, and scientific research and is known as the automated eye [16]. Computer vision has the advantages of high precision, strong continuity, low cost and high efficiency, and very flexible application scenarios. In general, it is faster and the process is simpler. Some of the results that have been achieved in computer nonlinear vision applications are shown in Figure 3.

As shown in Figure 3, computer nonlinear vision has been used in various aspects of various fields. For example, it is used in the military to automatically track and assist in capturing military targets, etc. Capture and detect the body and movement of pedestrians or vehicles in the field of traffic guards. The precise welding, cutting, and other processing processes of components and equipment in industrial production lines are very flexible and widely used.

For 3D modeling of cultural heritage, the acquisition and preprocessing of image data is very important. Due to the advantages of computer nonlinear vision, 3D modeling objects can be scanned accurately, thus laying the foundation for high-quality 3D modeling effects [17]. In this article, computer nonlinear vision technology is used to obtain 3D modeling parameters of national sports intangible cultural heritage to solve the problem of improving the integrity of 3D modeling objects.

The preprocessing of national sports intangible cultural heritage images is the first step we need to do. The purpose is to improve the visual effect of the image, improve the clarity of the image, and convert the image into a form more suitable for human or machine analysis and processing. The two-dimensional image preprocessing includes image smoothing filtering, contrast enhancement, and image feature extraction [18]. Errors and biases in preprocessing directly affect the accuracy of subsequent processing and decision-making. Precise preprocessing provides reliable input data for subsequent processing.

There are generally two types of image smoothing filtering: the spatial domain method and the frequency-domain method. The commonly used method for spatial image smoothing is the domain averaging method, it forms an image smoothed by the neighborhood averaging algorithm by replacing the original gray value of the pixel with the average of the gray values of the points near the pixel, and the image processed by this method can be expressed by the following equation:

$$t(z,x) = \frac{1}{X}\sum_{(i,j)\in S}\sum g'(i,j) = \frac{1}{X}\sum_{(i,j)\in S}\sum(g(i,tj)+\alpha(i,tj)), \tag{1}$$

where $\alpha(i,j)$ is white noise, $g\prime(i,j) = g(i,j) + \alpha(i,j)$ is an image with noise, S is a set of points, and X is the number of pixels.

For the noise component in the above formula, the mean and variance can be obtained as shown in the following formulas:

$$P\left\{\frac{1}{X}\sum\sum\alpha(i,j)\right\} = \frac{1}{X}\sum\sum P\{\alpha(i,j)\} = 0, \tag{2}$$

$$\mathrm{F}\left\{\frac{1}{X}\sum\sum\alpha(i,j)\right\} = \frac{1}{F^2}\sum\sum F\{\alpha(i,j)\} = \frac{1}{X}\delta^2, \tag{3}$$

where P is the residual noise average result is 0 and F is the variance value, resulting in a drop, making the image distortion blurred.

Median filtering is a technique for dealing with image noise [19]. The median filter is a nonlinear image smoothing method, which is very sensitive to the impulse interference level of salt and pepper. The noise suppression effect is good, while suppressing random noise, it can effectively protect the edge from blurring, and the statistical characteristics of the image are not required in actual operation, so it is very convenient to use. Under some specific conditions, median filtering can overcome the blurring of image details caused by linear filtering and is the most effective for filtering out impulse interference and particle noise. Its mathematical description is shown in the following formula:

$$t_i = M\{x_{i=b}, x_{i-1}, x_i, x_{i+1}, ..., x_{i+b}\}, i \in Z, b = \frac{(k-1)}{2}, \quad (4)$$

where k is the number of elements removed in the one-dimensional sequence $x_1, x_2, ..., x_n$ and i is the center position.

The spatial low-pass filtering is implemented by convolution of the spatial filter impulse response matrix with the input image. The result is shown in the following formula:

$$t(z,x) = \sum_{m=0}^{L} \sum_{n=0}^{L} g\left(z + m - \frac{L}{2}, x + n - \frac{L}{2}\right) * c(m,n), \quad (5)$$

where $g(z,x)$ is the input image, which is a $M * N$-pixel array; $c(m,n)$ is the low-pass filtering impulse response, which is a $L * L$-dimensional array; and $t(z,x)$ is the low-pass filtering result.

Frequency-domain image smoothing: In a given national sports intangible cultural heritage image transformation, it can achieve smoothing by attenuating a certain range of high-frequency components in the frequency domain. This is due to the fact that at the gray level of the image, other sharp jumps such as edges and noise can greatly affect the high-frequency components of the Fourier transform. The process is shown in the following formula:

$$t(z,x) = C(z,x)M(z,x), \quad (6)$$

where $C(z,x)$ is a function, that is, a low-pass filter; and $M(z,x)$ is the Fourier transform of the target image.

Through the experimental test, the median filter has the best effect on the elimination of single noise. In this article, the nonlinear median filter is used for image smoothing.

The Roberts edge detection operator is based on the principle that the difference in any pair of mutually perpendicular directions can be regarded as an approximation method for finding the gradient, as shown in the following formula:

$$\begin{aligned} g_z &= g(i,j) - g(i+1, j+1), \\ g_x &= g(i+1, j) - g(i, j+1). \end{aligned} \quad (7)$$

Then, the gradient of the image point can be obtained as shown in the following formula:

$$t(i,j) \approx R(i,j) = \sqrt{g_z^2 + g_x^2}. \quad (8)$$

Its result is obtained by the interaction of two $2 * 2$ templates, as shown in the following formula:

$$\begin{bmatrix} 1_* & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}. \quad (9)$$

The effect of detecting horizontal and vertical edges is higher than that of slanted edges, the positioning is accurate, and it is sensitive to noise [20]. This is because of the use of diagonal edges in the edge detection process The difference between two adjacent pixels in the direction to estimate gradient amplitude and detect edges. In order to overcome the shortcomings of the above methods, a more accurate Laplacian operator for edge localization is proposed, and its digital image is shown in the following formula:

$$\begin{aligned} g(i,j) &= \Delta_z^2 g(i,j) + \Delta_x^2 g(i,j) \\ &= g(i+1,j) + g(i-1,j) \\ &\quad + g(i,j+1) + g(i,j-1) - 4g(i,j). \end{aligned} \quad (10)$$

Due to the influence of noise, Gaussian filtering is usually used to filter the above operators, and its function expression is shown in the following formula:

$$t(z,x,\delta) = \frac{1}{2\pi\delta^2} \exp\left(-\frac{z^2 + x^2}{2\delta^2}\right), \quad (11)$$

where δ is the filter variance. After filtering the image, a smooth image is obtained as shown in the following formula:

$$g_s(z,x) = g(z,x) * t(z,x,\delta). \quad (12)$$

Finally, the image obtained after the above operator processing is shown in the following formula:

$$\begin{aligned} T_s(z,x) &= \nabla^2 g_s(z,x) = \nabla^2 [g(x,y) * t(z,x,\delta)] \\ &= \nabla^2 [t(z,x,\delta)] * g(z,x). \end{aligned} \quad (13)$$

Among them, to use this operator to obtain a good detection effect, a larger window should be used.

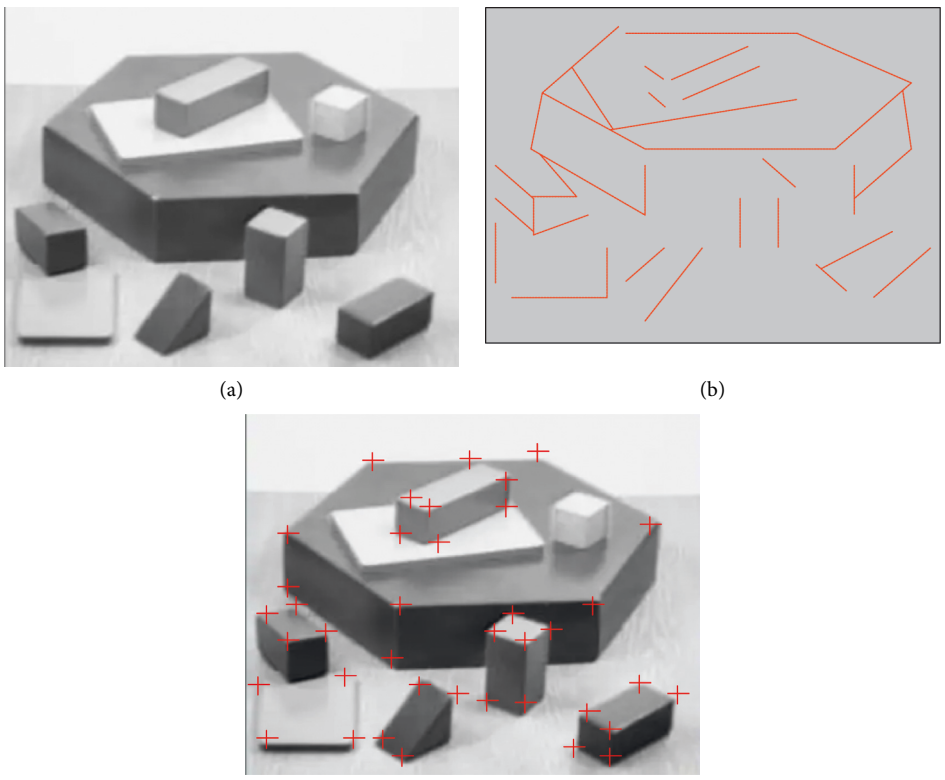
The B-spline function is used to detect the corners of the image, and its expression is shown in the following formula:

$$B(l) = \sum_{i=0}^{n} K_i N_{i,k}(l), \quad (14)$$

where $N_{i,k}(l)$ is the harmonic function, and its definition is shown in the following formula:

$$\begin{aligned} N_{i,1}(l) &= \left\{ \begin{matrix} 1, c_i \le l \le c_{i+1} \\ 0, \text{other} \end{matrix} \right\}, \\ N_{i,k}(l) &= \frac{(l - c_i) N_{i,k-1}(l)}{c_{i+k-1}} \\ &\quad + \frac{(c_{i+k} - l) N_{i+1,k-1}(l)}{c_{i+k} - c_{i+1}} (c_{k-1} \le l \le c_{n+1}), \end{aligned} \quad (15)$$

where c_i is the node value.



(a) (b)

(c)

Figure 4: Corner detection results. (a) Original image. (b) Curve fitting results. (c) Corner detection results.

Using the above function for curve fitting can reduce the fitting error and improve the accuracy, and its parameter formula is shown in the following formula:

$$M(l) = \sum_{i=0}^{n} h_i N_{i,k}(l), \tag{16}$$

where h_i is the coordinate vector of the control point and $N_{i,k}(l)$ is the harmonic function.

Then, the corner points are detected by the maximum curvature, and the points on the curve are shown in the following formula:

$$Z = h_0(l)O_{i-1} + h_1(l)O_i + h_2(l)O_{i+1} + h_3(l)O_{i+2}. \tag{17}$$

Calculate the derivative separately and substitute it into the curvature formula to calculate the simplified curvature parameter as shown in the following formula:

$$Q(l) = \frac{v_0 l^4 + v_1 l^3 + v_2 l^2 + v_3 l + v_4}{\left[\left(4a_1 l^3 + 3b_1 l^2 + 2c_1 l + d_1\right)^2 + \left(4a_2 l^3 + 3b_2 l^2 + 2c_2 l + d_2\right)^2\right]^{3/2}}. \tag{18}$$

Through the above method, the curve fitting and corner detection experiments are carried out inthe figure, and the specific results are shown in Figure 4

As shown in Figure 4, accurate corner detection results can be obtained through the above methods.

This article uses feature clustering to extract and match features of ethnic sports intangible cultural heritage. The problem of the accuracy of feature point extraction is solved by the feature clustering algorithm. Feature point clustering can accurately extract and classify the feature points of 3D modeling objects scanned by computer nonlinear vision. The object feature points are shown in Figure 5.

In this article, accurate feature extraction is achieved by weighting the K-means algorithm. Its objective function is shown in the following formula:

$$T(L, O, P) = \sum_{t=1}^{k} \sum_{i=1}^{n} l_{it} \sum_{j=1}^{m} q_j^{\partial} \left(x_{ij} - ot\, j\right)^2. \tag{19}$$

Among them, the constraints are shown in the following formula:

$$\sum_{j=1}^{m} q_j = 1. \tag{20}$$

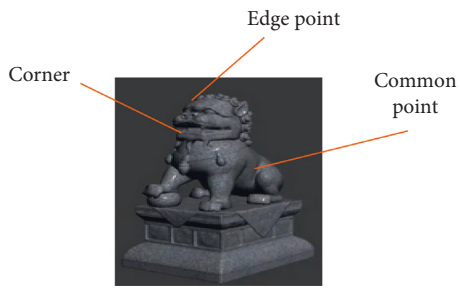


Figure 5: Schematic figure of feature points.

where q_j^{∂} is the added weight parameter. Its function is to calculate the sum of the weighted distances for each dimension while minimizing the distances in the entire cluster. That is, the influence of each dimension on the clustering results is adjusted by different weight values.

By solving the k-means algorithm with added weight parameters, the feature extraction and allocation parameters of the scanned object can be obtained, and then, feature matching can greatly improve the matching accuracy [21].

Through artificial intelligence computer nonlinear vision technology and feature clustering algorithm, the two-dimensional image of multiethnic sports intangible cultural heritage can be modeled in three dimensions. The three-dimensional reconstruction feature matching of ethnic traditional sports cultural heritage is shown in Figure 6.

As shown in Figure 6, the left and right images are obtained by camera calibration. Median filtering and corner detection are performed on the left and right images, respectively, and then, feature point matching is performed. The template images of different orientations of the precise lattice template are drawn, and then, the lattice is detected to calculate the homography matrix. After solving the internal parameters of the camera, the left and right images of the agreed target object are obtained. Then, calculate the essential matrix, obtain the projected matrix according to the internal and external parameters, and then, obtain the three-dimensional coordinates of the feature points. The algorithm matching results are shown in Table 2.

By combining AI computer nonlinear vision with feature clustering and 3D modeling, the problems of low image recognition accuracy and low matching degree in the modeling of national sports intangible cultural heritage can be well solved. The experiments and results are analyzed below.

3. Data Sources for the New Development Path of National Sports Intangible Cultural Heritage

The data sources of this article are mainly divided into two parts: questionnaire survey and experimental test. Through the issuance of questionnaires, information is collected and analyzed for the current development status of ethnic sports intangible cultural heritage and the current people's satisfaction with the development status of ethnic sports intangible cultural heritage as basic data for follow-up experiments. A total of 400 copies were collected, and 386 copies were recovered. The questions in the questionnaire are aimed at two aspects. One is the current understanding of people's traditional national sports culture. The specific content of the questionnaire is shown in Table 3.

This part of the questionnaire survey is aimed at the basic characteristics of the respondents and their understanding of the traditional national sports culture. The information mainly includes the gender, age, and occupation of the respondents, as well as the information about the national traditional sports culture that they do not know, have heard of, know a little about, or know very well about. And collected information on the national traditional sports and cultural activities of the respondents includes content information such as whether they like traditional sports, the number of sports activities, favorite sports, and the level of satisfaction with the current traditional sports culture.

According to the current questionnaire survey, this article developed a scoring table for the development of national sports intangible cultural heritage through collective discussion of the expert group to score and compare the satisfaction before and after the experiment. The content and examples of the scoring table are shown in Table 4.

Among them, the set scoring items are watchability, interactivity, inheritance, dissemination scope, and overall comprehensive evaluation. The scoring scale for the development of national sports intangible cultural heritage adopts a 5-point system; the higher the score, the better the score, the more satisfied, and the lower the score, the more dissatisfied.

The performance data are collected by testing various performance indicators of the 3D modeling method for the intangible cultural heritage of national sports. The specific test content is shown in Table 5.

This article evaluates the method performance by evaluating the scene transfer time, corner recognition efficiency, running time, and object modeling error rate of different 3D modeling methods.

4. Results and Discussion of the New Development Path of National Sports Intangible Cultural Heritage

4.1. Comprehensive Performance of Environmental Transmission and Computing Time in Different Scenarios. In this article, the comprehensive performance of the 3D modeling

Figure 6: Feature matching of 3D modeling of national sports intangible cultural heritage.

Table 2: Partially matched point coordinate values.

Left image coordinates	Right image coordinates	Left image coordinates	Right image coordinates
134,136	145,158	145,136	146,153
234,86	233,85	346,117	351,121
253,76	249,71	185,124	181,127
278,97	263,101	196,28	189,34
314,67	342,63	357,69	359,66
462,175	473,168	237,151	241,148

Table 3: Some examples of the questionnaire survey content.

Project	Person 1	Person 2	Person 3
Gender	Male	Female	Male
Age	34	21	61
Profession	Teacher	Student	Retired worker
Knowledge of traditional sports	Do not know much	Learn some	Know very well
Do you like traditional sports ?	Yes	Yes	Yes
Participation in traditional sports	21	14	5
Favorite sports	Tai chi	Lion dance	Folk dance
Are you satisfied with the current spread of traditional sports culture?	Not so satisfied	Pretty satisfied	Not so satisfied

Table 4: Example of satisfaction evaluation form.

Project	Person 1	Person 2	Person 3
Inheritance	2.21	3.27	3.54
Viewability	1.95	3.13	3.53
Interactivity	2.24	3.56	2.76
Propaganda scope	2.33	3.14	3.57
Overview	2.17	3.37	3.68

Table 5: Test part sample situation.

Index	Sample 1	Sample 2	Sample 3
Transmission time	914	1245	1745
Number of corners	1424	7442	10211
Execution time	72.14	123.31	184.26
Match success rate	0.984	0.748	0.826

method for different scene environment transmission and calculation time is tested, and the specific results are shown in Figure 7.

As shown in Figure 7, through the comparison of scene transmission of different scene scales, it can be found that the data transmission amount and the waiting time of a complete scene increase linearly with the scale of the scene. The latency for conceptual scene transfer remains largely unchanged. Because the amount of structured data for conceptualization scenes increases very little as the size of the scene increases, only an increase in its model ID, no order of magnitude difference occurs. But the transfer latency of conceptualized scenarios does not stay the same either. The data volume and transfer time of a conceptualized scene are related to the number of nodes it contains. As can be seen in Figure 7(b), the waiting time

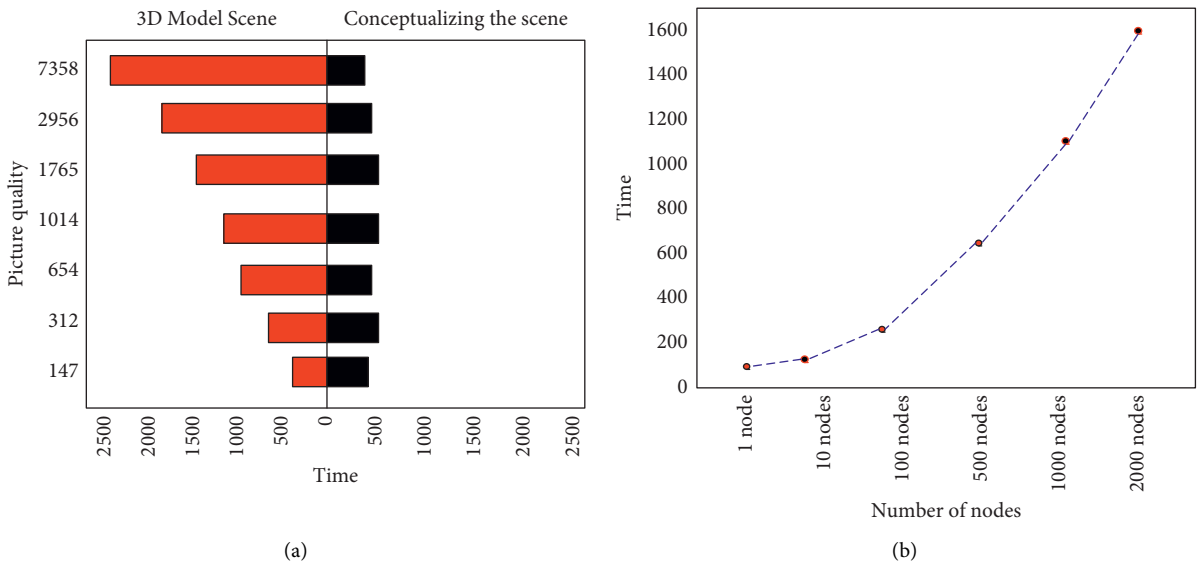


Figure 7: Comprehensive performance of scene environment transfer and computation time. (a) Comparison of transmitted 3D overall scene and concept scene. (b) The relationship between the number of nodes and the network delay.

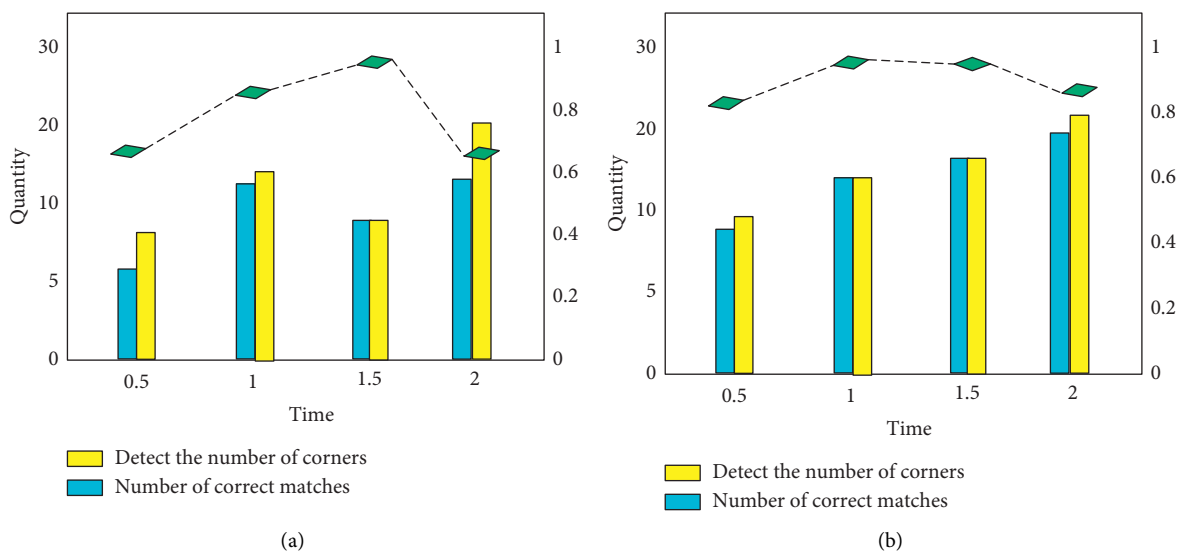


Figure 8: Corner detection and matching performance of different methods. (a) Traditional algorithm results. (b) The results of the algorithm in this article.

increases linearly with the number of nodes in the entire conceptualized scene. Of course, even if the number of nodes reaches 2000, the waiting time does not exceed 2 s, and the actual size of the scene at this time is already very large. A node is likely to refer to a model with a scale of 1 m. In addition, the figure also illustrates another result; that is, when the number of nodes increases, the processing time of the system logic algorithm does not increase significantly, which is still consistent with the increase in the amount of data transmission. This convinces people that the system's logic algorithms, including scene synthesis and scene assembly, can provide better processing power for large enough scenes.

4.2. Corner Detection and Matching Performance of Different Methods. This article tests the corner detection and matching results of ethnic sports intangible cultural heritage images using different methods, and the specific content of the results is shown in Figure 8.

As shown in Figure 8, it can be seen that the number of corner points detected and matched by the corner detection method in this article per unit time is higher than that of the traditional algorithm. On the 2 s time node, the traditional algorithm detected 23 corner points, 18 were successfully matched, and the matching was successful, and the rate was 78.3%. While the number of corner detections using this method is 26, 22 are successfully matched, and the matching

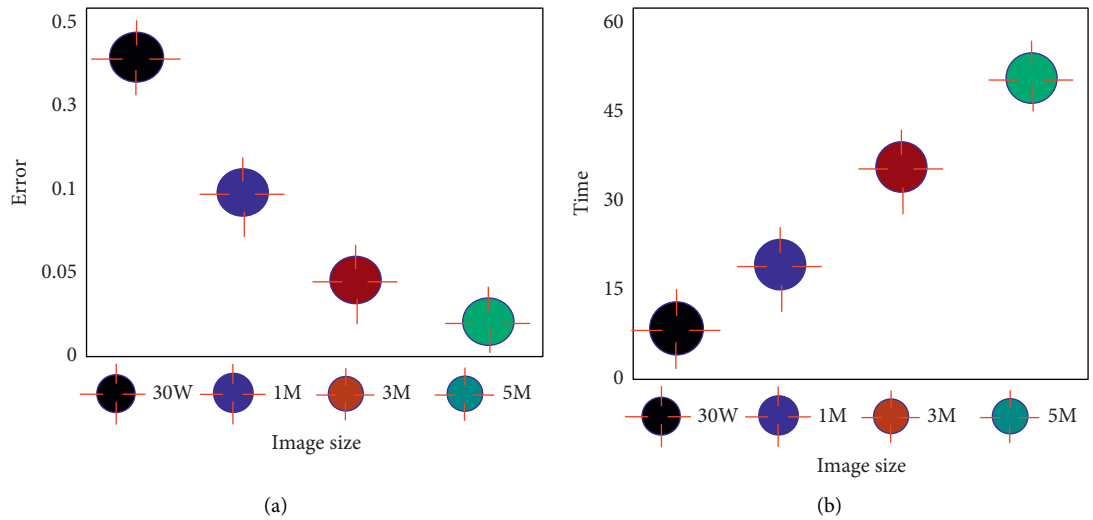


Figure 9: 3D modeling effects of different methods. (a) Errors of figures of different sizes. (b) Running time of images of different sizes.

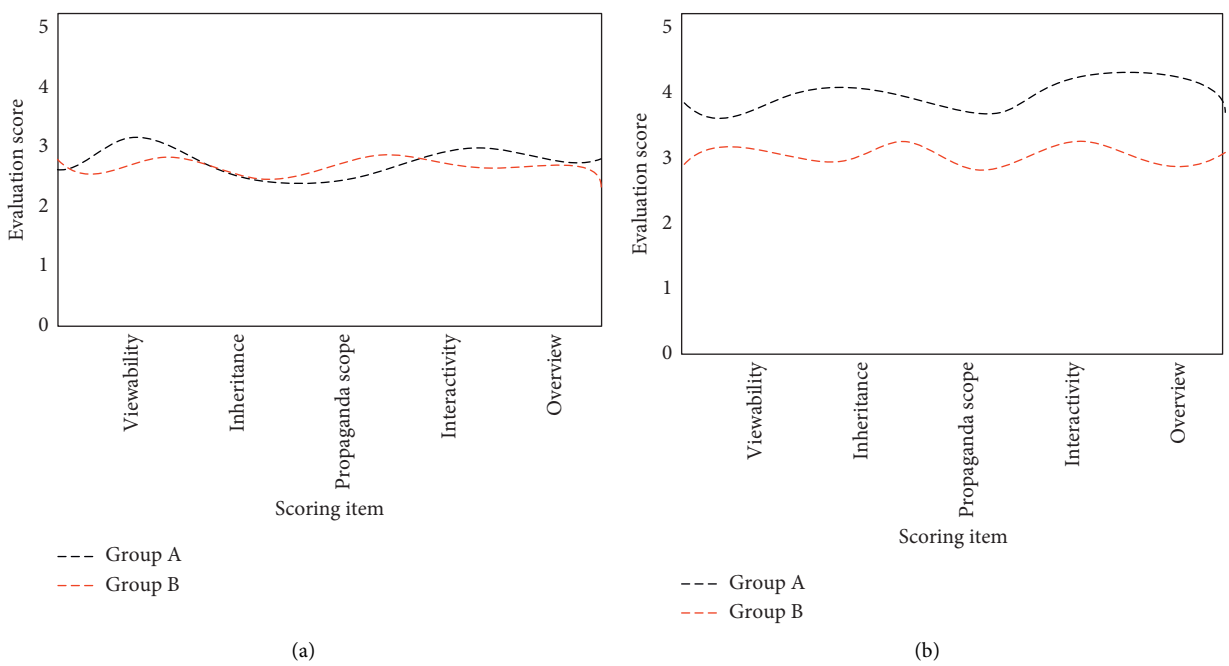


Figure 10: Comparison of satisfaction before and after the experiment. (a) Satisfaction evaluation before the experiment. (b) Post-experiment satisfaction evaluation.

success rate is 84.6%, which is 6.3% higher than the former. It can be seen that the corner detection method in this article not only reduces the time consumption, but also improves the accuracy.

4.3. Comparison Experiment of Different 3D Modeling Methods. This article will compare the modeling error effect of the 3D modeling method in this article and the traditional method through images of different sizes. The specific results are shown in Figure 9.

As shown in Figure 9, the 3D modeling method proposed in this article is better than the traditional method in terms of modeling error. When the pixels of the figure gradually become larger, the modeling error gradually decreases, so that the image becomes clearer visually. However, as the image pixels become larger, the computation time also increases. It can be seen from the comparison that the error rate of the method in this article is reduced by 0.124 compared with the traditional method, and the image modeling effect is relatively good.

4.4. Comparison of Satisfaction before and after the Experiment. In this article, after the performance test of the 3D modeling method is completed, an experimental analysis is carried out on the satisfaction of the development effect of the intangible cultural heritage of national sports. By

experiencing different cultural activities in groups A and B, group A carried out the experience education activities of national sports intangible cultural heritage using 3D modeling, and group B carried out traditional speech-style national sports intangible cultural heritage activities. The two groups were carried out at the same time for 1 hour. At the end of the activity, the testers were collected for satisfaction evaluation and a comparative analysis of the satisfaction before and after the experiment was carried out. The specific results are shown in Figure 10.

From Figure 10, it can be seen that the satisfaction of residents who have experienced different activities before and after the experiment has improved. However, the residents who have experienced the activities of 3D modeling have significantly improved their satisfaction with the current development of national sports intangible cultural heritage. Before the experiment, the residents' satisfaction with each index fluctuated around 2.77 points on average. After the experiment, the overall satisfaction of group A increased by 56.7%, and the average score could reach 4.34 points. And the satisfaction items are mainly focused on the interactivity and viewability brought by this form of 3D modeling. It can be seen that the 3D modeling of national sports intangible cultural heritage based on the environmental perspective can well meet people's needs for cultural appreciation and is conducive to its development.

5. Conclusion

Technological innovation drives the innovation of cultural heritage development, and the public's demand for cultural heritage development is getting higher and higher. The development of national sports intangible cultural heritage is inseparable from the contribution of 3D modeling technology. The scene theory has been applied in 3D modeling because of its social publicity advantages. Through comprehensive experimental tests, it can be seen that the 3D reconstruction method based on the scene theory perspective is superior to the traditional method in each performance. Through the analysis of the comprehensive performance of its environment transmission and computing time, the data transmission volume and waiting time of the complete scene can be obtained as a linear growth relationship with the increase of the scene scale, which can provide better processing capacity for large enough scenes. Through the corner detection and matching performance tests of different methods, it is found that the corner detection using this method reduces the time consumption and improves the accuracy. The matching success rate is 84.6%, which is 6.3% higher than the former. Compared with the traditional method, the error rate of the method in this article is reduced by 0.124, and the effect is excellent. Through the comparison of satisfaction before and after the experiment, it was found that the overall satisfaction of group A increased by 56.7.5% after the experiment, and the satisfaction items mainly focused on the interactivity and viewability brought by this form of 3D modeling. This improved 3D modeling method for national sports intangible cultural heritage can meet the needs of promotion and development. Of course, in the process of conducting experiments, there are factors such as unstable use environment, differences in operators, and uncertainties such as use time and frequency. The results of this experiment are not completely accurate and reliable, and there may be some differences.

Data Availability

The data used to support the findings of this study can be obtained from the author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest regarding the publication of this article.

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Research Article

Research on Digital Display of Nonlinear System Model of Tea Drinking Space in the Song Dynasty Based on Neural Network Technology

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Tea is the national drink of the Chinese nation. It combines the thoughts of various Chinese schools and has experienced the changes and baptism of successive dynasties and has been spread to this day. It is difficult to achieve the inheritance of tea culture by relying on ordinary display methods. In order to better display the digital effect of the nonlinear system model of the tea space in the Song Dynasty, using digital display, we can design the layout of the tea space in the Song Dynasty through video, audio, and dynamic pictures, which plays an important role in the inheritance of tea culture. This study analyzes the tea drinking space and tea culture and spreads the historical and cultural value of digital display; by comparing the comprehensive performance analysis and cultural extension results under different displays, as well as the desire for knowledge of history and culture, we can make an in-depth exploration. Through the statistical data information, we can conclude that under the function of digital technology, advanced science and technology and digital technology have a good effect in cultural inheritance, they can better promote the spirit of history and culture, and make the torch of history and culture live and pass on from generation to generation.

1. Introduction

Tea space culture is an important part of tea culture. Ancient literati have been pursuing elegant and simple slow life, and tea drinking space is an important place to show the pursuit of elegance by literati. The Song Dynasty, which is famous for its elegant literature and art, is particularly outstanding in the tea space culture. Its quiet and elegant tea space culture is worth reading by future generations. However, nowadays, museums mostly use traditional display methods to display the tea drinking space of the Song Dynasty. The order of its methods seriously limits the free play of the thinking nature of the human brain and cannot let the audience feel the unique charm of the tea drinking space of the Song Dynasty in an all-round and three-dimensional way. The traditional way of exhibition can no longer meet the requirements of current cultural publicity, so a new way needs to be adopted to display and publicize the tea space culture of the Song Dynasty.

The arrival of the era of artificial intelligence has broadened the new ideas of cultural propaganda, and the digital display of the nonlinear system model of the Song Dynasty tea drinking space based on neural network technology has entered the public's attention. Wang and Li and others believe that neural network technology is a dynamic system that processes the state information of continuous or intermittent inputs and takes the directed graph as the topological structure [1]. Bao and others indicate that this technology has the advantages of high nonlinearity, self-adaptive and self-learning habits, parallel distributed processing, and fault tolerance [2]. Jiang said that artificial neural network (ANN) is the key technology of intelligent control. Through the integration of artificial thinking and intelligent manipulation framework, neural network can

ensure the specific integration of data information with neurons as nodes in cyberspace, and the weight value between related neurons is no longer limited to the fixed data transmission framework, so as to make the realization of relevant data functions more accurate and meet the needs of intelligent control [3].

Neural network technology provides a strong support for nonlinear systems. Huang et al. and others said that artificial neural network is a machine learning model with strong mapping ability to nonlinear systems [4]. Zhang et al. said that artificial neural network is a highly nonlinear intelligent information processing system with adaptive learning characteristics. Neural network can flexibly and accurately solve multivariable nonlinear system problems by using a large amount of data [5]. Chen said that the deep neural network can be used to fit complex nonlinear systems with sufficient learning data [6]. Wang also expressed the same view that neural network is helpful to solve the control problems of uncertain and nonlinear systems [7]. Liu et al. and others said that neural networks have the characteristics of good convergence of complex nonlinear systems and can spontaneously organize, learn, and process [8]. Liu said that using neural networks to control nonlinear systems has become an important topic in the industry [9].

Digital exhibition is the inevitable choice of museums under the current development of science and technology. Wang believes that in the current era, using digital new media technology to display culture is a kind of cultural innovation. Integrating digital technology into the design of cultural exhibition space enriches the cultural connotation and diversity of intangible cultural heritage exhibition space and is also more conducive to the inheritance and development of China's intangible cultural heritage [10]. Yin expressed the same positive view that digital technology has opened up a new path for cultural exchange, and its immersive and interactive way has promoted the inheritance and development of culture [11]. The digital display of the nonlinear system model of the Song Dynasty tea space based on neural network technology is more suitable for the thinking mode of the human brain. It can break the traditional law of displaying linear narration, touch different sensory organs, help the audience perceive the tea space culture of the Song Dynasty through multiple channels, enrich the cultural experience of the audience, can deepen the audience's perception and understanding of the Song Dynasty tea space culture, and can better help the audience experience and explore the civilization of the Chinese tea culture.

This paper mainly studies the digital display of the nonlinear system model of the Song Dynasty tea space under the neural network technology, aiming to explore the advantages of the digital display of the Song Dynasty tea space through this research and make contributions to the promotion of the Song Dynasty tea space culture.

2. Value and Significance of Tea Space Culture in the Song Dynasty

The culture of tea drinking space in the Song Dynasty was fully popularized, and the types of tea art activities were more abundant, which promoted the diversified development of tea drinking forms, tea sets, and the corresponding tea drinking space. Tea drinking space has a common pursuit of physical environment and artistic conception, mainly focusing on material space. Tea art space is only the carrier of tea art activities. Based on neural network technology, we can analyze the tea drinking space of the Song Dynasty from a nonlinear system model. If you want to understand the tea drinking space of the Song Dynasty, you should base on the behavior subject and feel the tea culture experience of the Song Dynasty under the support of digital technology. The application of exhibition space should meet the space conditions and interactive needs, create personalized creative space, coordinate the design of tea space, and promote the inheritance and popularization of traditional tea culture.

Digital display has become a new carrier for the dissemination of tea culture, which can expand visitors' vision of tea culture cognition and improve visitors' humanistic quality. The animated images presented by dynamic video images, combined with the layout and display of tea space, bring visitors novel and unique experience, explore the tea culture of the Song Dynasty from a unique perspective, and present the tea customs of the Song Dynasty with the best picture display. The dynamic scene can enrich the humanistic connotation of visitors. The digital display of nonlinear system model allows visitors to have a deeper and detailed understanding, which is conducive to the spread of cultural spirit and improves the value of traditional culture.

The display of tea space in the Song Dynasty has changed the original static state, and the details cannot be understood. Dynamic digital display can better observe and experience the relevance of tea culture and tea space. Through the nonlinear system model to convey folk culture information, feel the charm and magic of traditional culture, so as to obtain psychological comfort. In the design of tea space, the inherent humanistic and historical landscape can be created and designed. The technical support of neural network can better interpret the cultural connotation. The digital display of tea space in the Song Dynasty can also cultivate the aesthetic emotion of visitors, stimulate the interest in tea space design and tea culture, and also reflect the artistic charm of tea culture. The Song Dynasty is an important period of development and prosperity of Chinese tea culture. Its culture has distinctive artistic characteristics and rich cultural connotation and heritage.

In the process of the development and impact of Internet culture, the digital display of tea drinking space in the Song Dynasty, mastering relevant historical knowledge in the whole display expression, can see the profound connotation and value influence of culture. People in the Song Dynasty

love tea very much, which can cultivate their sentiment, improve themselves, and cultivate their personality. Visitors get peace of mind from the display, bring enjoyment, and meet their psychological needs. The core value of tea culture is to improve cultural quality, attach importance to noble personality, and perfect self-spiritual character. After thousands of years of precipitation, tea culture has a special significance in today's society to appreciate the culture of tea and the cultural value and connotation of tea itself and pay attention to the development of spiritual level.

3. Digital Display of Nonlinear System Model Based on Neural Network Technology

Museum is an important symbol of the development of national civilization, which bears the function of "education and dissemination". However, the traditional display mode of the museum is sequential and linear, and its information carrier is only the display object and static explanatory text (the explanatory text is also orderly and linear), which leads to the limitation of the play of the thinking nature of the human brain (the thinking nature of the human brain has the characteristics of nonlinearity, jumping, and dispersion). This straight-line and lack of change display are not conducive to deepening the audience's understanding of the cultural relics displayed. Especially when the intangible cultural heritage such as the Song Dynasty tea space culture is displayed, the publicity and communication function of the traditional display method is even more insufficient. The audience can only watch in order, according to the predetermined route of the museum, and most of them can only look at the flowers at a glance, which makes it difficult to have a deep understanding of the connotation and charm of the tea space culture of the Song Dynasty.

The digital display of nonlinear system model based on neural network technology is more in line with the requirements of cultural publicity and dissemination in today's era. Digital display has the characteristics of nonsequencing, which enriches the display technology and means, breaks the law of traditional display linear narration, solves the problem that only a single display means can display a single information, and allows the audience to understand the information of tea space culture in the Song Dynasty from multiple perspectives.

When displaying the tea space of the Song Dynasty, combining physical exhibits with digital technology can enhance the education and communication role of physical museums. Digital display can touch the audience's various sensory organs through text, image, video, animation, sound, and other ways and help the audience perceive the information of the Song Dynasty tea space culture from various sensory channels, so that the audience can feel the unique charm of the Song Dynasty tea space culture in an all-round and three-dimensional way, so as to obtain a complete, vivid, and systematic understanding of the Song Dynasty tea space culture. At the same time, digital display is more interactive. In traditional exhibitions, the flow of information is one-way, and the audience can only passively accept information. In the digital display, the text information is more dynamic and open, and the audience has the right to choose freely. They can process and transform the tea space according to their own wishes, which makes the visit more fun. In this way, the audience's participation will be higher and their interest will increase. At the same time, digital display is also virtual. In the digital display of the virtual Song Dynasty tea space scene, the audience can use external technical means to carry out activities in the virtual scene and can observe the layout of the Song Dynasty tea space without restrictions, which make the audience feel more immersed and dynamic. This further enhanced the audience's interest and impression of the Song Dynasty tea space culture. Digital exhibition emphasizes that the audience is the core of the exhibition, which not only strengthens the interaction between people and exhibits but also strengthens the interaction between people and the outside world. In this atmosphere of education and appreciation, the audience is more enthusiastic, more involved, more impressed, and the display effect is better.

The digital display of nonlinear system model based on neural network technology can better show the concept of "people-oriented". It transforms boring words into images, videos, animations, sounds, and other forms, providing the audience with a comprehensive perception experience. The single information transmission is transformed into experience activities, which shortens the distance between the audience and history and culture. The audience not only obtains the fun of participation but also obtains a systematic and profound understanding of the tea space culture of the Song Dynasty.

4. Simulation Verification

4.1. Performance Analysis of Two Displays of the Song Dynasty Tea Space Model. The interactive demand of tea space for human environment and spatial environment and the clear level of tea space and the role of spatial cultural atmosphere make tea space more expressive, infectious, and tensile. During the exhibition, the dimensions of space and time have been expanded unprecedentedly. The all-round exhibition can allow visitors to observe parts and details. Under the multimedia technology, they can perceive the information of the Song Dynasty tea space model from a variety of sensory channels, so as to obtain a more complete, profound, and systematic understanding. Now, the performance of two different displays is analyzed, and the following Table 1 is obtained:

Table 1 shows the performance comparison results of the two displays of the Song Dynasty tea space model. From the data results, the digital display in terms of multisensibility and space-time scalability is due to the ordinary display effect, and finally realizes the good interaction between visitors and tea culture.

According to the performance analysis results in the above table, the following Figure 1 is obtained:

As shown in Figure 1, the comprehensive performance visualization effect of the two displays is shown, and the gap between the two can be clearly seen. The performance of

Table 1: Performance analysis of two displays (%).

Group	Multisensibility	Space-time ductility
General display	56.63	50.34
Digital display	86.45	88.94

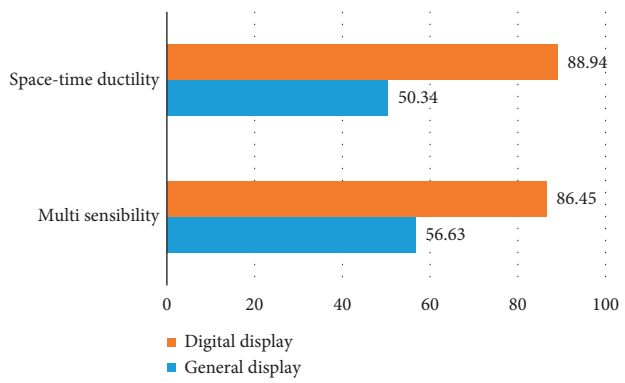

Figure 1: Performance visualization of two displays (%).

digital display is better, which can expand its influence and bring the best visiting effect to visitors without time, space, and other constraints.

4.2. Comparison of Two Display Effects. Digital display can express the needs of the Song Dynasty tea space for the humanistic environment and spatial environment. The tea space meets the needs of aesthetic appreciation and knowledge culture. In the layout of the tea space, we emphasize the culture, especially the tea culture, deeply excavate the spiritual resources of excellent traditional culture, and pay more attention to the extension of cultural values. As a very common spiritual demand, aesthetic appreciation fully enjoys this appreciation and aesthetic feeling in the tea space. Now for the spatial effects of tea drinking in the Song Dynasty under two different displays, the following Table 2 is obtained:

Table 2 shows the comparative effect of tea drinking space in the Song Dynasty under the two displays. There is a statistical significance of $t < 10.000$, $p < 0.05$ when comparing the data. Digital display, with its unique display effect and beautiful scientific and technological means, makes the way for visitors to acquire knowledge more active and has made a certain contribution to the dissemination and inheritance of tea culture.

According to the comparison effect in the above table, the following Figure 2 is obtained:

As shown in Figure 2, it shows the visual effect of the comparison of the two kinds of tea drinking spaces in the Song Dynasty. It can be clearly seen that the digitally displayed tea drinking space in the Song Dynasty is conducive to the aesthetic appreciation ability of visitors and the extension of traditional cultural values. In addition, it is of great significance to promote the spirit of tea culture.

4.3. Influence of Tea Culture Transmission under Two Kinds of Exhibitions. Tea culture has a wide range of communication channels, and ordinary exhibitions lack interaction, and there are no more opportunities to explore new knowledge. Digital tea space exhibition can enable visitors to have a deeper perception and understanding of tea culture. In addition, with the support of computer technology, digital exhibition can create a vivid tea culture atmosphere, bring visitors unique feelings, and the cost of the exhibition is lower than ordinary exhibitions. Digital display only increases the production cost of digitalization, which is significantly lower than that of other exhibitions. The display of digital tea space highlights a strong flavor of tea culture. Table 3 is made for the dissemination of tea culture under two different displays:

Table 3 shows the comparison results of the cultural spirit transmission of tea culture under the two displays: the audience's thirst for knowledge of tea culture and the exhibition cost. It can be seen visually that digital display has a positive significance for the transmission of tea culture. The effect of digital display can not only enrich the knowledge level of visitors but also improve the spiritual and cultural connotation.

According to the comparison information in the above table, the following Figures 3 and 4 are obtained:

As shown in Figure 3, the visualization effects of the two displays on the dissemination of cultural spirit and the audience's thirst for knowledge of tea culture can be clearly seen. The contrast gap between the two sets of data can be clearly seen. The digital display of the nonlinear system model of tea drinking space in the Song Dynasty promotes the effective dissemination of traditional cultural spirit, and its cultural spirit connotation can be perfectly presented in tea culture.

As shown in Figure 4, the cost comparison visualization effect of the two displays is shown. The general display of tea space in the Song Dynasty is significantly higher than the digital display in terms of exhibition cost, which can indirectly explain that the digital display has improved the new ideas for other traditional cultures.

4.4. 4 Comparison of Visitors' Interest and Satisfaction under the Two Displays. Digital tea space display is more and more inclined to visitors. Based on neural network technology, the digital display of the nonlinear system model of tea space in the Song Dynasty can be transformed into a harmonious and interactive relationship. Visitors can change their previous passive position, actively participate in the activities of digital display, and learn knowledge through experience. Digital display breaks the traditional restrictions of time and space. A good interactive platform has been established for viewers and tea space display to improve visitors' interest and satisfaction. Now, we investigate the interest and satisfaction of visitors under two different displays and make charts according to the results and get the following Table 4:

In Table 4, the interest and satisfaction of visitors under the display of the two Song Dynasty tea drinking spaces are counted. From the table, it can be found that under the

Table 2: Two kinds of tea space effects in the Song Dynasty (%).

Group	Aesthetic appreciation	Extension of traditional cultural values
General display	62.35	64.57
Digital display	90.17	93.24
T	6.348	6.242
P	0.038	0.037

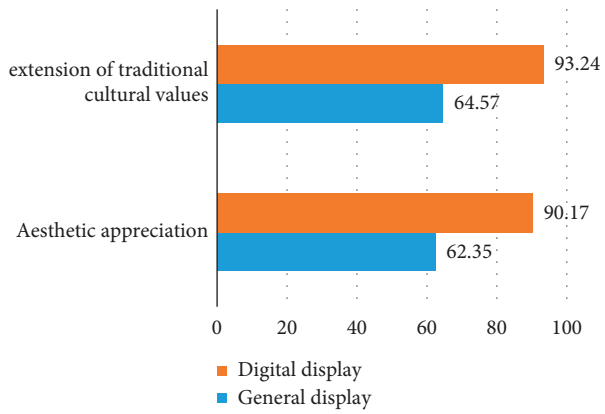

Figure 2: Comparison and visualization of two kinds of tea drinking spaces in the Song Dynasty (%).

Table 3: Analysis of tea culture transmission under two displays (%).

Group	Cultural spirit communication	Audience's thirst for knowledge of tea culture	Exhibition cost
General display	64.32	60.26	76.43
Digital display	89.27	90.45	48.61

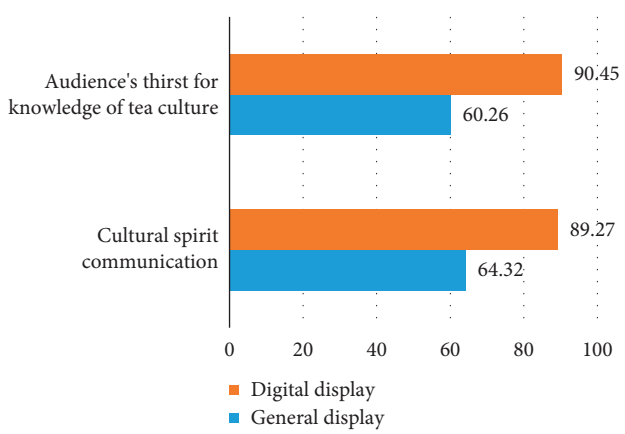

Figure 3: Comparison of the two displays on the dissemination of cultural spirit and the audience's thirst for knowledge of tea culture (%).

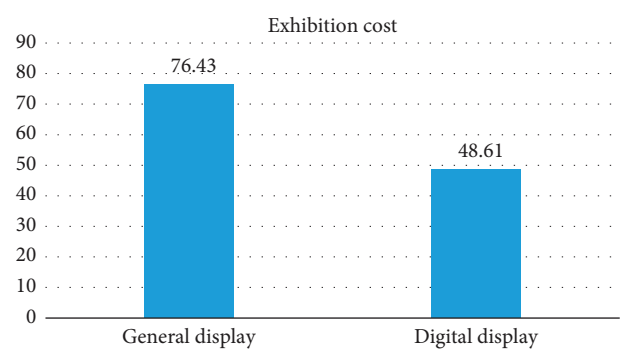

Figure 4: Cost comparison of two displays (%).

digital display, the interest and satisfaction of visitors can be improved. It indirectly shows that digital display has fascinating mysterious charm.

According to the statistical information in the above table, the following Figure 5 is obtained:

As shown in Figure 5, the visualization effects of visitors' interest and satisfaction in the two kinds of displays are shown, and the contrast gap between the two groups of data can be clearly seen. The impact of digital display on the display of tea space in the Song Dynasty is very obvious, mobilizing visitors' strong interest in the display of tea space, and significantly improving their satisfaction in the display effect.

5. Discussion

The emergence of digital media represented by the Internet has provided a new channel for the cultural publicity of museums and exhibition halls. Through the digital processing of the Song Dynasty tea space culture, it helps to

Table 4: Analysis of interest and satisfaction of the two displays (%).

Group	Interest	Satisfaction
General display	76.43	75.82
Digital display	94.28	92.16

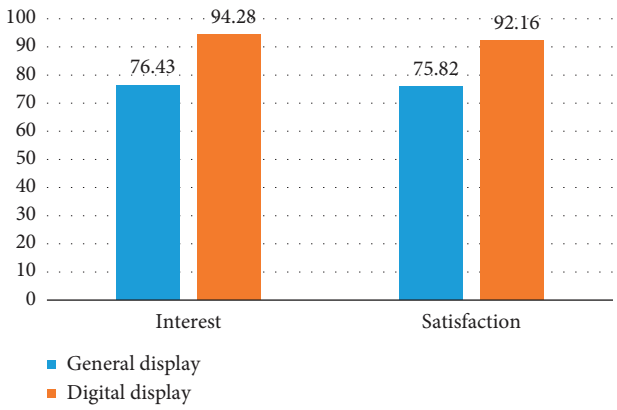

Figure 5: Visualization of interest and satisfaction of two displays (%).

deepen the audience's understanding of the Song Dynasty tea space culture and also creates a new reading and interpretation space for the Song Dynasty tea space culture. Yang Xiaoxue (2022) believes that it is necessary to integrate digital technology into museum work. In the process of cultural relics display and dissemination in the museum, using digital technology to innovate the form of display and dissemination can bring people a better viewing experience [12]. Wei Ming (2021) said that through the integration of multimedia technology, the combination of dynamic and static, virtual and real response, and the use of digital display technologies such as pictures and words, physical display, historical images, scene restoration, and virtual reality, it can well interpret the charm value of traditional culture, so that visitors can see the big from the small and explore the whole from the small while watching the exhibition [13].

In this study, we studied the digital display of the nonlinear system model of the Song Dynasty tea space based on neural network technology, through dynamic interactive experience to appreciate the traditional culture, in which the tea space culture has rich artistic connotation and embodies the aesthetic value. The effective integration of tea space design and tea culture can be verified by the digital display of nonlinear system model. No matter from all levels, the design of tea space reflects different cultural connotations and also creates a unique cultural artistic conception. The design of tea space in the Song Dynasty is personalized, and tea culture also has a strong moral and cultural color, which can highlight natural and quiet ideas from digital display. The digital display of the nonlinear system model of the Song Dynasty tea space based on neural network technology directly reflects the characteristics of the psychological spirit. The application of multimedia makes the digital display process not only a spiritual experience but also has strong aesthetic appreciation ability, which makes the tea space design have a cultural flavor, integrates the tea culture concept of the Song Dynasty into the tea space design, and then improves the overall design level of tea drinking space.

6. Summary

The Song Dynasty was the heyday of the development of China's tea culture. The social customs of drinking and advocating tea promoted the development of tea culture. Today, with the rapid development of digitalization, digital display has gone deep into various fields and industries. Compared with ordinary display methods, this study uses the nonlinear system model of neural network technology, and the digital display of tea space in the Song Dynasty has more sensibility and space-time ductility, enhances visitors' ability to improve aesthetic appreciation, expands the tea culture that shows the tea drinking space, and better extends the traditional cultural value. Digital display can save the cost of human and material resources of the whole exhibition and play a good role in promoting the spread of the cultural spirit of tea culture and the audience's thirst for knowledge of tea culture. In the process of exhibition, it will bring new feelings to visitors and enhance their interest and satisfaction. The precipitation of thousands of years of history and culture, with the help of the power of new media, better understands the connotation and essence of tea culture and provides new ways and possibilities for the dissemination and inheritance of tea culture.

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Conflicts of Interest

The authors confirm that there are no conflicts of interest.

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Research Article

Research on Digital Media Art Film and Television Special Effects Technology Based on Virtual and Reality Algorithm

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Art special effects, as a kind of new media art form, bring different visual impacts to viewers in film and television animation. This study discusses the application of digital media art film and television special effects' technology through virtual and realistic algorithms. The wide application of digital media art film and television special effects' technology has achieved the purpose of saving production time and cost for the creation of film and television dramas. Through the comprehensive analysis and research on art creation, image impact, film viewing perception, and natural interactive emotion under different technological environments, and the analysis of the comparison results, it can be seen that digital media art film and television special effects' technology has a far-reaching impact on film and television animation, can better carry out the sustainable development of film and television field, also promote the sustainable development of science and technology to a certain extent, promote the modern development of digital media art design, support society's continuous development and progress, and better promote the all-round integration of digital media art and film and television creation.

1. Introduction

With the development of science and technology, virtual reality algorithm technology is also being promoted widely. J. Lanier puts forward the concept of virtual reality (also known as spiritual technology) in 1989. He believes that virtual reality uses computer technology to create a realistic sensory world with hearing, touch, vision, and even smell. Users can browse the virtual world according to preset technology and related devices and can interact with others subjectively at the same time.

Virtual reality algorithm technology is very comprehensive, including a variety of high-tech, with interactive, immersive, perceptible, autonomous, and other characteristics. Now, it has become one of the core technologies in the production of special effects, providing comprehensive technical support for film production and playing an important role in the whole process of film production. Liu said that using virtual reality technology can promote the development of film production, improve all links, stimulate the audience's visual experience, and meet the audience's needs [1]. Digital media art film and television special effects technology has brought new technical support to art creation and changed people's entertainment lifestyle and habits. Si believes that the movie pictures produced by virtual reality technology can produce shocking visual effects, which can bring new aesthetic taste to the audience [2]. Star Wars and other sci-fi films have used virtual reality algorithm technology to show the shape of objects through reality so that the audience has a real sense of invincibility. Zhang said that avatar, released in 2010, has become the peak work in the special effects' industry [3], pushing the VR algorithm technology to the peak of the film industry. Since then, film and television producers have added virtual reality technology to their works. Shen et al. said that, with the help of VR algorithm technology, film and television directors can directly see the completed picture of background effects in front of the monitor [4]. Han et al. believe that the development of VR has opened a new era of development in the film field and created a new film form [5]. Virtual reality technology can create new audio-visual effects. Technology based on virtual and reality algorithms is more infectious and artistic innovation.

In 1980, digital media art, which combines ordinary art and digital media technology, rose rapidly in China. Its new and innovative characteristics make it deeply loved by the majority of people. Tang et al. believe that virtual reality algorithm technology plays a leading role in digital media art. The expressiveness of the works is stronger, and the visual impact is also stronger [6]. The image processed by digital technology is closer to reality and has higher picture quality. Zhang believes that the important content of VR is to produce a realistic virtual environment in the later stage of the film, then establish a virtual model according to the audience's aesthetic trend and market trend, and finally produce special effects with the best visual effect [7]. Lan said that the application of VR to the special effects of film and television works has become a key technology for the special effects' production of domestic science fiction films and television works. The application of VR technology can make the information picture on film higher than reality. Film and television producers can create some scenes that are unlikely to happen in real life and can also design some model roles. Compared with traditional films, the special effects of films using virtual reality technology are more realistic and have stronger artistic expression [8].

Virtual reality algorithm technology provides more possibilities for the imaging language of movies. Yao said that, with the wide application of VR algorithm technology, images can be placed in virtual content when processing images, and then image fusion can be better carried out, and diversified special effects production can be carried out [9]. People use technology to liberate images from words, making image recording a more convenient and explicit way of expression. Li said that, in the production of special effects, the participation of virtual reality algorithm technology gradually deepens with the continuous improvement of the technical level. Virtual reality technology can reproduce the original complex scene, simulate content remodeling, and other diversified programs so that the picture and content will be richer than the finished products without virtual reality technology, and the effect of some special pictures will be more significant, which has been greatly improved in terms of special effects production [10]. Wang said that film and television special effects using virtual reality algorithm technology can realize lens connection and special effect creation, making many impossible pictures possible [11]. Wang et al. said that the application of virtual reality algorithm technology in the film production process will become more and more mature, changing the film production mode and production mode [12].

This study focuses on the application of virtual reality algorithm technology in digital media art film and television special effects technology, provides a reference for the further development of digital media art value, and contributes to the development of digital media art film and television special effects technology.

2. Development Status of Digital Media Art Film and Television Special Effects

With the development of the times, people's horizons are gradually broadened, and a single film focusing on the plot is far from meeting the needs of modern people. People have higher and higher requirements for the experience of the visual senses. While appreciating the plot, they pay more attention to the shocking special effect scenes and the visual impact brought by creating illusory creatures and scenes. There is no doubt that all these have become a new standard for evaluating the success of a film in the contemporary era. Digital media art will stay in the traditional creative ideas and ideas and lack of innovation in artistic creation. The diversified development of digital media art has gradually marginalized traditional cultural characteristics. Cultural heritage is an indispensable and important core element and deepens the in-depth understanding of traditional culture. In the blind pursuit of special effects, it is easy to ignore the spiritual realm and cultural elements in artistic works.

The technology of virtual and reality algorithms has also been widely used in the field of film and television. Modern art creation must follow the trend of the times and make positive changes according to the accepted appreciation angle. The special effect technology of virtual and reality algorithms can transform abstract things into visualization and enhance the interaction and communication between viewers and film. Therefore, it is important to bring substantial breakthroughs in artistic works in digital media artistic film and television special effects, integrate virtual and reality algorithm technology, apply art special effects technology to create, realize the innovation and development of digital media art creation, and bring more real and touching artistic experience to viewers. With the innovation of media technology, there are good opportunities for the sustainable development of current film and television works. The application of digital media art in the future film and television special effects will bring reform and innovation to the film industry. Through virtual and reality technology, the efficiency of film production will be greatly improved, and better viewing effects will be brought to viewers. The film and television effects will be more realistic and idealized, letting viewers feel the visual feast brought by the film from many aspects.

3. Digital Media Art Film and Television Special Effects Creation Based on Virtual and Real Algorithm

3.1. Virtual and Reality Algorithm. Artistic film and television special effects creation works are inseparable from data information. Virtual and reality algorithms can achieve the maximum optimization of valuable information. Under the massive data information content, we can remove the complicated data, deeply mine the useful information, and analyze and study the main data information. The accuracy and efficiency of their algorithms can improve the capture speed of massive data information extraction in time. By studying the information fusion of virtual scenes and real environments, we can enhance users' perception of the objective world, and from this valuable information, we can get a sense of creation. We can refer to the rich and diverse information content, make the virtual and reality algorithm understand the viewer's psychology in the data information,

create the image content that visually conforms to the viewer's preferences, bring the audio-visual experience of multi-element interaction and integration, integrate the digital media art film and television special effects, achieve the realistic dynamic picture effect, dynamically respond to the viewer's psychological behavior, and promote the interaction of artistic film and television works. The information data assistance of virtual and reality algorithm is added to the special effects of the picture so that the two technologies can be reasonably used to analyze the data of each detail of the digital media art special effects, extract the most favorite pictures and fragments of the viewer, and summarize the key points of the details. In addition, it can provide a certain reference value for the creation of artwork.

3.2. Artistic Film and Television Special Effects' Creation. The creation of digital media art special effects based on virtual and reality algorithms makes the pictures more three-dimensional and strengthens the perception of viewers. A simulated virtual space environment is established, which further stimulates the imagination and expressiveness of creation and combines virtual and reality algorithm technology to create works with more visual impact and expressiveness. In the virtual world, let the whole film and television special effects' picture continue to create better special effects in this environment. The combination of the two technical means can provide more space for film and television creation and creative potential. At the same time, it opens the door to more new worlds for digital media art film and television special effects creation and widens its various paths of artistic expression. The combination of art and technology, artistic elements, and bold creative ideas adds luster to the content through special effects technology. The wonderful ideas of art promote the realization of digital media film and television art and enrich the performance of pictures to a certain extent. Film and television special effects bring stunning effects; while attracting the audience's attention, they also firmly grasp their psychology, and special effects skills have gradually developed into an indispensable dish in the modern and future film and television industry. Excellent film and television special effects can add a lot of color to the whole film. The promotion of art and creation can better enhance the artistic expression of film and television works.

4. Integrated Application and Development of Virtual Reality Technology and Digital Media Technology

The integration between digital media technology and virtual reality technology, through collaborative development, can create brand-new technical concepts and promote effective development. After entering the era of information technology, take digital media art technology as the support point, build a good virtual scene simulation, and create an interesting experience with a strong sense of immersion for viewers. The ingenious integration between the two plays a great value experience. The combined use of it and virtual reality technology can further improve the application effect. In the context of postproduction, virtual scenery is used to adjust the work scheme, complete the all-round creation of the virtual reality world, provide viewers with a very realistic experience, and optimize the virtual world to the greatest extent so that it can be effectively processed in detail, and further optimize the interaction with viewers.

Virtual reality technology can effectively improve the flexibility of artistic creation means, expand creative ideas, give new vitality to the creation of artistic works, and increase free play space to effectively improve the fluency of artistic creation. In digital media art, film, and television special effects' technology, virtual scene simulation ensures the authenticity of the virtual world and allows viewers to immerse themselves in the scene. Detailed processing is conducive to the effective integration between virtual reality technology and digital media art technology and promotes the optimal and innovative application between them. In the virtual scene, improve the authenticity of the visual, auditory, and tactile aspects of the viewer in the virtual environment, ensure that the viewer gets a sense of satisfaction and immersion, make the background content of the scene more realistic, and effectively realize the interaction between the virtual world and the real world.

Digital media art film and television special effects' technology is naturally invested in the virtual world, and viewers get a sense of experience and good artistic enjoyment of the visual image, breaking the boundary between the real world and the virtual world, breaking the presentation mode of film and television artworks, effectively expanding the scope of special effects, and creating a very realistic virtual scene. At present, VR algorithm technology has been relatively extensive, and the development potential of the market is huge. The two complement each other, and their application effect is very significant. Virtual reality technology has generally entered the public's sight, further improving the public's happiness index, not only making achievements in the film and television industry but also promoting the innovative development of more new fields. Integrate technology into art creation, create dynamic virtual images, and have a real sense of experience at the same time. The integration of the two technologies can reasonably optimize the data information, improve the overall work efficiency, present a more optimized design effect, and make the sound, image quality, and special effects have stepped progress.

5. Simulation Verification

5.1. Comparison of Two Special Effects' Technologies in Artistic Creation. The optimization of the virtual reality algorithm is promoting the increasing diversification and enrichment of digital media art in art forms, art styles, and art types. Virtual reality technology has brought a broader platform for the development of imagination and creativity for digital media art and has brought moving visual effects to viewers based on the theoretical knowledge of virtual reality art creation in art creation. Pay attention to the interaction with the viewer, be

immersive and be able to make a benign composition, and integrate into the public and life. Now, we analyze two special effects technology, make charts according to the statistical information, and get Table 1.

Table 1 shows the comparison results of two kinds of special effects' technology in artistic creation. Integrating digital media art, film, and television special effects' technology uses virtual and real algorithms to freely control the expression form of digital media art in artistic creation. Compared with ordinary technology, it is obvious that the technology used in this study has been further improved in creative form, style, and type.

According to the statistical information in the above table, Figure 1 is obtained.

As shown in Figure 1, the visualization effect of the two kinds of film and television special effects' technology in artistic creation is shown, and the contrast gap between the two groups of data can be clearly seen. Digital media art film and television special effects' technology can skillfully express various images in artistic creation, showing a fatal attraction. It can be seen that the development of this special effects' technology has promoted the development of the film and television field.

5.2. Comparison of the Impact of Two Special Effects' Technologies. When the viewer is in it, he will get a unique sense of surreal space experience in the virtual situation. Under the impact of artistic effects, he will create a new form of more real and virtual interaction and bring more artistic experience to the viewer. The interactive combination of vision, hearing, and psychology will inevitably promote the connotation of digital media art to be richer and more distinctive, with a strong sense of spatial hierarchy. Improve the impact and influence of digital media art special effects technology. Now, we analyze the impact of two kinds of effects technology, make charts according to the data results, and get Table 2.

Table 2 shows the comparison results of the impact of the two film and television special effects' technologies. Special effect technology of this study can create a real and high simulation environment, allowing viewers to pass through multiple senses. Virtual reality technology can integrate the digital media special effects' world and the real world to the greatest extent, and its visual, auditory, and psychological feelings are significantly higher than ordinary film and television special effects' technology.

According to the data results in the above table, Figure 2 is obtained.

As shown in Figure 2, the impact visualization effect of two kinds of film and television special effects' technology is shown. The general film and television special effects' technology is lower than the special effect technology of this study in terms of psychological perception, which indirectly shows that the digital media art film and television special effects' technology can be better loved by viewers, and the impact effect of psychological perception can directly reflect the presentation effect of film and television special effects.

5.3. Comparison of Viewing Perception under Two Special Effects' Technologies. In recent years, virtual reality technology has also entered a new stage of development, and its sense of realism and immersion is also constantly improving. It has a greater shock in the perception of film viewing. When the film is appreciated, it can bring the audience into the film and television and perfectly present the film in a very strange film viewing corner. The enrichment of special effects promotes the extension of the viewer's senses. With the support of virtual technology, digital media art creation can show imagination, expressiveness, and more shocking visual effects. Now, we analyze the viewer's perception of movie viewing, and make Table 3.

Table 3 shows the comparison results of post viewing perception of the two special effects' technologies, which can indirectly conclude that the special effect technology of this study is more suitable for the viewer's mind. This special effect is closely combined with the plot of the film to create an environment consistent with the content of the film so that viewers can experience the new entertainment effects brought by the special effects through multiple physical senses.

According to the analysis results in Table 3, Figure 3 is obtained.

As shown in Figure 3, the visualization effect of the viewing perception of the two special effects technologies is shown. Compared with the data, there is a statistical significance of $t < 10.000$, $p < 0.05$. Immersive experience and panoramic viewing can make viewers get a better viewing experience.

5.4. Natural Interactive Emotional Comparison of Two Special Effects' Technologies. Viewers' ultimate pursuit of the virtual world has led to the emergence of 3D movies such as avatar, which achieve an immersive viewing experience and an interactive emotional experience in the virtual world. Immersive to feel the thrill and tension, the processing of artistic special effects will pay attention to the detailed performance of the scene, bring viewers super luxurious visual enjoyment, interact and associate according to the film content in the virtual world aesthetics, and aftertaste the true feelings brought by the film. Now, compare the two special effects' technologies in sensory stimulation, scene detail performance and virtual aesthetic interaction association, and make Table 4.

Table 4 shows the natural interactive emotional comparison results of the two film and television special effects technologies. Compared with the traditional special effects technologies, the special effect technology of this study pay attention to the viewer's sensory stimulation and scene detail performance, leaving an interactive space for the viewer to make interactive memory and association when watching, and enjoy the emotional aftertaste of the film.

Based on the data in Table 4, Figure 4 is obtained.

Figure 4 shows the natural interactive emotional visual effects of the two film and television special effects' technologies. Compared with the two film and television special effects' technologies, it is enough to highlight the good development trend of digital media art film and television special effects' technology, which can promote the sustainable development of the film and television field.

Table 1: Comparison of two special effects' technologies in artistic creation (%).

Group	Artistic form	Artistic style	Artistic type
General technology	69.05	68.31	65.47
Digital media art film and television special effects technology	89.33	92.56	90.38

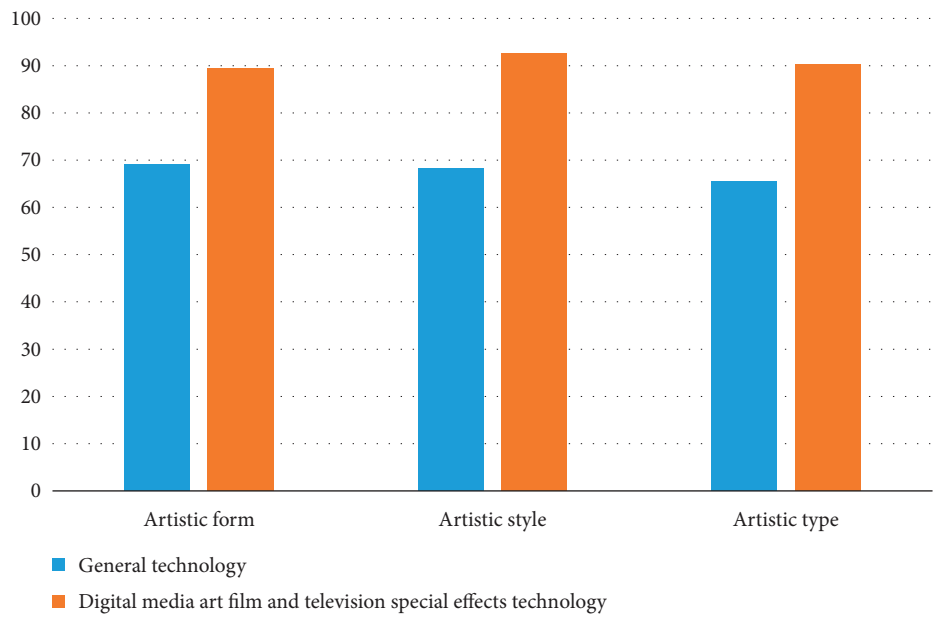

Figure 1: Visualization of two special effects' technologies in artistic creation (%).

Table 2: Comparison of impact force of two special effects' technologies (%).

Group	Visual effect	Auditory effect	Psychological perception effect
General technology	72.45	74.39	73.69
Digital media art film and television special effects' technology	94.06	93.56	96.47

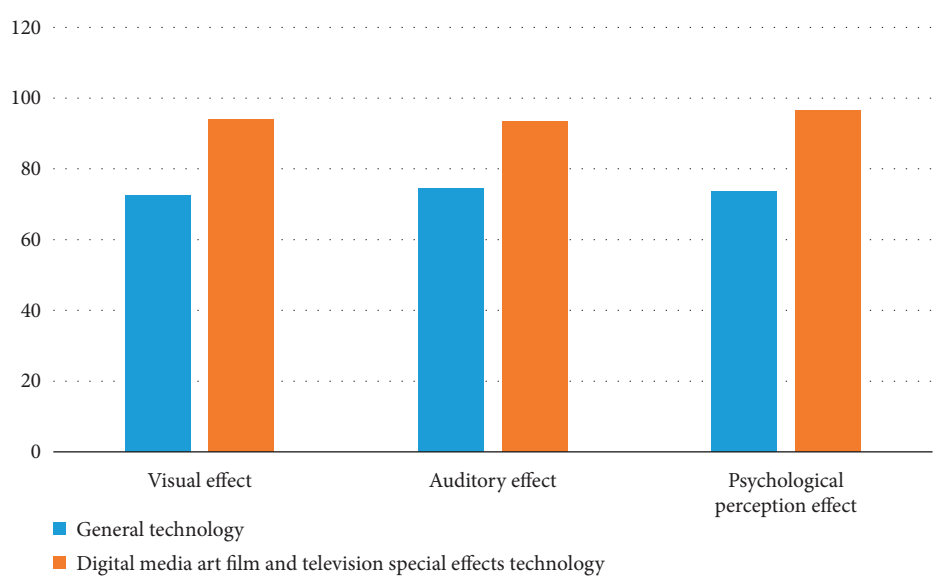

Figure 2: Impact visualization of two special effects' technologies (%).

Table 3: Comparison of viewing perception of two special effects' technologies (%).

Group	Immersive experience	Panoramic view
General technology	74.35	72.14
Digital media art film and television special effects' technology	97.36	93.27
T	6.235	6.458
P	0.045	0.041

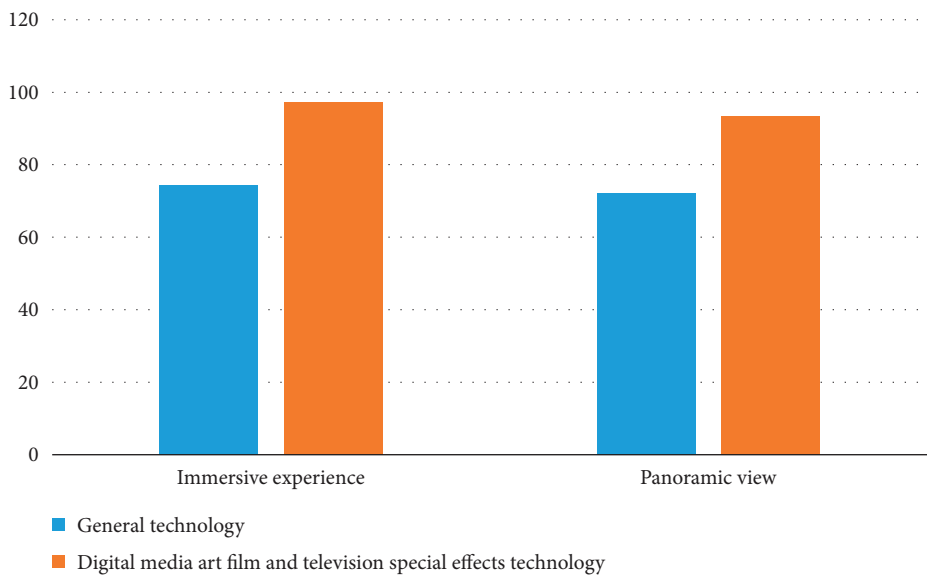

Figure 3: Comparison of visual perception of two special effects' technologies (%).

Table 4: Comparison of natural interactive emotion between two special effects' techniques (%).

Group	Sensory stimulation	Scene detail performance	Virtual aesthetic interaction association
General technology	74.35	75.34	70.52
Digital media art film and television special effects' technology	96.22	94.56	93.59

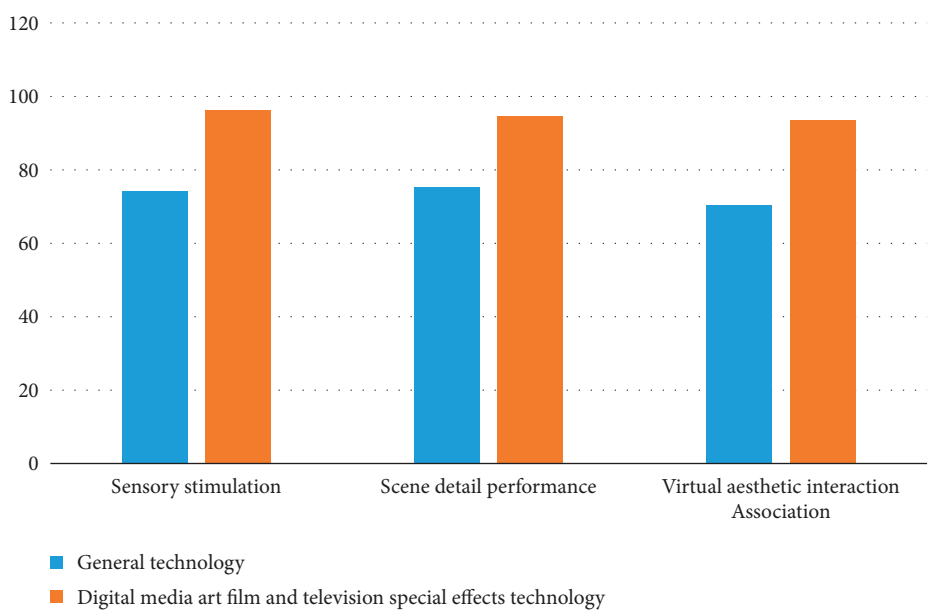

Figure 4: Natural interactive emotional visual analysis of two special effects' technologies (%).

6. Summary

On the basis of VR algorithms, this study discusses the application and development of digital technology. Special effects' technology in the film can show more shocking visual effects in creation so that digital media art can obtain greater development space. And with convenient information access channels and rich information integration methods, it plays an important role in the lives of the people. This study analyzes the effects of ordinary special effects' technology and special effect technology of this study in artistic creation, image impact, film viewing perception, and natural interactive emotional analysis. From the comparison results, the digital media art film and television special effects' technology has broken the boundary between the real world and the virtual world. With a new way of presenting film and television works, viewers have gained a sense of experience and good artistic enjoyment on the visual screen, expanded the scope of film and television special effects, created a very realistic virtual scene, and achieved remarkable audio-visual effects. Digital media art special effects have gradually been recognized by the audience, promoting the development of film towards personalization [13].

Data Availability

The data underlying the results presented in the study are available within the article.

Disclosure

The author confirms that the content of the manuscript has not been published or submitted for publication elsewhere.

Conflicts of Interest

The author declares that there are no potential conflicts of interest in our paper.

Authors' Contributions

The author has seen the manuscript and approved it to submit to your journal.

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Research Article

Research on Evaluation Method of Wayfinding Signs in Medical Institutions Based on Mobile Network Intelligent Navigation

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With the rapid development of our country's economy, there has been a phenomenon of population concentration and centralization of medical institutions. At the same time, with the continuous development and improvement of medical disciplines, large-scale general hospitals have become more comprehensive and larger in area. Therefore, hospital users often get lost in the public space of the hospital. Therefore, the purpose of this article is to study the evaluation method of wayfinding signs in medical institutions based on mobile network intelligent navigation. This article first analyzes the research status of navigation signs in medical institutions and then introduces the current wayfinding behaviors of large general hospitals, and analyzes the problems and deficiencies in them. On this basis, the intelligent navigation is researched and designed. This article systematically expounds the main characteristics of hospital users' pathfinding behavior, the spatial order of the process, and the hierarchy of pathfinding behavior, and uses questionnaire survey, field survey, and other research forms to carry out experimental research on the theme of this article. Studies have shown that the hospital's public organization space model will directly affect the efficiency of people seeking medical care.

1. Introduction

Large-scale hospitals in my country often have complex building structures and can accommodate a large number of patients [1, 2]. People usually need to find the target location accurately and efficiently during medical treatment. However, preliminary studies have shown that even though most large hospitals have indoor recognition systems, many people still spend unnecessary time looking for directions during treatment [3, 4].

In the research on the navigation signs of medical institutions, many experts and scholars have achieved good results. For example, the book AboutFace4 Interaction Design Essence by Alan Cooper elaborates the goal-oriented design method in detail and puts forward a good design to make users more efficient, which is a general guideline for interaction design [5]; Yicheng Bai proposed a novel technology for hospital guidance systems, especially for the visually impaired [6]. Unfortunately, these studies on hospital navigation signs have not been paid attention to, so the topic of this article has very good practical significance.

The purpose of this article is to improve the efficiency of hospital visits for users, and to design the intelligent navigation system of the hospital's wayfinding as the purpose. By conducting questionnaire surveys and analyzing and comparing the data obtained in four hospitals in a certain place, the research theme of this article is studied. Based on the in-depth analysis and modeling of the problems in the field of information, the intelligent navigation system establishes a variety of information organization mechanisms and process control mechanisms, senses users' needs in real time, grasps and uses users' cognitive context, simulates human thinking mode, and guides users to locate their information needs through reasoning and analysis.

2. Application Research on the Evaluation Method of Wayfinding Signs in Medical Institutions Based on Intelligent Navigation

2.1. Analysis of Existing Wayfinding Behaviors in Large General Hospitals

2.1.1. Main Characteristics of Hospital Users' Pathfinding Behavior

(1) The flow of medical treatment

In the public space of the hospital, the behavioral characteristics of the hospital users have a clear process and purpose. As a large general hospital and a multifunctional and integrated architectural form, such as treatment, inspection, medicine collection, hospitalization, and academic office, it produces a variety of different purpose pathfinding process methods [7, 8].

Wayfinding behavior for the purpose of seeing a doctor

In the hospital building, there is a regular medical treatment process, which is usually registration-waiting-seeing a doctor-checking-treatment-taking medicine-leaving.

Wayfinding for the purpose of hospitalization

The hospitalization process in the hospital building is usually hospitalization application-main processing-payment-inpatient room-completed.

Wayfinding behavior for the purpose of follow-up visits

This wayfinding behavior generally includes re-examination, consultation, taking medicine, or several simultaneous medical treatment modes.

Way-finding behavior for the purpose of follow-up visits

The users of wayfinding behaviors are generally hospital communication and learning personnel or outsiders who are led and guided.

(2) The spatial order of the process

In the public space of hospitals, hospital users have the characteristics of the process, and the corresponding public space order levels need to correspond to the order, so that the space order guides hospital users to better wayfinding and spatial cognition. In order to cope with the sequential nature of the medical treatment process, the spatial logical order of the public space of the hospital has been formed, and different spaces have been set up in different levels. Hospital public space is divided into a public center system, a public subsystem, and a connection system connecting the two according to the medical treatment process from high to low [9, 10]. As shown in Figure 1, the logical order is arranged according to the relationship of reason, which conforms to the law of people's understanding of things. This order is often used to introduce complex things and phenomena, as well as expository texts that introduce reason. It is generally explained in the order of from shallow to deep, from easy to difficult, from concrete to abstract, from simple to complex, and from primary to secondary.

2.1.2. The Hierarchy of Pathfinding Behavior. For hospital users, a complete pathfinding process should start in the city. Until returning to the city, the scope of pathfinding in the public space of a large general hospital studied in this article is not limited to the pathfinding behavior inside a single building. It is an incomplete wayfinding behavior. This article divides a complete pathfinding into four levels: city to hospital area, hospital area to cell, cell to department, and department to leave. Each level is interconnected and inherited from each other [11, 12].

(1) City Campus. The wayfinding behavior of hospital users has already begun in the city. Field surveys have found the main transportation methods for hospital users, which are as follows: public transportation includes urban public transportation systems such as buses and subways, and self-driving transportation includes self-driving cars and other means of transportation. Therefore, the wayfinding behavior from urban public transportation stations to the hospital area and urban roads to the park is also an important part of the hospital's wayfinding.

(2) Campus Monomer. Large general hospitals generally cover different areas such as outpatient area, medical technology area, inpatient area, emergency department, pediatrics, rehabilitation, teaching, and research, so the second stage of pathfinding for hospital users is the pathfinding behavior from the hospital area to the individual.

(3) Monomer Department. After the hospital user accurately completes the second phase of pathfinding from the hospital area to the individual, they will enter the most important pathfinding phase in the public space of the hospital, that is, the individual to the specific medical department.

2.2. Analysis of Hospital Public Space Auxiliary System and Wayfinding Behavior

2.2.1. The Contradiction between the Navigation System and Hospital Users. The use of the navigation system has its own hierarchy based on the level of the medical treatment process. The navigation system is mainly used in the first pathfinding stage city to hospital pathfinding behavior described above, and the third pathfinding stage alone to the department. The specific use is one of the navigation systems from the city to the hospital (the first wayfinding stage); to reach the urban area around the hospital by self-propelled vehicles or urban public transportation, the city navigation system is generally used to assist the wayfinding and then enter the courtyard. The second is the use of the navigation system from a single unit to the department (the third wayfinding stage). The main

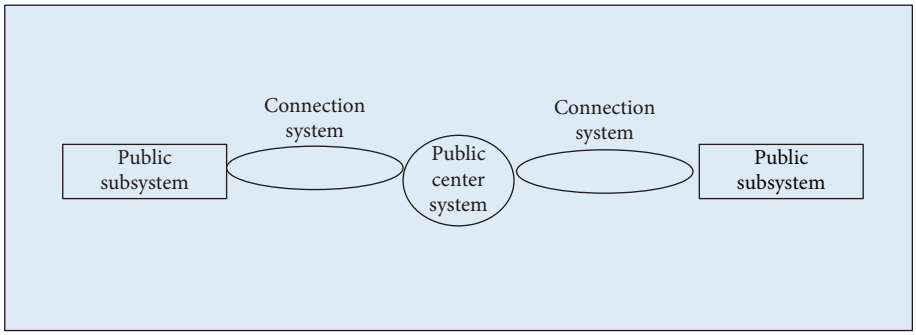

Figure 1: Hospital public space order.

function of positioning in the navigation system is to find the position, relying on the synthetic positioning method. The method is to add the route units according to the number and angle. This process includes the accumulation of errors, but these errors are compensated by constantly comparing with the road position of the digital map (map matching).

Although the navigation system in the hospital assists hospital users in the wayfinding behavior when visiting a doctor to a certain extent, the navigation system inside the building still follows the navigation mode in the city and the point-to-point navigation mode. The pathfinding behavior of hospital users in the public space of the hospital has the characteristic of the process; that is, their pathfinding behavior is a multipoint pathfinding behavior, so the navigation system cannot solve the process of hospital users getting lost.

2.2.2. The Contradiction between the Sign System and the Cognition of Hospital Users. Although the identification system in the hospital is an indispensable auxiliary tool in the process of hospital users' consultation, its design has contradictions with the hospital users' perception and wayfinding behavior. Identification system refers to the setting of a visual image system in the form of text, graphics, and symbols, which can clearly express the content, location, direction, principle, and other functions in the hospital. The setting method of the icon content in the identification system often adopts up north and down south, but the hospital users in the treatment cannot perceive their own position, and where is north is even more difficult to talk about. There is a certain correlation between the user's location perception and the presentation of hospital graphics. For example, "I am here" on the icon requires reference to the surrounding image elements. If the presentation of the icon does not highlight the imageable elements, the identification will be difficult. If there is no perfect sign system, it means that the hospital's map system and road sign system are not perfect, and it takes a lot of time to find a department. These are indispensable components in modern hospitals. It can be said that the design and setting of signs is one of the symbols to measure the degree of civilization of a hospital, and also one of the symbols to measure the quality of the hospital's planning level.

2.2.3. The Contradiction between Artificial Medical Guidance System and Path Cognition. Guiding language elements and hospital user path cognition elements. The linguistic elements of guidance should be unified with the cognitive elements of hospital users and at the same time increase the cognitive elements in the building. Element mining is to make further preparations for design and development. Based on the analysis of the survey results, the structural type and color orientation of the logo are extracted, the spirit and characteristics of the logo are listed, the relevant graphic elements are excavated, and the direction of logo design is found, so that the design work is targeted, rather than the aimless combination of words and graphics. In addition, when the route is more complex for destination guidance, it is difficult to be remembered by people if it covers more than three points of pathfinding. Therefore, hierarchical guidance appears; that is, one level of pathfinding can be completed by asking for directions at a time. The way needs to be asked twice. The signs determined in the proposal stage of the identification system may not be perfect in detail. After the correction of different forms of expression such as standard drawing, size correction, black-and-white application, and line application of the signs, the use of the signs will be more standardized. At the same time, the characteristics and structure of the signs will not be lost when used in different environments, so as to achieve unified, orderly, and standardized dissemination.

2.3. Design of Intelligent Wayfinding Navigation Marking System

2.3.1. System design principles

(1) Principle of Reliability. The principle of reliability is very important to the quality of a system. The correct route planning several times or even dozens of times is not enough to prove that the system is mature. After the design is completed, the reliability still needs to be strictly tested, including the overall system and different functional modules. Strict functional tests must be carried out, and the reliability of functions is particularly important. The purpose of reliability design is to make the life cycle of the product meet the specified reliability requirements by adopting the corresponding reliability design technology on the basis of

comprehensively considering the performance, reliability, cost, design, and other factors of the product.

2.3.2. Principle of Convenient Operation. The intelligent and simple operation method and comfortable human-computer interaction mode enable students to use the software more quickly and have a better user experience.

(2) Layout Positioning Design. Fully grasp the overall environmental characteristics of the hospital space, analyze its function, nature and internal logic, and plan in detail the route map for people to pay attention to logistics, and set the specific location of the sign. For example, the signs of the divided junctions, entrances and exits, stairways, crowd gathering points, public facilities, and important functional areas of hospital roads should be planned and dealt with appropriately at suitable locations to ensure the most effective guidance.

2.3.3. Universal Logo. The general medical logo design is based on graphics, supplemented by concise text, to achieve the purpose of easy generalization, easy copying, and generalization of hospital information. The hospital is a special public space environment, in which patients want to quickly and accurately complete the diagnosis and treatment process, and it is required that the general identification should have strong intuitiveness, prompting, and other characteristics.

2.3.4. Subject Identification. The main logo of the hospital is mostly composed of the name of the hospital and simple graphic symbols. The main logo is unique and can represent the overall image of the medical institution. This is what we often call the hospital emblem. The emblem is mainly set on the roof of the building, the wall of the outer wall, the top of the gate building at the main entrance, or the prominent position on the outer wall of the hospital. The design is usually based on the exterior wall materials of the main building of the hospital, using strong three-dimensional graphics and text for creation. At present, the most common is to use beautiful hollow fonts and flexible lamps and combined expression techniques for production. In addition, the hospital logo is often designed and applied to the public media such as the medical staff's badge, the hospital's letter paper, envelopes, and publicity albums to show the hospital's own image.

2.3.5. Space-Oriented Logo. Space-oriented signs refer to the ability to correctly guide people to find the target as soon as possible in a complex medical environment, and they are mainly set on the wall and the ground. Ground guidance signs are generally set up in gatehouses, emergency rooms, and other relatively rapid and chaotic environments. The direction system mostly indicates the direction and destination through arrows. It mainly tells people the direction of travel and the main facilities along the way, so as to guide people to reach their destination accurately and quickly. They are expressed in the form of more continuous indicator arrows combined with text descriptions or extended guidance with different colors representing different areas. Under normal circumstances, the sign guide board in the building is set at the main entrance of the building, the center of the outpatient hall, and around the elevator on the floor, and it is generally made into a solid column type and a wall hanging type. The spatial system is based on the principle of comprehensive guidance and uses maps to express the positional relationship between places. Different from the directional system, the spatial system informs the environment as a whole, making it convenient for people to use information selectively. It usually indicates the location of pedestrians, the location of entrances and exits, and other nearby transportation modes.

2.3.6. Analysis of functional modules

(1) Positioning Function. The current location positioning function is a function that any location service software needs to have. When you want to know the specific location, you can open the software to display the current location. After accurate positioning, it can also display other related location information near the current location. When the user moves, the small smart icon for positioning also moves, and the location can be determined in real time. In the case of noise interference, considering the ranging accuracy, signal bandwidth, required power, and different satellite identification, GPS adopts pseudorandom code ranging technology. Using pseudo-random coded signals can achieve low signal-to-noise ratio reception, greatly improve the reliability of communication, and achieve code division multiple access communication.

2.3.7. Query Function. You can query the specific location you want to know through the designated location query function. The system will generate a corresponding icon to indicate its location, and related information about this location will also be displayed on the phone screen.

2.3.8. Route Navigation Function. The route navigation function is the most important function of all the functions of the software. It is the function of the user to query the route planning and route guidance from the starting address to the destination address according to their actual needs, that is, from one place to another.

2.3.9. Mark Location Information Function. Display more important information to facilitate users to quickly obtain.

2.4. Indoor Positioning Algorithm Based on MEMS-IMU

2.4.1. Pedestrian Walking Gait Analysis. Pedestrians have a unique regularity in the process of movement. The main factor that affects the pace is step frequency. Usually, the gait parameters of pedestrians are symmetrical to each other. The walking time refers to one heel touching the

ground to the opposite heel touching the ground. The average time of the step length is about 0.5s. The gait cycle refers to the average time it takes for one of the heels to touch the ground to that side heel touching the ground again.

Gait analysis is an examination method to study the walking law. It aims at revealing the key links and influencing factors of gait abnormalities through biomechanics and kinematics, so as to guide rehabilitation evaluation and treatment, and contribute to clinical diagnosis, efficacy evaluation, and mechanism research. In gait analysis, some special parameters are often used to describe whether the gait is normal or not. These gait parameters usually include the following categories: gait cycle, kinematic parameters, dynamic parameters, EMG activity parameters, and energy metabolism parameters.

2.4.2. Zero Speed Detection Algorithm. Because the movement data of walking is continuous, the two adjacent data of the combined acceleration and the combined angular velocity are averaged as the current data. For the calculation of the variance of the combined acceleration and the combined angular velocity, a total of nine data in the four groups before and after the current data are calculated. Variance is a measure of the degree of dispersion of random variables or a group of data measured in the probability theory and statistical variance. In probability theory, variance is used to measure the deviation between random variables and their mathematical expectations. Calculate the mean value, and use the variance value of the nine sets of data as the current variance value. The basic formula used therein is shown as follows:

$$\begin{cases} \left|a_k^b\right| = \sqrt{\left[a_k^b(1)^2 + a_k^b(2)^2 + a_k^b(3)^2\right]}, c_1 = \begin{cases} 1, \ |a_k^b| < th_{a\max}, \\ 0, otherwise, \end{cases} \\ \sigma_{a_k^b}^2 = \dfrac{1}{2s+1} \displaystyle\sum_{j=k-s}^{k+s} \left(a_j^b - \overline{a_j^b}\right)^2, c_2 = \begin{cases} 1, \ |\sigma_{a_k^b}^2| < th_{\sigma\max}, \\ 0, otherwise, \end{cases} \\ \left|w_k^b\right| = \sqrt{\left[w_k^b(1)^2 + w_k^b(2)^2 + w_k^b(3)^2\right]}, c_3 = \begin{cases} 1, \ |w_k^b| < th_{w\max}, \\ 0, otherwise, \end{cases} \\ \sigma_{w_k^b}^2 = \dfrac{1}{2s+1} \displaystyle\sum_{j=k-s}^{k+s} \left(w_j^b - \overline{w_j^b}\right)^2, c_4 = \begin{cases} 1, \ |\sigma_{w_k^b}^2| < th_{\sigma\max}, \\ 0, otherwise, \end{cases} \end{cases} \tag{1}$$

where $a_k^b(1)$, $a_k^b(2)$, and $a_k^b(3)$ represent the three-axis acceleration, and $th_{a\max}$represents the combined acceleration threshold; $a_j^b, \overline{a_j^b}$ represent the average value of the three-axis combined acceleration and the combined acceleration, respectively, and the table $th_{\sigma\max}$ shows the variance of the combined acceleration threshold; $w_k^b(1)$, $w_k^b(2)$, and $w_k^b(3)$, respectively, represent the mean value of the three-axis combined angular velocity and the combined angular velocity. Table $th_{\sigma w\max}$ shows the combined angular velocity variance threshold; the value of s is taken as 4. When a single condition meets the zero speed, the value is 1, and if it is not satisfied, the value is 0; finally, the result of the single condition is ANDed, and when the foot is on the ground, that is, at the time of zero speed, the data at the time of zero speed is set to zero, the formula for sum operation is shown in the following equation:

$$c = c_1 \,\&\, c_2 \,\&\, c_3 \,\&\, c_4. \tag{2}$$

As for the single step time, it refers to the time required to take a step in the walking cycle, that is, the time from the first landing of the heel of one lower limb to the second landing of the heel of the opposite lower limb. It is measured in seconds. Under normal circumstances, the single step time of both lower limbs is equal. If the single step time of both lower limbs is not equal, it indicates the asymmetry of gait.

2.4.3. Adaptive Threshold Setting Based on K-Means Clustering Algorithm. The k-means algorithm selects k objects and takes these objects as k initial cluster centers. For the remaining objects, according to the distance between the object's position and the k cluster centers, divide them to the cluster centers closest to them. If the distances of multiple cluster centers are equal, they can be divided into any group and then start to calculate the average value of each cluster. The calculated new cluster center is used as the center of each cluster. Through continuous iterative calculation, when the set objective function is less the calculation stops when the error range is set. The optimization objective function adopted by the k-means clustering algorithm is shown in formula (3). Density-based method: a fundamental difference between the density-based method and the other methods is that it is not based on various distances, but based on density. In this way, the disadvantage that the distance-based algorithm can only find quasi-circular clustering can be overcome. The guiding idea of this method is that as long as the density of points in a region is greater than a certain threshold, it will be added to the clusters close to it:

$$E = \sum_{i=1}^{k} \sum X \in c_i \left|X - V_i\right|, \tag{3}$$

where E is the sum of the deviations between all points and the cluster center to which they belong, X is the point in R^m, which represents a given data point, and V_i is the average value of the cluster C_i. The process of the k-means clustering algorithm is shown in Figure 2. The first step of the graph theory clustering method is to establish a graph suitable for the problem. The nodes of the graph correspond to the smallest unit of the analyzed data. The graph theory

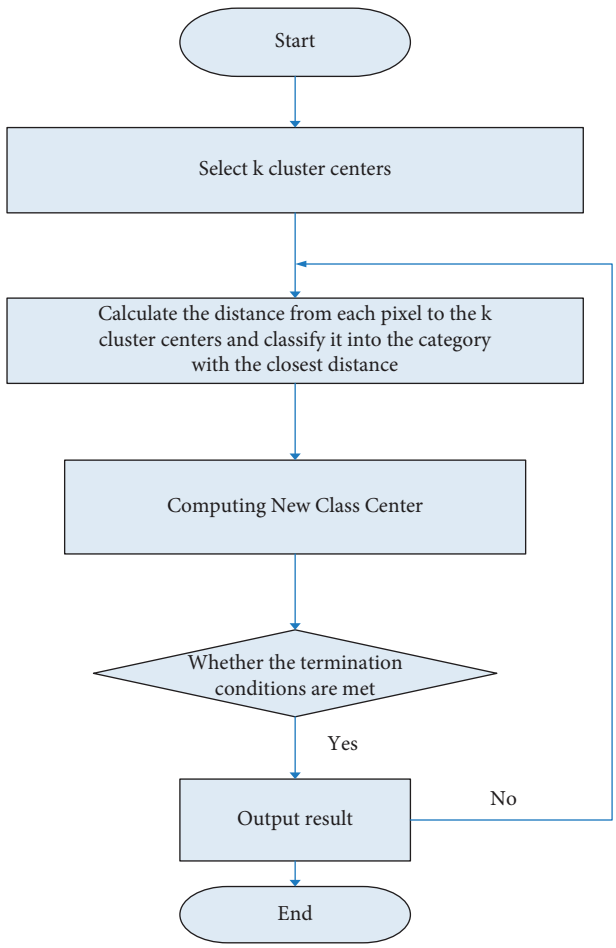

Figure 2: The clustering algorithm flow of k-means.

Table 1: Statistics of the number of investigations and experiments in the target hospital.

	Number of questionnaires	Streamline tracking	Asking for directions experiment	Pathfinding experiment
Hospital 1	39	5/10	5/15	6
Hospital 2	40	5/10	5/15	0
Hospital 3	40	0	0	0
Hospital 4	159	15/30	15/45	0

clustering method takes the local connection characteristics of sample data as the main information source of clustering, so its main advantage is that it is easy to deal with the characteristics of local data.

3. Experimental Research on the Evaluation Method of Wayfinding Signs in Medical Institutions Based on Intelligent Navigation

3.1. Experimental Protocol. In order to make this experiment more scientific and effective, this experiment went deep into four hospitals in a certain place to conduct experimental investigations. This time, a targeted questionnaire was set up according to the different organizational models of the four hospitals. A total of 160 questionnaires were distributed in this experiment, and the experimental data of the target hospitals are shown in Table 1.

3.2. Research Methods

3.2.1. Field Research Method. In this experiment, we went to four hospitals in a certain place, and conducted on-site investigation and analysis of the current situation of hospital users' pathfinding and collected data. These data provide a reliable reference for the final research results of this article.

3.2.2. Questionnaire Survey Method. This experiment conducted a questionnaire survey of four hospitals by setting up targeted questionnaires. This survey adopts a semi-closed method, the purpose of which is to promote the correct filling of the survey subjects. The types of questionnaires in the questionnaire mainly include structured, open, and semistructured. Among them, the semistructured type lies between the structural type and

Table 2: Analysis of the wayfinding behaviors of hospital users in the process of consultation.

	Follow the flow of people	Use navigation	View logo	Ask someone to ask	Identify the direction from space
Hospital 1	4	0	16	19	13
Hospital 2	5	8	8	8	21
Hospital 3	5	0	19	24	12
Hospital 4	2	0	16	19	13

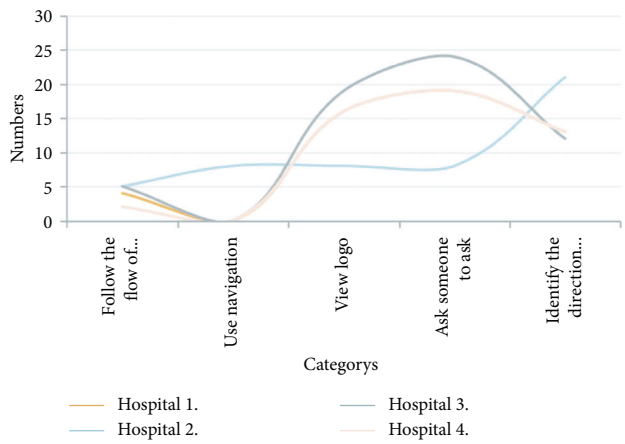

Figure 3: Analysis of the wayfinding behaviors of hospital users in the process of consultation.

Table 3: Analysis of the causes of hospital users getting lost.

	The space is too complicated	Lack of features	Identification reason	Personal reasons	Others
Hospital 1	7	14	9	7	3
Hospital 2	8	15	10	3	4
Hospital 3	10	14	12	1	1
Hospital 4	9	13	9	6	3

the open type. The answers to the questions are fixed, standard, and free for the retractors, absorbing the advantages of both. This kind of questionnaire is widely used in practical surveys.

3.2.3. Mathematical Statistics. Use related software to make statistics and analysis on the final research results of this article.

4. Experimental Analysis of the Evaluation Method of Pathfinding Signs in Medical Institutions Based on Intelligent Navigation

4.1. Analysis of the Wayfinding Behavior of Hospital Users in the Medical Process. In order to make this experiment more scientific and effective, this experiment conducted an experimental investigation on the wayfinding behavior of hospital users through a questionnaire survey. The data obtained are shown in Table 2.

It can be seen from Figure 3 that the most common way for hospital users to find their way when they are lost is to ask someone. There are 70 people, which is far more than one-third of the total number of people surveyed. The people who use the navigation system are the least. Therefore, the feature

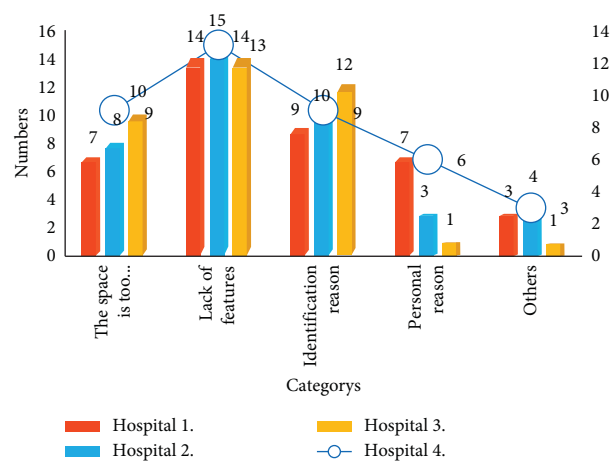

Figure 4: Analysis of the causes of hospital users getting lost.

of space is strengthened. The auxiliary system needs to be solved urgently.

4.2. Analysis of Causes of Hospital Users Getting Lost. In order to further research and analyze this experiment, this research conducted a field investigation on the causes of

hospital users' getting lost. The data obtained are shown in Table 3.

It can be seen from Figure 4 that most of the interviewees believe that the hospital's intricate design, lack of space, and legal features lead to getting lost. The main reason for people getting lost is the lack of spatial features, followed by the more complicated spatial plane. And hospital users believe that the complexity of radial spatial organization is less than that of linear network spatial organization. To sum up, the spatial organization mode of the hospital will directly affect the efficiency of hospital users.

5. Conclusion

This article aims at improving the efficiency of outpatient clinics for hospital users and analyzes the problems between the current hospital public assistance system and pathfinding, and use the indoor positioning algorithm based on MEMS-IMU to study the intelligent medical institution wayfinding navigation system studied in this article. This article conducts on-site investigations in four hospitals in a certain place and concludes that the pathfinding behavior of hospital users comes from the perception of space signs, etc., which lays the foundation for the optimization of pathfinding behavior.

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Conflicts of Interest

There is no potential conflict of interest, and all authors have seen the manuscript and approved to submit to the journal. The authors confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

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Research Article

Research on the Application of 3D Animation Special Effects in Animated Films: Taking the Film Avatar as an Example

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Nowadays, 3D animation special effects are used more and more frequently in film and television works. The integration of its animation special effects enhances the visual impact of the film and makes it easier to resonate with the audience. Movies that use three-dimensional animation special effects have a more prominent performance in both visual effects and artistic expression. Taking the film Avatar as an example, this study is committed to providing a reference for the research of three-dimensional animation effects in Chinese film and television works through the analysis of the practical application effects of three-dimensional animation effects. Three dimensional technology provides technical support for film and television special effects, which has achieved unprecedented development. It combines reality with virtualization, brings virtualization to the screen, and then presents it to the audience, contributing to the progress of Chinese film and television art.

1. Introduction

With the development of computer software and hardware, 3D animation technology came into being, which has brought great changes to the art of film and television. Xu (2019) believes that 3D animation special effects production is a new multimedia technology derived from computer technology [1]. 3D animation special effects technology can ignore the limitations of time, space, place, characters, and conditions and can display complex, abstract, and attractive visual effects or special effects through computer operation, so as to enrich the image of characters or things in the film. In 1977, the dazzling effects and strange space display in Star Wars made people understand the three-dimensional animation special effects technology for the first time. In 2009, "Avatar", which was popular all over the world and achieved a remarkable box office miracle, directly announced the coming of the era of 3D special effects.

Today, 3D animation special effects technology has been quite mature and has been widely used in film and television production, such as animated films, film and television special effects, and stunt lenses. The three-dimensional animation special effect technology can simulate the effect of real objects in the computer virtual environment, reproduce the three-dimensional scene in real life, and improve the beauty of the scene special effect of film and television works. Through the use of three-dimensional animation effects, the level and efficiency of film and television production have been greatly improved. At the same time, the application of this technology promotes the picture effect to achieve a qualitative leap, fully meets the audience's rising visual requirements, makes the audience feel immersive, and thus increases the audience's resonance. Zheng said that using 3D animation special effects technology in film and television postproduction can effectively achieve the expected special effects of film and television works [2]. The three-dimensional animation has rich and diverse expression methods, which enhances the artistic expression and appeal of the works, and breaks through the development of general animation art. Su said that with the support of high-tech technologies such as 3D animation special effects, the lifelike "virtual reality" of film and television works can bring immersive aesthetic experience to the audience [3]. Liu said that 3D animation technology can save film production costs, protect the safety of actors, and produce a stronger visual impact effect [4]. Three-dimensional animation

technology plays a beautifying effect and three-dimensional animation technology can be changed at any time to show the three-dimensional sense of these things. Zhu et al. believe that compared with real shooting or other forms of expression, 3D animation technology can express more abundant pictures and display them more freely [5]. 3D animation technology shows complexity, scientific principles, and abstract concepts in simplified and vivid forms. Du et al. believe that 3D animation special effects technology has brought more forms of expression to film and television work. The use of 3D animation and special effects technology can complete the lens with a high difficulty coefficient in film and television works and the lens that cannot achieve the shooting effect, and improve the viewing experience of the audience on the basis of saving time and cost [6]. Hu (2020) directly said that 3D animation special effects technology provides a shortcut for the improvement of film art [7].

Kong believes that, in a sense, the visual effect of using special effect art in film and television production has surpassed the film itself. It shows that 3D animation special effects for film and television are important for films [8]. Of course, no matter how useful 3D animation special effects technology is, the most important thing for film and television works is strategy and creativity. Wang et al. said that in film and television works, 3D animation special effects technology is only an auxiliary technology and its value is to better express creativity. If it is separated from the strategy and creativity of film and television advertising, 3D animation special effects technology will be nothing new [9].

The focus of this study is to analyze the application of 3D animation special effects in animated films, taking the film Avatar as an example. It is committed to providing a reference for the research of 3D animation special effects in Chinese film and television works through the analysis of the practical application effect of 3D animation special effects, and contributing to the progress of Chinese film and television art.

2. Development and Characteristics of 3D Animation Special Effects Technology

To make 3D animation special effects, we need to establish a virtual space, use a virtual camera to record the motion change trajectory of the whole animation, then render it, and finally complete the complete video screen through special effects and editing. Three dimensional animation has appeared since the 1970s. Its function is to record the movements of dancers. Later, with the development of computer technology, 3D animation special effects technology has developed well. Nowadays, 3D animation special effects have been widely used in film and television works.

3D animation special effects technology is very convenient and fast. The producer only needs to design the object image, adjust the relevant actions, and set the rendering parameters, and the computer will generate a series of continuous graphic documents according to the relevant programs. 3D animation special effects are not affected by the real place, people, and climate and can complete the scenes that are dangerous or impossible to shoot in reality. At the same time, whether it is a scene existing in real life or a fantasy scene, 3D animation special effects technology can present it perfectly; the picture it represents will be very real, so that the audience will not feel contradictory or false. In the movie Avatar, the mysterious and beautiful Pandora planet is made by three-dimensional software, in which the Neville and various monsters are all made by computer virtuality.

3D animation special effects technology is efficient and convenient, but it also has some certainty. As a computer technology, 3D animation special effects technology requires a high level of professional technology for the producers of film and television works. In the production process, with the improvement of the complexity of the production process and the required authenticity, the cost of 3D animation special effects technology will also show an exponential growth trend. Avatar has a total investment of 310 million US dollars, more than half of which is spent on 3D digital technology.

2.1. 3D Animation Special Effects Save Human and Material Resources for Film Creation. When shooting special effect shots of film and television works, producers need to spend a lot of human, material, and financial resources to make scenes, arrange personnel, and shoot pictures. Some special effects shots are dangerous, and after you spend your energy shooting, the picture may not be able to achieve the desired effect. The three-dimensional animation special effects solve this problem well. By using three-dimensional animation effects, producers can produce realistic scenes, characters, or action pictures.

2.2. 3D Animation Special Effects Provide a Variety of Forms of Expression. In the past, in order to create some scenes in film and television works, producers needed to use complex ways to express them, but the final effect of such scenes may not be ideal. Now, because of the three-dimensional animation special effects, producers can use this technology to make realistic scenes and integrate people and real scenes into them, so as to finally produce realistic pictures without conflict, thus improving the artistic value of film and television works.

2.3. 3D Animation Special Effects Can Bring a Real Visual Experience to the Audience. In the past, due to the limitations of film technology, the content of film and television works was difficult to display perfectly, so the audience could not fully understand the aesthetics contained in film and television works. Today, 3D animation special effects technology has broken the restrictions of technology on the development of film and television works. Producers can perfectly restore the pictures they want to describe through three-dimensional animation special effects technology, which will increase the beauty and interest of film and television works and thus enhance the audience's sense of film viewing experience.

3. Artistic Expression of 3D Animation Special Effects

The great changes brought about by 3D animation have made a great breakthrough in lens expressiveness. In the virtual three-dimensional space, the characters, together with various auxiliary devices, present vivid dynamic pictures for the audience. In the film Avatar, adjusting the virtual light can realize the visual feast of light and shadow transformation. Light also plays a vital role in the production of content. As an element of visual art, light and shadow can strengthen the sense of space in the animation scene, promote the three-dimensional scene to be more three-dimensional, and make the picture feel more in depth. A strong sense of context cannot be reflected by ordinary animation or special effects. Both in terms of vision and appeal, it provides a certain reference value for the future development of the animation film industry.

The effective control of light and shadow can better express the inner emotions of animated characters. 3D animation can realize the integration of scenes and characters' inner emotions, adjust colors, and make reasonable changes in light and shadow, so as to enhance the artistic vitality of animated scenes. Therefore, the role of light and shadow in three-dimensional space, model material, and picture effects is irreplaceable. It gives the animation film the soul and makes the animation more vivid and vivid. In the process of character action changes, it also needs to be connected with relevant characters to carry out special effects animation on the whole, presenting a kind of aesthetic feeling on the whole, and dealing with details more carefully to improve the overall quality of the animation film. The audience experiences the processes of immersion, disengagement, and immersive viewing, which can promote the sustainable development of film and enhance the influence of art.

The quality of an animated film depends on the composition of the overall picture. Perception, cognition, and emotion are integrated into the three-dimensional space. The flexibility and diversity of composition give the picture a strong appeal. It not only gives the audience a distinct and impressive visual impression but also plays an important role in promoting the overall aesthetic performance of the film. Three-dimensional animation special effects greatly broaden the expressive vision of animation.

4. Simulation Verification

4.1. Expression Form Analysis of Animation Special Effects. 3D animation technology can perfectly and accurately present scenes that cannot be shown in reality through computer three-dimensional animation special effects. No matter how complex ideas and diverse the ideas are, modeling, special effects, and background texture can be achieved through three-dimensional animation. With the advantages of animation technology, a three-dimensional simulation model can be established to show the three-dimensional effect of virtual objects through the model, creating a beautifying effect, fully displaying the sense of three-dimensional design. Visually, it can also be more intuitive and cool, giving consideration to the scene and details. Visual shock requires the layout of all elements in the interaction between the lens and the scene. Now, we analyze the expression forms of 3D animation special effects and ordinary animation special effects, make charts according to the statistical information, and obtain the following Table 1:

Table 1 shows the statistical results of the two groups of animation special effects in the form of expression. The data results of three-dimensional animation special effects in the sense of form design, the consideration of scene and detail, and the layout of all elements have reached more than 92%. From the comparison of the results, it can be indirectly concluded that the image expression processed by three-dimensional animation technology has more rendering power and observability.

According to the data information in Table 1, Figure 1 is obtained:

As shown in Figure 1, the visualization effect of the two groups of data in the form of an expression is shown. Compared with the data, there is a statistical significance of $t < 10.000$, $p < 0.05$. It is obvious that there is a great difference between the two groups of data and the display of 3D animation special effects is more tense. Therefore, the development and wide application of 3D animation technology can better adapt to the animation film market.

4.2. A Comprehensive Analysis of Two Groups of Animation Effects. 3D technology has given a lot of technical support in animated films, which can preview the design results in advance, see the future display effect, and play a role in boosting the subsequent development of animated films, making the picture more realistic, with more visual impact, complete immersion, and enjoy the beauty of the picture. The addition of three-dimensional animation art has created a new situation for animated films. After the release of the film Avatar, it has caused great repercussions in the society and achieved the best market effect. Revolutionary progress has been made in special effects production, and animated films are an important platform to show advanced production technology. Now, we compare the preview results, visual and auditory effects, and audience satisfaction of the two groups of animation special effects. According to the data comparison results, we make a chart and obtain Table 2:

Table 2 shows the analysis results of two groups of animation special effects in the preview results of special effects production, visual and auditory effects, and audience satisfaction. In the visual and auditory effects, the atmosphere can be rendered through three-dimensional animation special effects, making the story more vivid and three-dimensional. The data comparison is as high as 97%, which improves the visual impact. The content of special effects production is also displayed with high-quality effects.

According to the statistical results in Table 2, Figure 2 is obtained:

As shown in Figure 2, the comprehensive comparison visualization effect of the two groups of animation effects is shown. The general animation effects are lower than the

Table 1: Expression form analysis of two groups of animation effects (%).

Group	Sense of form design	Give consideration to scenes and details	The layout of all elements
Ordinary animation special effects	73.45	70.38	70.19
3D animation effects	92.34	93.78	93.27

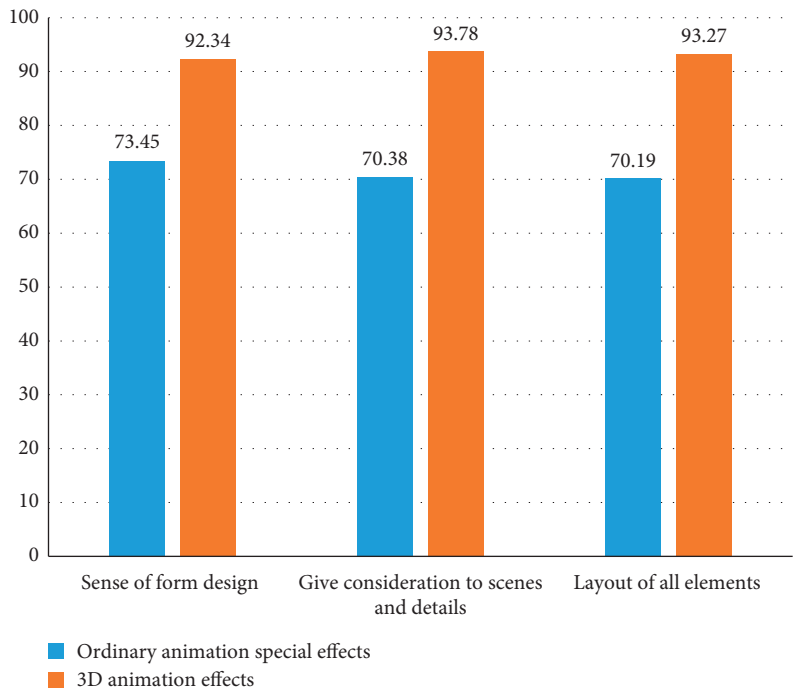

Figure 1: Visualization of the expression form of two groups of animation effects (%).

Table 2: Comprehensive analysis of two groups of animation effects (%).

Group	Preview results of special effects production	Visual and auditory effects	Audience satisfaction
Ordinary animation special effects	69.34	74.39	73.67
3D animation effects	93.45	97.23	95.54

three-dimensional animation effects in terms of public satisfaction, which indirectly shows that the three-dimensional animation effects can better adapt to the broad audience, and the satisfaction of the audience can directly reflect the impact on the willingness to watch the film.

4.3. Effectiveness Verification of Two Groups of Animation Effects. With the rapid development of computer technology, the production of three-dimensional animation special effects has become the main direction of design. Compared with ordinary animation special effects, three-dimensional animation special effects have super-intensity model-building ability, and can visualize the best effects of performance. Under the high-efficiency production content, in the auxiliary elements of the film, the analysis is carried out for the transformation of roles, backgrounds, and lights. Three-dimensional animation has a broader development and application space. The effective collocation of scenes and characters can make the animation more hierarchical as a whole. After the production of 3D animation, it has high flexibility and diversity. Now, the effectiveness analysis of 3D animation special effects and ordinary animation special effects is verified. According to the data results, charts are made and Table 3 is obtained:

Table 3 shows the efficiency analysis results of two groups of animation special effects. The efficiency, pioneering, and diversity of three-dimensional animation special effects in animation films and television are significantly better than ordinary animation special effects. Under the effect of efficiency, it can improve the work efficiency of production and design, and under the effect of pioneering and diversity, it can improve the quality of animation film and television.

According to the comparison data in Table 3, Figure 3 is obtained:

As shown in Figure 3, it shows the effectiveness of verification and analysis visualization effect of two groups of animation special effects. Compared with ordinary animation special effects, three-dimensional animation special effects can be made into an overall moulding result through design ideas and design drawings, which can show the

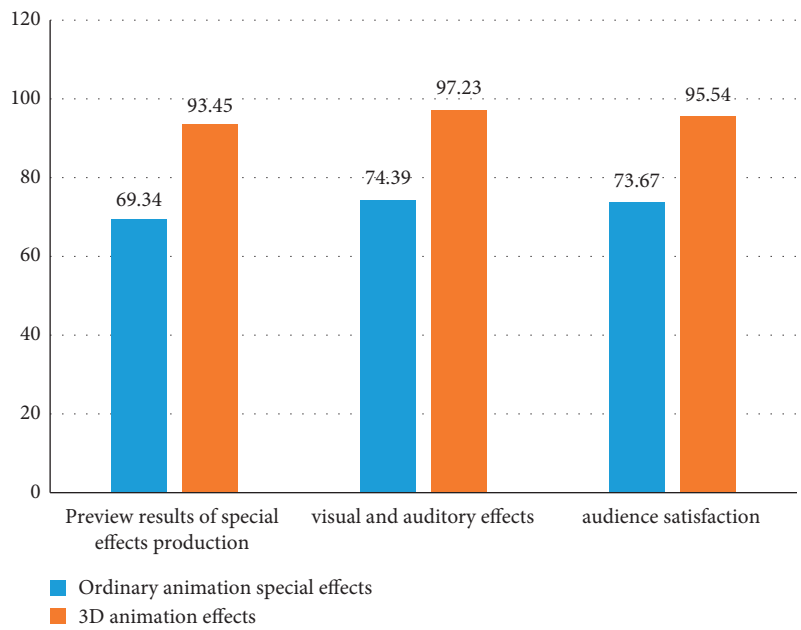

Figure 2: Comprehensive comparison and visualization of two groups of animation effects (%).

Table 3: Effectiveness analysis of two groups of animation effects (%).

Group	Efficiency	Pioneering	Diversity
Ordinary animation special effects	68.73	68.25	67.58
3D animation effects	95.45	94.37	96.31
t	7.564	6.876	7.425
p	0.038	0.042	0.039

specific details of animation production. Modeling and simulation technology can better improve the production efficiency and bring the public novel and vivid feelings from the perspective of multiple performances.

4.4. A Comparison of the Artistic Expressiveness of Two Groups of Animation Special Effects. 3D animation can not only enrich the visual effects of animated films but also have more artistic expressiveness. 3D animation has become the main trend in the future development of the animation industry. Once a little careless, it will directly affect the effects of animated films. 3D technology makes the animation scene effectively combined with the technology in the production process. The light and shadow of animation are constantly changing, as is the integration of characters and places in the background. Under the three-dimensional animation technology, the virtual environment constructed by the model will simulate the light and shadow, background, and characters in a three-dimensional manner, so as to achieve a very intuitive and three-dimensional picture effect. Now, we analyze the artistic expressiveness of the two groups of animation special effects and make charts according to the statistical data information. Table 4 is obtained:

Table 4 shows the comparison results of the two groups of animation effects in light and shadow expressiveness, dynamic and spatial expressiveness, and texture and detail expressiveness. From the statistical results, it can be indirectly shown that the animation artistic expressiveness of three-dimensional technology can be better presented, which plays a good role in enhancing the expressiveness of animation art.

According to the expressiveness in Table 4, Figure 4 is obtained:

As shown in Figure 4, it shows the visual effects of artistic expressiveness analysis of two groups of animation special effects. Compared with different special effects, three-dimensional animation special effects can better promote the development of animation films, better adapt to the development trend of the times, and enhance the influence of this effect in the production process.

5. Discussion

The development speed and level of the animation film industry are constantly improving. The current development of the application of three-dimensional animation special effects has made the film industry have better progress and development. Both the film screen and the production technology have been greatly improved, which has promoted the better expansion of the performance space of the animation film and improved the production effect and level of the overall film. Cai constructed a film special effect animation in a new aesthetic space by taking the theoretical concept of immersion threshold and aesthetic space as the starting point. Combined with the cooperation of visual and auditory, editing, and cooperation, it will show the immersion of film special effect animation in aesthetic space [10]. Huang can improve the clarity of the video picture presented in the computer digital art design of the film by establishing a digital art model, drawing 3D animation

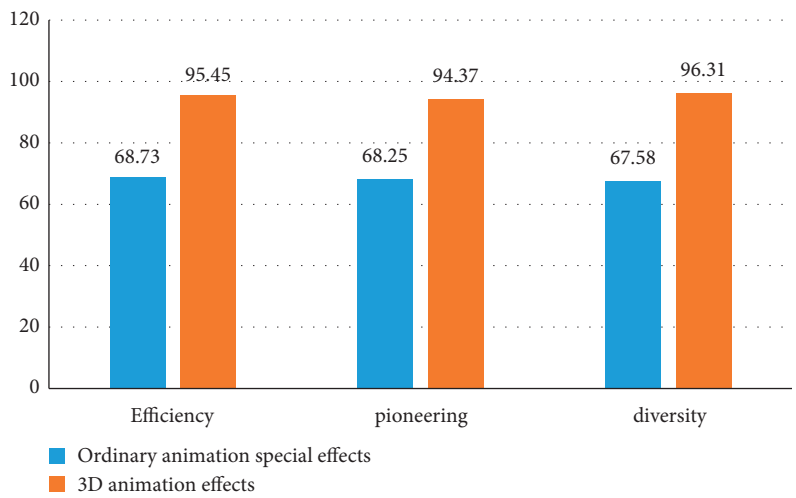

Figure 3: Effectiveness analysis and visualization of two groups of animation effects (%).

Table 4: Comparison of the artistic expressiveness of two groups of animation special effects (%).

Group	Light and shadow expressiveness	Dynamic and spatial expressiveness	Texture and detail expressiveness
Ordinary animation special effects	70.83	78.62	76.34
3D animation effects	92.67	96.51	96.78

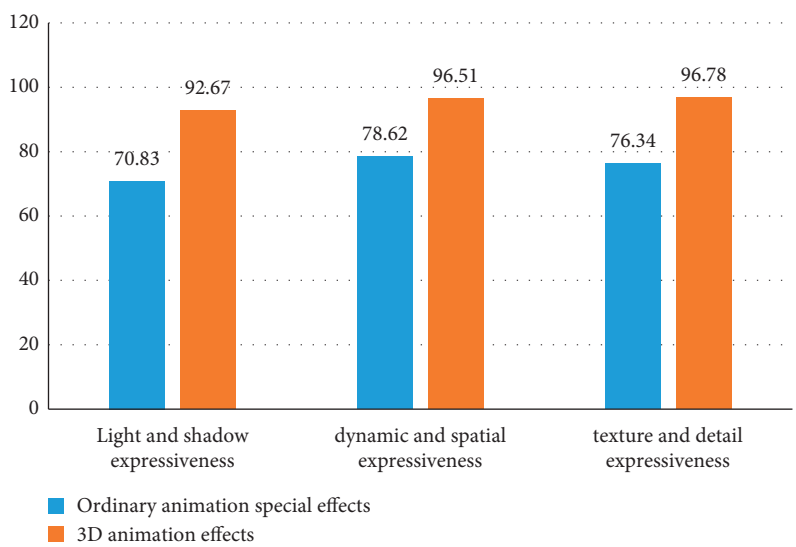

Figure 4: Visualization of artistic expressiveness of two groups of animation effects (%).

special effects, and outputting 3D special effects digital art. Compared with the traditional design method, the texture of the picture has been significantly improved, which verifies the computer digital art design of 3D animation special effects production [11]. Wei discussed the interactive animation special effects production of visual communication design. Many advanced technologies will be used for design and creation, making its animation films more appreciative, better realizing the effect of conveying information, promoting the diversification of film forms, and ensuring the effective implementation of three-dimensional animation special effects technology in the film [12]. Wang pointed out that the application of three-dimensional special effects has become an important manifestation of the extension and integration of animation film art. The unique aesthetics of computer animation and the sensory impact on a broad audience have also promoted the aesthetic picture of virtual reality [13].

Yang et al. showed that the controller has excellent performance in anti-interference and reasonably optimized the parameters of the ADRC [14] The controller is a key part of the whole user experience, especially for the animation

special effects application. Yang et al. can process the image quality through several image processing effect parameters for the adaptive fractional integral mask noise reduction algorithm, which can effectively improve the image enhancement ability of the fractional differential mask [15]. In three-dimensional animation, we make the image more vivid and make the image colour more realistic.

In this study, based on an in-depth study of the impact of three-dimensional animation effects in animated films, this technology has been widely used in the entertainment field: its main applications include film and television special effects and character animation; three-dimensional technology improves the audience's sense of experience when watching animated films. The results show that three-dimensional animation effects not only greatly promote the development of film and television works but also create a new situation for the development of film and television works, bring new vitality to the development of film and television works, and let the broad audience enjoy a beautiful visual feast.

6. Summary

This study takes the film Avatar as an example to explore the application of 3D animation special effects in animated films. The integration of 3D animation special effects into animated films can better shoot animated films, so that they have a realistic sense of 3D visual and auditory effects. 3D animation special effects can not only produce animated films but also complete film and television shots that cannot be solved by real shooting. It will not be affected by weather, seasons, and other factors, and has strong modifiability, and the quality requirements are easier to control. It can play an unprecedented audio-visual impact on the stories and products. Three dimensional animation special effects are integrated into animated films, in order to better capture the realism with three-dimensional visual and auditory effects. Audiences get emotional resonance through the on-screen experience. This empathy ability comes from the impact of sensory and unconscious inner perception activities. The experience process from vision to the heart is the expansion of film creation. By analyzing the forms of expression, artistic expressiveness, and visual and auditory effects of three-dimensional animation special effects and ordinary animation special effects, this study can maximize the advantages of three-dimensional animation special effects technology, make a great breakthrough in the expressiveness of film lens, and promote the sustainable development of the animation film industry [16, 17].

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Conflicts of Interest

There are no potential conflicts of interest in our paper.

Authors' Contributions

All authors have seen the manuscript and approved it for submission to your journal.

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Research Article

A Study of Ethics on Intelligent Nonlinear Prediction Creative Design

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In order to build a safe, credible, responsible, and sustainable intelligent nonlinear prediction creative design system, this paper explores the process of intelligent creative design through four stages of user research, concept ideation, design generation, and design evaluation, then discusses the potential ethical issues in three fields of data perception, experiential computing, and intelligent production in the process of intelligent creative design; and then analyzes the ethical dilemmas that intelligent creative design systems may face. It can establish a necessary theoretical foundation for the upcoming vigorous development of intelligent creative design and set up the situation to rethink design values in the age of artificial intelligence.

1. Introduction

With the rise of technologies such as big data, deep learning, and block chain, artificial intelligence is being fully embedded in all aspects of human society. The creative design industry has also started the process of intelligence, and intelligent nonlinear prediction creative design platforms are constantly emerging. Intelligent nonlinear prediction creative design, referred to as intelligent creative design, is the application of nonlinear prediction models in deep learning to creative design. It focuses on the intelligence of the creative design process and uses artificial intelligence technology to help solve design problems and generate design solutions. At present, it has been involved in user research, concept ideation, design generation, and design evaluation [1], such as Ali Luban, Jellyfish Intelligence, and Qualtrics Experience Management. These applications are concentrated in the fields of graphic design, interface design, packaging design, cultural design, etc. [2]. There are also manufacturers who have begun to test the field of product design and explore technologies such as intelligent geometric modeling methods for functional analysis. However, due to the complexity of product design context and design knowledge representation, there is no available application of product design. The development of intelligent creative design generates more new design paradigms and expands new spaces for creative design and has a far-reaching influence on the creative design industry. On the one hand, intelligent creative design entrusts part of the work to artificial intelligence to make up for the shortcomings of human designers, allowing human designers to focus on more creative work; on the other hand, intelligent creative design greatly enhances the accessibility of creative design by realizing personalized customization automatically and makes it possible for "everyone to be a designer" by lowering the threshold for creative design.

The creative design industry has a completely different attitude towards intelligent design platforms. Technological optimists believe that intelligent creative design will replace more than 90% of the jobs in the field of creative design, while design professionals believe that intelligent creative design can only replace the low-level part of design work, and it is powerless to high-sensitivity and high-creative work. No matter where the intelligent creative design platform goes, the ethical issues brought about by intelligent creative design also need to be considered. On the one hand, early intervention in the development of intelligent creative design can imagine and evaluate the important impact of

intelligent creative design on society and regulate the development of intelligent creative design. On the other hand, the research on the ethics of intelligent creative design is conducive to the creative design industry to reflect on the design value in the era of artificial intelligence and to explore the new possibilities of the creative design industry.

2. Related Research Studies

2.1. Intelligent Creative Design. Intelligent creative design is a new thing, and scholar's research mostly focus on the procedures, methods, and prospects of intelligent creative design. Liu et al. [3] reviewed the methods, trends, and challenges of generative product design since 1998; Tang et al. [4] proposed an intelligent design system framework based on data modules and design modules; Luo et al. [5] proposed the paradigm and value of creative design integrating intelligent technology to enhance the new economy. Concerning the ethical issues that intelligent creative design may bring, the current concerns are mainly reflected in the substitution of creative design work and the intellectual property dilemma that may arise from intelligent creative design. Humans have lost their information advantage over algorithms, and practitioners in the creative design industry and design research scholars are confused about the positioning of creative design in the era of artificial intelligence. In the postmachine learning era, artificial intelligence has the ability to surpass intermediate designers in some specific fields by simulating the thinking activities of designers, which will lead to a crisis in the relationship between the subject and object of designers and artificial intelligence [6]. Is artificial intelligence challenging creative designers without morality? What changes need to be made in creative design in the era of artificial intelligence to adapt to the development of the times? The creative design industry has to face these problems.

Combining the entire creative design process, technologies such as knowledge graphs, deep learning, affective computing, generative adversarial networks, and block chains continue to pour in, all of which support the development of an intelligent creative design from all angles. Creative design requires a lot of knowledge, support, and information input. Human designers constantly combine the input information with their own knowledge and create new solutions through design thinking and skills. Structured knowledge representation is the basis for artificial intelligence to simulate the creative design process. The knowledge not only comes from the design knowledge and skills that creative designers have learned over the years but also from the domain knowledge of design objects and more of the attributes of users, needs, motives, attitudes, behaviors, values, etc. Some knowledge is explicit, and more knowledge is implicit. Through machine learning and deep learning, artificial intelligence imitates the knowledge and skills of human designers and has advantages in structured knowledge simulation. For design ideas and design styles that can be clearly defined, artificial intelligence has a greater advantage than human designers in the transition from 1 to 100, which is called incremental innovation. But the process of breakthrough innovation from 0 to 1 is similar to a black box. The high perceptual thinking of human designers in the design process is still difficult to simulate through algorithms. However, with the advancement of technology, especially in the postmachine learning era, the goal of imitating the design thinking and decision-making of human designers will always be gradually approached, which forces the design industry to face transformation and rethink the value of design. We need to think about how creative design can empower artificial intelligence instead of passively accepting the changes that artificial intelligence will bring to the creative design industry.

2.2. AI Ethics. Ethics is the inquiry into how we live and how we can live better. It is generally believed that ethics refers to the principles and norms that should be followed when dealing with the relationships between people, people and nature, and people and society [7]. Correspondingly, the ethical issues of artificial intelligence include the ethical conflicts between human beings, human beings and nature, and human beings and society. The ethical conflict of human beings itself is manifested in the dilemma of artificial intelligence, causing people's cognition of themselves, the existence of human subjects, and the division of responsibilities between humans and machines. The ethical conflict between human beings and nature is reflected in the uncertainty of artificial intelligence systems in the decision-making between economic benefits and environmental and ecological issues. The ethical conflict between human beings and society is reflected in social inequality, desertification of interpersonal relationships, and the loss of protection of privacy rights. The ethical issues of artificial intelligence have attracted widespread attention from all over the world. UNESCO adopted the Recommendation on the Ethics of Artificial Intelligence in Paris in 2021, which provides recommendations for member states to regulate artificial intelligence governance in terms of values and principles, policy action areas, and monitoring and evaluation. The challenges faced by the development of the new generation of artificial intelligence in China include breakthrough in the theory of artificial intelligence under the interdisciplinary, standardizing artificial intelligence ethics, and building artificial intelligence development ecology [8]. Not only the government and academic institutions but also artificial intelligence companies have begun to explore artificial intelligence ethics. Google has set up a special ethics committee, and Baidu has repeatedly proposed the establishment of sustainable and responsible artificial intelligence in public. However, ethical issues are often highly controversial. The aforementioned Google ethics committee, which is composed of outsiders, was adjusted to consist entirely of company executives within a week of its establishment.

The ethics of artificial intelligence involve various aspects, and its research is also complicated. Iphofen and Kritikos [9] explore how artificial intelligence makes ethical decisions about its behavior and interactions with humans. Wu et al. [8] believe that when artificial intelligence technology encounters ethical problems, both technical experts

and ethics experts feel powerless or unbearable, and it is necessary to carry out interdisciplinary research based on "design scenarios and use scenarios." In general, AI ethics has become a worldwide issue that the industry and academia are worried about. It is difficult for all stakeholders to reach a consensus on many issues, which requires continuous exploration in the field of theory and practice.

2.3. Design Ethics. Design ethics mainly studies the ethics and social responsibility issues in design behavior and seeks the perfect integration of "instrumental rationality" and "value rationality" [10]. Design is dynamic; it is choice, action, and result; it is the unity of purpose and means; and it is also the concrete embodiment of values. The continuous input of information in the design process will affect the results of the design. Designers are always thinking about who to create value for, what value to create, and how to create value. Value and ethics are closely related, and ethical thinking and design thinking have a lot of overlap [11]. Regardless of whether designers are aware of ethical decisions in the design process, their actions are influenced by ethical thinking, and the design results are also constrained by design ethics. How to actively input moral values into design behavior, especially how to deal with complex human nature with rational and systematic design methods, is a problem that needs to be studied in design ethics.

Design ethics pays attention to design issues such as vulnerable groups, environmental sustainability, fairness and justice, and cultural diversity through inclusive design, sustainable design, discursive design, etc. With the advent of the era of artificial intelligence, design ethics research has gradually begun to pay attention to the design ethics of artificial intelligence products and services, providing a basis for evaluating artificial intelligence ethics. Zhang et al. [12] proposed introducing speculative design into the emerging field of technology ethics and incorporating users into the decision-making process of technology ethics through design fiction and thought experiments. Wang [13] believes that data noise may interfere and threaten the principles of social inclusion, fairness, and justice in creative design. Zhou [14] elaborated on the security issues and data privacy issues caused by robots and called on designers to participate in the ethical construction of artificial intelligence. Zhao et al. [15] started with the interaction between intelligent machines and human society, constructed a moral framework for intelligent machines, and discussed the factors of people's moral judgment of intelligent machine behaviors. In the future, design trends such as inclusive design, sustainable design, speculative design, social responsibility design, confrontational design, and discursive design are gradually emerging and put into practice. How to eliminate the negative impact of artificial intelligence through design values has become a design ethics focus of research.

Overall, the intelligent creative design is still at a fairly early stage, and its ethical discussion is not rich. Intelligent, creative design is mainly reflected in three aspects, namely, digital perception, experiential computing, and intelligent production. Digital perception utilizes advanced digital means to capture, regenerate, or synthesize various sensory inputs from the external world, such as sight, hearing, touch, smell, and taste. Experiential computing is the use of algorithms to obtain experience insights such as user behavior, attitudes, and motivations. Digital perception and experience computing are mainly related to user research and design evaluation and are used for mining and analysis of user needs and pain points and analysis and optimization of product behavior experiences; intelligent production is related to concept ideation and design generation and is used to generate creative solutions based on algorithms (as shown in Figure 1). Intelligent, creative design is dynamic. Digital perception, experiential computing, and intelligent production continue to cycle and iteratively move forward. Data, knowledge, and algorithms are accumulated inside and outside the system and promote the evolution of the system itself. The development of science and technology is a double-edged sword. While promoting human economic and social development, it will also raise a large number of ethical issues, such as the data ethics of digital perception, the algorithm ethics of experiential computing, and the design ethics of intelligent generation. To study the ethics of intelligent creative design is to predict the problems in the development process of intelligent creative design in advance, which is of great significance for building a safe, responsible, and sustainable intelligent creative design system.

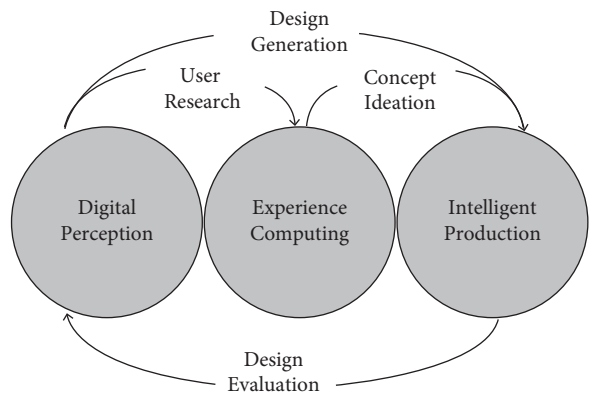

Figure 1: Intelligent creative design process.

3. Data Ethics for Digital Perception

3.1. AI-Enabled User Research. The value creation of creative design is diverse, and design concepts are also in a situation of blooming. Human-oriented needs are always one of the core principles of various design concepts, and trends and needs are the starting point of creative design most of the time. User research runs through the whole process of creative design. It is not only an important way to capture user needs in the early stages of design but also an important means of design evaluation in the later stages of design. In the process of development, design science has produced many user research methods, such as observation, interview, questionnaire, cultural probe, and contextual interview. On this basis, design studies have also developed research tools

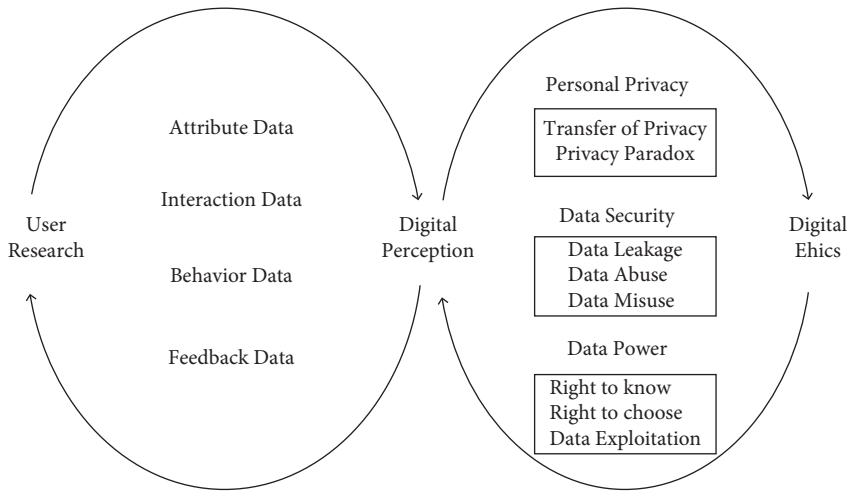

Figure 2: Data ethics for digital perception.

such as personas, customer journey maps, stakeholder maps, value network maps, and ecosystem map. Enterprise communities, such as the Xiaomi community, have not only become a bridge between enterprises and users to maintain customer relationships but also become a catalyst for enterprise product development. Participatory design, as one of the main user research methods that Xiaomi used, aggregates the collective wisdom of various stakeholders through community operations, helping enterprises achieve rapid and efficient product iteration and ecological chain expansion. Artificial intelligence has greatly enriched the sample and data volume of user research, creating conditions for improving the reliability of user research.

User research requires a large amount of data, including user attribute data, interaction data, behavior data, and feedback data. There are various means of data collection, such as biometric data, such as face recognition, voice recognition, fingerprint recognition, and behavioral data such as Internet browsing records. After these data are stored, cleaned, analyzed, and visualized, new insights can be obtained. Participatory design methods have also strengthened the breadth and depth of stakeholder participation with the intervention of artificial intelligence, and various network-based cocreations, crowd intelligence innovation, and collaborative design models have surfaced, which are innovative processes that gather the wisdom of the public to complete complex tasks on the Internet platform. The essence of participatory design is to obtain data by strengthening the participation of stakeholders, to find more data support for creative design and to enhance the customer experience of stakeholders. User research must comply with ethical norms, the informed consent of the subjects must be obtained when selecting subjects, and the scope and means of data use must be declared. These conventional norms in reality have not been implemented with the intervention of artificial intelligence, and data ownership has become a perspective of design ethics research. In addition, users behave differently when they know they are being researched and when they do not know they are being researched, which affects the accuracy of the research results. There is a paradox in this, that is, users who obtain the right to know may have inaccurate feedback on their results, but if they do not obtain the right to know, there will be ethical problems. This ethical dilemma requires the intelligent creative design platform to carefully grasp the content and extent of data collection and prudently handle ethical issues including personal privacy, data security, data power, and data exploitation (as shown in Figure 2).

3.2. Personal Privacy and Data Security. We are generating data all the time, from the cameras that can be seen everywhere on the street; the mobile phones everyone holds in their hands, the face recognition in and out of public places during the epidemic; and the smart home products running at home. Even if you walk into a store to buy an item, you are being monitored. It is just that some people perceive that they are being monitored, while others do not. Some monitoring is to detect attacks in public places and maintain public safety, which has its value; some is to monitor the business behavior of enterprises, purely for commercial interest. With the development of smart technology, endless sensors will surround us in the future. The development of intelligent, creative design requires obtaining user needs through data, and the data we generate is reshaping our lives. People mostly have no concept of what data is being collected, but once reminded, they worry about who is collecting data, what data are being collected, whether it is safe, where it is stored, how it will be used, etc. Therefore, it is not that people do not care about these data, but that they do not perceive their existence; once they perceive their existence, people will worry about the possible adverse consequences. There is also a paradox in privacy issues, that is, on the one hand, users are worried about privacy leakage, and on the other hand, they leak their privacy through various media and continue to transfer their privacy rights through smart homes and social media. The privacy paradox involves not only individuals but also operators and market regulators. Breaking the privacy paradox requires the joint efforts of the above three parties.

When big data is involved in user research, it is necessary to label users. The principle behind it is to monitor and rate users' behavior, but this type of technology is very intrusive. Web crawler technology has become a way of user research. Data capture is ubiquitous, all user behavior is undisclosed, and everyone is in the middle of a prison, desperately trying to climb out of this monitored cage. As Foucault said, "Our society is not a society of spectacle, but a society of surveillance" [16]. Personal privacy involves human dignity, and privacy design principles for user research need to be introduced to ensure that users themselves have the right to know, rather than passive consent. In addition, users have choices about user research. The development of artificial intelligence technology is for the common development of mankind, but there is a contradiction between the integrity of human development and the independence of individual development. The more artificial intelligence technology develops, the stronger the artificial intelligence's control over independent individuals. How to balance public interest and privacy protection of personal interest has become a difficult problem with AI-enabled user research [17]. Under different cultural backgrounds, users have different understandings of personal privacy and the boundaries between individuals and others. To carry out ethical data collection, it is necessary to handle the above problems carefully. For privacy protection, distributed decentralized learning, federated learning, cryptography, and technologies such as translucent information filtering have become important development directions. Of course, the development of technology is always rising in a spiral. If there is monitoring technology, there will be anti-surveillance technology. Ethical norms have become a necessary option for the sustainable development of the industry.

Safety is an important perspective of ethical research, and safety is also a basic principle of creative design, including actual safety and perceived safety. The former is based on efficiency-based safety data, representing the objective degree of safety, while the latter includes subjective feelings such as user trust and control. When users perceive that they are being monitored, their concerns about safety immediately appear, just like psychological tests, people's awareness of insecurity is awakened. Data security in user research is also another dimension that data ethics needs to consider. Data leakage, data abuse, and data misuse will all have serious ethical consequences. Face recognition technology itself is particularly fragile and can be easily cracked. Since the face information itself is difficult to change, once it is leaked, it is difficult to recover; the password can be changed; should the face be changed if the face is leaked? In addition, face recognition technology also has the risk of being abused, such as racial discrimination and behavior prediction. User research powered by artificial intelligence is highly dependent on data, and the digital footprint of users gradually left on the media has become the basic support for user research. Once a data security problem occurs in an intelligent creative design platform, it will have a significant negative impact on the platform itself, users, and society.

3.3. Data Power and Data Exploitation. Data is a resource, and its ability to "predict" the future enables data owners to have data power, while individual users as data producers have quietly become "data tenants." There is an imbalance of power between individuals who generate data and institutions that utilize data, leading to the phenomenon of data exploitation, the essence of which is reflected in the "information asymmetry" between individual users and data capital [18]. Of course, information asymmetry is ubiquitous and not just a feature unique to the data age, but this asymmetry can be enhanced in the data age through data empowerment. As a result, a few oligarchs control all aspects of the economy and society, the threat of data monopoly is approaching step by step, and the contests and conflicts between countries over data power continue to emerge. The design itself is also a kind of power. Designers shape the lives of the public through their work, and even more and more paternalistic designs are born. The power between the designer and the user is inconsistent, and the designer determines the user's specific senses, aesthetic preferences, and user behavior [19]. When there is a clear difference between the designer's decision and the user's preference, the user will have a strong sense of discomfort and express their dissatisfaction with the design through various channels. Data-driven design is the superposition of data power and design power, which is easily manipulated by data capital and deliberately exploits the fruits of human labor. For example, food delivery riders are limited by the data of food delivery platforms such as Meituan and Eleme, which are the most well-known food delivery service platforms in China. Most of them are troubled by multiple problems, such as unreasonable delivery times, retrograde route planning, and high overtime fines. The solution to these problems requires the constraints of ethical norms.

For data exploitation to occur, it must go through the process of design. The involvement of design ethics is of great significance for maintaining fairness and justice. Design ethics emphasizes the social responsibility of design, especially considering the rationality of design behavior itself from the consequences of design behavior. Designers need to have a full understanding of the complexity of the virtual world and the real world and introduce ethical thinking into the data-driven design thinking model through thinking about the balance of stakeholders' benefits. It is necessary to consider the benefits of stakeholders accurately, which are caused by decisions and actions in the context of data-driven design. The interest of human nature, life safety, and moral hazard is considered necessary conditions for design thinking. All parties have not reached an agreement on the ethical norms of design. Most of the ethical designs come from the bottom-up ethical consciousness of designers. Like responsible artificial intelligence, responsible design requires combining theory with practice, so that data-driven design not only needs to be effective and efficient but also needs to have emotional warmth and human care.

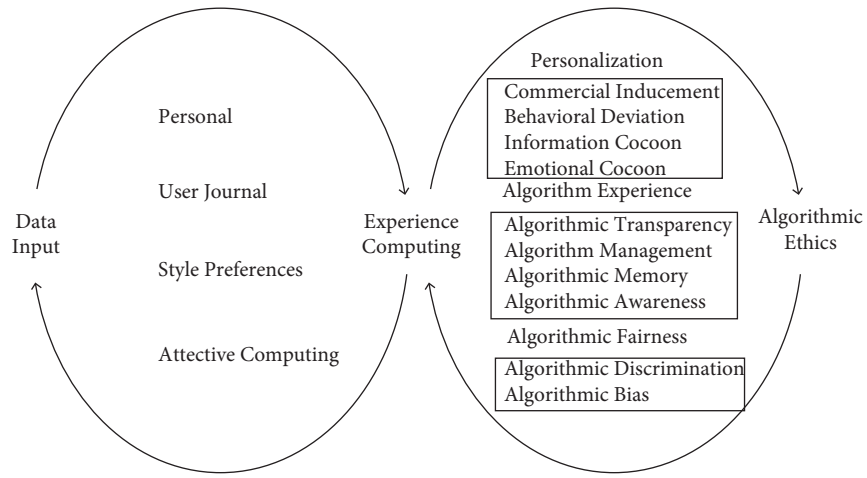

Figure 3: Algorithmic ethics of experience computing.

4. Algorithmic Ethics of Experience Computing

4.1. AI-Enabled Experience Insights. The data itself does not directly generate value, but the transformation of data into meaningful insights through algorithms does. AI-enabled experience insights include persona and user journeys based on dynamic data and design style preferences and evaluations based on imagery boards [20]. A persona is a frequently used tool in the experience insight process, which is defined as a virtual person representing a potential customer or user group, usually created by designers based on insights into real-world situations. The purpose of persona is not only for user-centered design but also for evaluating the user's risk level, business value, etc. In recent years, with the development of data technology, machine learning technology, and the generation of massive data sets, personas summarized by intelligent methods and dynamic personas from generated data have gradually emerged. In addition to personas, there are also tools such as customer journey maps and image boards in the design field to investigate user needs or evaluate design solutions. Artificial intelligence can also generate users' behavior paths to obtain users' usage patterns and combine customers' image boards to obtain customers' aesthetic preferences. Personalization has become a selling point for many companies; therefore, thousand interfaces could be provided for a thousand people. The principle behind it is that companies realize dynamic personas based on algorithms. Massive data generates dynamic personas and customer journey for typical users, which improves the accuracy and precision of services for enterprises. This kind of personalized service is not a true reflection of users' interest but often a behavioral deviation caused by commercial inducement. With the change of the situation, the personalized service derived from the algorithm can easily make the user fall into the dilemma of the information cocoon, and it is difficult to guarantee the user's long-term benefit.

AI-enabled experiential insights bring a series of ethical issues. Users are subtly affixed with various labels and lose their autonomy in defining their own identity. Most users are completely objectified, and most users cannot perceive the existence of such "portraits" and naturally cannot understand the operating principles and uses behind them [21]. When users cannot perceive this label, we have reason to doubt the lack of legitimacy and rationality caused by this opacity. If the user perceives this label, it will make the user feel manipulated, and the consumer's sense of security and trust will also be reduced. When people know that they are searching for a certain product on an e-commerce platform, the search results are affected by their spending power and present completely different products. Even if each product has a different price for each different buyer; obviously, they have emotional changes. The sustainable development of AI-enabled experience insights needs to be discussed and handled carefully with regard to these ethical issues; otherwise, it will easily lead to confrontation between consumers and enterprises (as shown in Figure 3).

4.2. Affective Experience and Affective Computing. Emotions are people's inner feelings, which are often expressed through facial expressions, body movements, voice intonation, etc. People can feel the emotional changes in each other through observation. Emotion is also the focus of human-computer interaction and user experience. The emotional experience in human-computer interaction is divided into positive emotions and negative emotions. Positive emotions include resonance, love, desire, enjoyment, optimism, liveliness, confidence, interest, and satisfaction. Negative emotions include grotesque, masochistic, indulgent, unwilling, and sad [22]. Emotional experience is related to user expectations, which is of great significance to design research. In the field of design, tools such as Kansei Engineering have also been developed to measure emotional experience. Kansei Engineering originated in Japan, and it uses rational methods to study sensibility, including aesthetics, emotion, feelings, and sensitivity in a wide range of meanings. Products that can arouse users' positive emotions often have broad market prospects. In recent years, with the development of artificial intelligence technology, affective computing has become a research field of design science,

often used in the design evaluation of products or services, and has gradually become a new tool for design science to develop new products or services.

Affective computing is the application of artificial intelligence technology to the emotional field. By collecting characteristic clues such as facial expressions, body movements, voice intonation, eye contact, even muscle tremors, and subcutaneous blood flow information, people's emotions can be analyzed through specific algorithm models. Affective computing is widely used in the design, education, medical, and other scenarios. Affective computing helps to increase the chance of design success, but the implementation of affective computing requires the help of a large number of biometric technologies. It generally does not inform users that emotional signal acquisition is in progress, nor does it inform users of the results and their scope of use [23]. For ordinary users, emotional information is sensitive and private. In order to prevent harm, many users will control their emotions so that they are not easily visible. If users perceive their emotions being recognized by the machine in real-time, invisible pressure will be given to users, and a contradiction between technological development and user needs will be presented. Therefore, although affective computing is widely used, its development is also plagued by many factors in real situations, and it is difficult to put it into concrete practice.

4.3. Algorithmic Black Box and Algorithmic Fairness. Algorithms are seemed to be mysterious because of their black box nature. Even if users have certain algorithm awareness, it is difficult for users to understand the operating principles and results behind the algorithms. The algorithm is directly related to the user experience of the system to which it belongs. The transparency of algorithm analysis, algorithm management and user control, algorithm memory, and algorithm awareness directly affect the user's algorithm experience. Algorithm experience is used to approach a user-centric view of algorithms and how users perceive algorithms. The algorithm itself is also a concrete manifestation of values. The invisibility of the algorithm leaves room for the black-box operation of stakeholders, which brings problems such as asymmetric benefits and risks. Algorithm creators can shape the product service system according to their own interest, which brings uncertainty to regulation. Therefore, there is an urgent need to develop explainable and understandable AI that takes into account the values of safety, responsibility, explainability, and fairness; eliminates data bias and maintains algorithmic justice; and prevents power alienation.

It is not easy to achieve fairness in algorithms. First, algorithms are implemented by specific people, which may be driven by commercial interests and cause unfairness. Second, humans are biased, and algorithms are created by humans who are particularly vulnerable to bias, which leads to algorithms with inadvertently biased properties. Algorithmic injustice and algorithmic discrimination cause serious social harm. Just like racial discrimination, gender discrimination, and occupational discrimination in reality, algorithms with biased attributes will strengthen this discrimination and bring hidden worries to the development of human society [24]. In addition to the main purpose of the algorithm, the precision, accuracy, and recall rate of the algorithm itself also affect the fairness of the algorithm. The algorithm precision is the ability of the algorithm to produce accurate results, the algorithm accuracy is the percentage of the algorithm that produces the correct result, and the algorithm recall rate is the ability that finds the relevant results through the algorithm. Therefore, the fairness of the algorithm can also be solved to a certain extent through technical paths such as debiasing algorithms. Experience computing is to calculate the user experience state through an algorithm. In order to obtain an accurate user experience state, it is a necessary condition to ensure the fairness and justice of the algorithm.

5. Design Ethics for Intelligent Production

5.1. AI-Enabled Design Production. Data-driven generative design is a methodology for automatically creating a large number of design solutions that meet user standards and requirements through an iterative algorithmic framework [25]. The dynamism and variability of data mean that each data update can bring a different design solution. With the help of generative adversarial networks, the creative design content generated by artificial intelligence has been comparable to the level of human designers and can achieve design content generation from text-to-image synthesis, image-to-image translation, image enhancement, and content style transfer. This will lead to a variety of generative design methods based on shape grammar, CAD parameterization, evolutionary algorithms, and so on. Generative design can imitate most designs using machine learning, style transfer, etc. For example, the design styles of design masters such as Naoto Fukasawa, Dieter Rams, and Luigi Clani can be generated under the algorithm.

Like the designs produced by human designers, AI-enabled design productions are also constrained by design ethics and need to meet design principles such as inclusiveness, safety, responsibility, and sustainability. In addition, computational creativity in the field of artificial intelligence and design computing in the field of design have different understandings and implementation paths for creativity in the era of artificial intelligence. Computational creativity is devoted to simulating human intelligence to enhance machine creativity and developing computational models of human creativity, while design computing is devoted to applying models and algorithms to help designers come up with better ideas; the former is devoted to replacing humans with machines, and the latter is dedicated to turning the machines into tools for human designers. At present, the design level of computational creativity is approaching midlevel designers. In the future, with the advent of the postmachine learning era, whether machines can think as wildly as humans do, whether they have emotional warmth and humane care like humans, we still do not know. However, human beings are also gradually adapting to artificial intelligence, and the generative design it can also become the object of design. Creative designers introduce

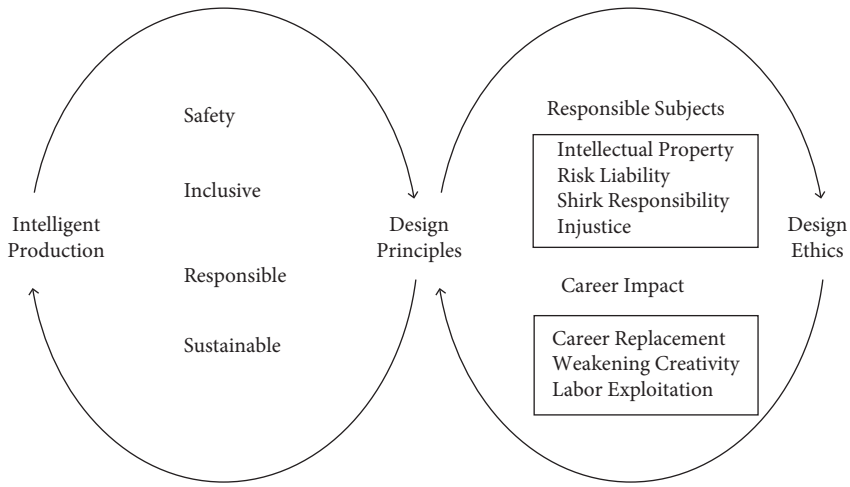

Figure 4: Design ethics for intelligent production.

the principles of generative design into the design process so that the previously standardized design solutions can present the characteristics of customization for thousands of people, extending the possibilities of creative design. Both aesthetics and ethics are branches of philosophy whose ideas are often intertwined. Just as the machine age produces machine aesthetics, the age of artificial intelligence will also produce intelligent aesthetics. The general model of the design aesthetic paradigm based on deep learning has become the power source of intelligent creative design. At the same time, AI-enabled design production also brings ethical issues such as unclear responsibility, unclear intellectual property rights, and an impact on human creativity and designer professions (as shown in Figure 4).

5.2. Intellectual Property Rights and Responsible Subjects. AI-generated designs rely less and less on human input, and even the generated works can be patented, independently which has raised questions about whether AI can be an ethical subject. For a design work, the stakeholders that may be involved include the AI program itself, AI program developers, and AI program users. The "author" in this context faces the possibility of redefining [26]. At present, the copyright ownership of such works in various countries generally belongs to the "people," not the algorithm. However, with the continuous evolution of the algorithm, when the algorithm is fully capable of independent design in the future, how will the intellectual property rights of the work belong? If an algorithm can be the designer of a work or the inventor of a patent with the same rights as a human designer, who is responsible for defects or safety risks in products based on that design or invention? According to the principle that rights come with responsibilities, the complexity of the real situation is far more than this.

The core technology of AI-enabled design production is deep learning. Deep learning is to learn the inherent laws and representation levels of sample data. Imitation and plagiarism will be considered an infringement in real design situations, but how to define the degree of imitation and plagiarism and whether deep learning constitutes infringement is difficult to determine. If the works used to train artificial intelligence are still under copyright protection, it is even more debatable whether these works can be used for deep learning? If the work is suspected of plagiarism, can the algorithm be held liable as the responsible subject? How to take the corresponding responsibility? If the algorithm is the subject of responsibility, then whether there are real "people" who deliberately plagiarize and technically shirk their responsibility. At present, the ultimate responsibility of all countries for the behavior and results of algorithms must always be borne by humans, and algorithms themselves should not acquire legal personality. However, the rights and responsibilities of the stakeholders in running AI, such as designers, developers, optimizers, and users, are not clear. This has resulted in the fuzzy areas of intellectual property rights for intelligent creative design, and these fuzzy areas have hidden dangers for the intellectual property rights of intelligent creative design.

Generative design generates kaleidoscopic design solutions in a short period of time, and for humans, we can define rules and algorithms. However, since the results are unpredictable and difficult to control due to the influence of many variables, it is extremely difficult to effectively monitor such complex results. The artificial intelligence system cannot become the responsible subject, and the real responsible subject cannot supervise the results generated by the algorithm. Attributing responsibility to the responsible subject who cannot implement effective supervision will deprive the responsible subject of the right to defend, resulting in injustice. Creative design solutions in business practice involve many stakeholders, and the consequences of ineffective supervision will bring disorder and confusion to intelligent creative design platforms. "Responsible AI" has become the key to solving such problems. Responsible artificial intelligence strengthens the impact factors of ethics and human controllability in artificial intelligence systems, and "distributed responsibility" has become a new research paradigm.

5.3. Creativity and Career Impact. The design activities of human designers include not only rational, structured knowledge but also perceptual unstructured knowledge,

such as analogies, associations, and emotions. Different designers have different understandings of the same thing and create different design solutions which are also attractive [27]. Delegating some of the productive work to AI allows creative designers to focus on higher value, more creative work. However, with the continuous evolution of intelligent creative design, more and more useful design tools are born, which may cause some human designers to over-rely on tools and technologies, further causing concerns about the relative weakening of human designers' creativity [28]. Theoretically, human design knowledge and skills will be learned and continuously evolved by artificial intelligence systems, infinitely approaching the design capabilities of human designers, and even surpassing the design capabilities of human designers in some vertical fields. This places higher demands on human designers themselves to cope with competition from artificial intelligence and the external environment [29].

With the continuous introduction of various intelligent creative design tools, the work at all stages of creative design is constantly being replaced by artificial intelligence systems. Design professionals disdain this kind of work and believe that creative design still needs to come from the hands of professional designers, but technological optimists believe that artificial intelligence will eventually replace most design work, and human beings are increasingly dependent on intelligent creative design tools. As a result, human beings have gradually become the vassals of technology. The two viewpoints will not prevent the evolution and development of intelligent creative design systems, but they will also provide inspiration for people to rethink the relationship between humans and artificial intelligence.

In the scene of human-machine collaboration, some intelligent creative design platforms incorporate the labor of creative designers into the entire service system and drive the operation of the system through algorithms and mechanisms. It is necessary to be alert to such trading platforms that deliberately exploit human work and creativity through algorithms. How to view the division of labor between artificial intelligence systems and humans and how to establish trust and cooperation between humans and artificial intelligence systems deserve further consideration. With the development of technologies such as virtual reality, augmented reality, and block chain, human life and production methods are facing reconstruction, new demands will emerge, and design will also be facing more new opportunities and challenges.

6. Conclusion

Through digital perception, experiential computing, and intelligent production, artificial intelligence intervenes in various stages of the creative design process, such as user research, concept ideation, design generation, and design evaluation, and guides intelligent creative design to form a closed loop and iteratively move forward. Of course, how to ensure that ethical values such as data ethics, algorithm ethics, and design ethics are embedded at the beginning of the creation of the intelligent creative design platform so as to realize the ethical governance of the sustainable development of the platform is beneficial to all interested parties. Data ethics governance needs to ensure privacy protection and data security in AI-enabled user research, design evaluation, etc., while balancing the data rights of stakeholders and preventing excessive data exploitation; algorithm ethics governance needs to ensure fairness and justice of algorithms, enhance user algorithms' experience, and prevent commercial inducement in the name of personalized customization; design ethics governance needs to distinguish between the intellectual property rights and responsible subjects of intelligent creative design to prevent the excessive exploitation of human designers' labor and creativity. Moreover, the ethics of intelligent creative design also involves many ethical dilemmas and paradoxes, such as the informed consent of user research, the accuracy of conclusions, and the ownership and responsibility of intellectual property rights. These ethical dilemmas and paradoxes require further exploration by more interdisciplinary stakeholders. In the field of design research, design concepts such as speculative design, sustainable design, and inclusive design will provide good soil for the ethical research of intelligent creative design. In addition, building an intelligent creative design ecosystem is also a major approach. The intelligent creative design system is like a spear and a shield. While replacing some design work, it is also generating new types of work, such as design architects. The artificial intelligence ecosystem needs interdisciplinary and cross-field participants. In a healthy AI ecosystem, every player across multiple industries and fields can find their own way to develop [9, 30, 31].

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Disclosure

This article is the research result of the, 2022 Zhejiang Province Philosophy and Social Science Planning Project "Ethical Research on Intelligent Art Design" (no. 22NDJC176YB).

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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Research Article

Water-Saving Benefit Model Analysis of Plain Reservoirs in Arid Areas Based on Nonlinear Data Prediction under Floating Ball Cover

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In order to reduce the ineffective evaporation of plain reservoirs in arid areas, strengthen the effective utilization of water resources, and explore effective water-saving benefit models. *Research methods*: Field tests were carried out with antievaporation floating balls with different coverage rates, and the water-saving rate and economic benefits under floating ball coverage were analyzed. By analyzing the frequency of different wind speeds, daily evaporation under different coverage rates, monthly evaporation inhibition rates under different coverage rates, and the cost of materials used were analyzed. The results showed that (1) during the test period, the total evaporation from the water surface of different cover groups was 149.5 mm, 122.2 mm, 100.1 mm, 81.1 mm, and 63.1 mm, respectively, and the evaporation inhibition rates of different cover groups were 18.4%, 30.8%, 43.4%, and 58.6%, respectively. (2) Comprehensive consideration of the preliminary input and output ratio of the latter determine when the float coverage rate of 50% is the optimal coverage rate, the annual water savings of 5421.86 m^3, the annual increase in production value of 87,700 yuan, and the float in the reservoir site operation for 5 years to reach the recovery period and start to profit. (3) Based on the analysis of the economic indicators of laying floating balls in a large area of the reservoir and the calculation of the sales income and total investment, the results show that the total investment is a sensitive factor, and the project has a strong risk resistance ability. Therefore, the floating ball covering method to inhibit the ineffective evaporation of water surfaces is practical and feasible in terms of reservoir water-saving and economic benefits.

1. Introduction

As one of the most important natural resources, water resources are indispensable when human beings and other organisms are interdependent [1–3]. The total freshwater resources on land account for only 2.53% of the total water bodies on Earth, and most of them are solid glaciers mainly distributed in the north and south polar regions. In addition, in semiarid and arid areas, water resources are an important limiting factor for the local realization of the high-quality development of the "economic ecological" community and the lifeline of Northwest China [4]. Especially in Xinjiang, China, due to the unique climatic conditions, the annual average precipitation in Xinjiang is only about 150 mm, but the annual evaporation is as high as 2000–3000 mm, causing serious water loss to the local plain reservoirs and ponds [5]. Therefore, the evaporation prevention of plain reservoirs in arid areas has very important practical significance. In the arid areas of inland China, the annual precipitation is too low, and the evaporation is too large. Therefore, alleviating the consumption of water resources in arid areas and reducing evaporation are the key issues. The research shows that the physical covering method is ideal for evaporation prevention and water-saving technology for plain reservoirs in arid areas. Scholars at home and abroad have conducted a lot of research on the physical coverage method to suppress the ineffective evaporation on the water surface. In 2013, Benzaghta [6] and others studied the water surface evaporation inhibition rate in the humid climate

area covered by Mengkuang mat, plywood, and galvanized tile plate. The test showed that the evaporation inhibition rates were 40%, 33%, and 26%, respectively. After the test, the water under the coverage was tested and found that there was no adverse change in the water quality; in 2015, California laid nearly 96 million black polyethylene floating balls in the reservoir to reduce evaporation [7]; in 2016, Licun Li [8, 9] and others used PVC foam boards with different coverage areas and thicknesses as covering materials to calculate the water surface evaporation inhibition rate under their coverage; in 2017, Silva [10] and others used floating discs to suppress the evaporation of the water surface of the solar gradient pool; in 2018, Hou et al. [11] conducted an experimental study on different parameters (coverage, diameter, and freedom coefficient) that affect the floating ball evaporation inhibition rate. The results show that the coverage has the greatest impact on the floating ball evaporation inhibition rate, followed by freedom coefficient and floating ball diameter; in 2020, Lizhen et al. [12] compared the magnetic floating plate with the nonmagnetic floating plate with a coverage area of 25%, 50%, and 75%, respectively, and concluded that the evaporation inhibition rate increased by 5.5%, 3.5%, and 1.8%, respectively; in 2020, Shi et al. [13] and others compared the evaporation inhibition rate of floating balls without arrangement under the same coverage area. The results showed that the effect of floating box fence combined with floating balls was better than that of single floating balls; in 2020, Kewu Han [14] and others studied the efficiency of reducing water surface evaporation under PE floating ball coverage.

Previous studies have analyzed the evaporation inhibition effect of different covering materials. The larger the coverage area, the higher the water-saving rate. However, the most important economic benefits in the application of physical evaporation prevention technology have not been analyzed and calculated. Through experiments, the water-saving rate of the evaporator under different coverage of floating balls is analyzed and studied, the most appropriate coverage is determined, and its economic benefits are evaluated so as to provide a reference for physical evaporation prevention technology.

2. Materials and Methods

2.1. Overview of the Study Area. The test site is located in shengjinkou reservoir in Shengjin Township, Turpan City, Xinjiang Uygur Autonomous Region. It is surrounded by mountains, Bogda mountain in the West and North, Kumtag hill in the East, and Queletag mountain in the South. Its unique terrain forms a warm temperate arid desert climate, which is characterized by dryness, windiness, and large temperature difference [15]. The annual average temperature is 15.1°C, the maximum temperature is 49.6°C, and the minimum temperature is -29.2°C. The annual average precipitation is 16.2 mm, and the average evaporation is 2845 mm. The annual average wind speed is 1.1 m/s, and the maximum wind speed is 25 m/s.

2.2. Test Materials. According to the previous research results [16], the homogeneous polyethylene ball with a diameter of 100 mm is used as the antievaporation material. The natural arc structure of the sphere reduces the contact area between the sphere and the object in the heavy wind and waves, reduces the wear of its own materials, and enhances the durability of the materials. A large area of water is easy to form waves. The spherical surface will be wetted when the floating ball moves up and down with the waves, and most of the water on the spherical surface will flow back into the water along the floating ball. Only a small part of the water will be adsorbed on the surface of the floating ball, and the water adsorbed on the surface of the floating ball will be evaporated quickly. The evaporated side wall of the floating ball can still inhibit the evaporation of the water surface [17].

2.3. Test Principle. The main factors affecting water surface evaporation are temperature, wind speed, relative humidity, water vapor pressure, and so on. The temperature rise of the water body absorbing heat will accelerate the movement speed of water molecules, thus overflowing into the air. The increase in wind speed will accelerate the disturbance rate of the surface air, and the water vapor will quickly diffuse to the outside space. The water vapor in the atmosphere is always in an unsaturated state. Therefore, the accelerated migration of water molecules will also accelerate evaporation. The black floating ball can effectively block a large amount of solar radiation and reduce the pressure difference on the water surface so as to effectively prevent evaporation.

2.4. Test Layout. Five circular evaporators with a diameter of 1.2 m and a height of 0.8 m are set on the dam crest of the reservoir, and the floating ball coverage areas are 0%, 25%, 50%, 75%, and 91%, respectively. A small evaporating dish is placed near the evaporator to monitor the on-site evaporation of the reservoir. Due to the different evaporation intensities of the water surface in each evaporator, the water volume in the evaporator will decrease in varying degrees. In order to accurately reflect the evaporation of the water surface, the water in each evaporator will be added to the same height after recording the data at 20 : 00 every day. The water level change is observed by scm-60 water level probe, and the observation accuracy is 0.01 mm. At the same time, automatic weather stations are used to monitor wind speed, atmospheric pressure, humidity, temperature, and other data.

As shown in Figure 1, the layout of the field equipment of the evaporator is shown, and the detection facilities are set according to the field conditions and experimental needs.

3. Results and Analysis

3.1. Wind Speed Analysis. The portable meteorological station is used to observe the meteorological data at the test site, collect the wind speed data during the test period, and make statistics on the days and frequencies of different wind speeds, as shown in Table 1. During the test period, the wind level is 0–1, and the wind speed is 0–1.5 m/s on most days,

Figure 1: Site layout plan.

Table 1: Days and frequencies of different wind speeds.

Serial number	Wind speed m/s	Wind level	Days d	Frequency %
1	0–1.5	0–1	7	3.9
2	1.6–3.3	2	133	72
3	3.4–5.4	3	37	20.2
4	5.5–7.9	4	2	1.1
5	>8.0	>5	5	2.8
Total			185	100

accounting for 3.9% of the total test period; when the wind speed is 1.6–3.3 m/s, the proportion reaches 72% in the total test period; when the wind speed is 3.4–5.4 m/s, the proportion reaches 20.2% in the total test period; when the wind speed is 5.5–7.9 m/s, it accounts for 1.1% of the total test period. During the test period, wind speed greater than 8 m/s will occur for a short time, accounting for only 2.8% of the total days.

As shown in Table 1, according to the statistics of the number of days, wind speed, and frequency of wind speed above levels 0–8, it can be seen that the frequency and number of days of wind speed at level 2 are more.

3.2. Analysis of Evaporation Capacity and Evaporation Inhibition Rate

3.2.1. Evaporation Capacity Analysis. The test period is from March to August 2021, of which May to August is the high evaporation period of the year. The evaporation capacity of the evaporator under different coverage rates during the test period is counted. As shown in the following figure, the evaporation in the test period increases day by day with the change of time. From the 20th day, the evaporation gradually increases with the increase of temperature, reaches the peak value in the test period, and gradually decreases around the 90th day. The coverage rate ranges from 0% to 91%, and the maximum evaporation per day is 2.3 mm, 1.8 mm, 1.7 mm, 1.3 mm, and 1.2 mm, respectively. Compared with the evaporator without coverage, the evaporation is reduced by 21.7%, 26.1%, 43.5%, and 47.8%, respectively.

As shown in Figure 2, the evaporation that began on the 20th day gradually increased with the increase of temperature and began to decline after the 90th day.

Based on the above data, the change in total evaporation can be obtained from Figure 3. During the test period, the

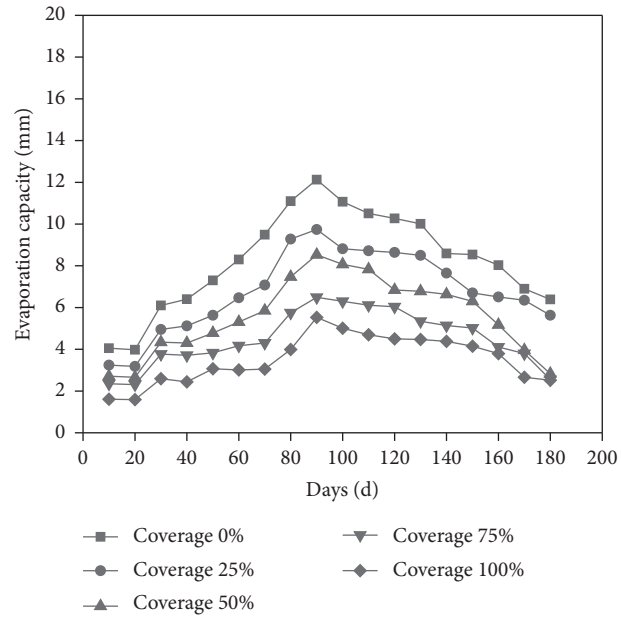

Figure 2: Daily evaporation at different coverage rates.

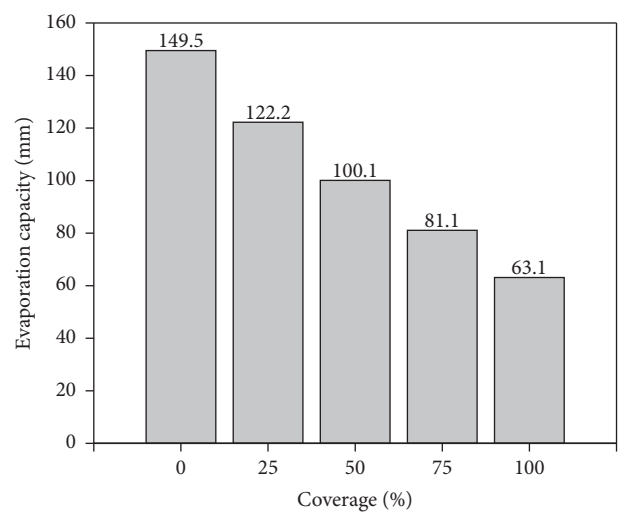

Figure 3: Total evaporation during the test period.

total evaporation from 0% to 100% coverage was 149.5 mm, 122.2 mm, 100.1 mm, 81.1 mm, and 63.1 mm, respectively. The evaporation decreased with the increase in coverage, and the evaporation decreased by 18.3%, 33%, 45.8%, and 57.8%, respectively, compared with the evaporator without coverage.

3.2.2. Analysis of the Evaporation Inhibition Rate. The water surface evaporation inhibition rate is an important index for watersaving in reservoirs in arid areas. See formula (1) for the calculation method as follows:

$$\alpha = \frac{E_0 - E}{E_0} \times 100\%, \quad (1)$$

where $x3b1$; is the evaporation inhibition rate, %; E is the evaporation capacity of the evaporator under the floating

ball cover, mm; E_0 is the evaporation capacity of the uncovered floating ball evaporator, mm. It is calculated that the average evaporation inhibition rate of 25%–91% coverage during the test period is 18.4%, 30.8%, 43.4%, and 58.6%, respectively, and the evaporation inhibition rate of the coverage area increases by 40.2% from 25% to 91%, which shows that the evaporation inhibition rate increases with the increase of the coverage area and vice versa.

As shown in Table 2, the evaporation inhibition rate increases with the increase of the coverage area. The smaller the coverage area, the smaller the inhibition rate.

Table 2: Monthly evaporation inhibition rate of different coverage areas.

Month	Evaporation inhibition rate %				
	0%	25%	50%	75%	91%
3	–	20.0	31.3	40.0	59.1
4	–	22.1	34.1	45.2	60.6
5	–	16.2	27.8	45.1	60.9
6	–	17.3	30.3	47.2	55.0
7	–	21.8	36.6	51.6	64.2
8	–	13.2	24.8	31.0	51.7
Average	–	18.4	30.8	43.4	58.6

3.3. Economic Benefit Evaluation and Analysis. In the popularization and application of floating balls, the most important evaluation index is the economic benefit generated by watersaving, so on this basis, it is analyzed in combination with the field reservoir. The selected case study area is the test site of this study. The Shengjinkou reservoir in Shengjin Township, Gaochang District, Turpan city, has an area of 5775 m^2, and the average annual evaporation for many years is 2845 mm. The polyethylene floating ball used in this test is selected as the paving material, and the unit price of this material is 150 yuan/m^2. Taking the agricultural water in this area as an example, the main local crop is grapes, the land volume per mu is 1500 kg, and the market price is 6.65 yuan/kg. According to the calculation, the material cost price and water-saving benefit are shown in the following table, and the cost calculation formula of the floating ball material is as follows:

$$P_T = S \times T, \tag{2}$$

where P_T is the total price of covering materials, yuan; S is the total area of covered water surface, m^2; P is the unit price of covering material 1 m^2, yuan.

Calculate the annual water saving of the antievaporation covering material by the following equation:

$$Q = \alpha \times E \times S, \tag{3}$$

where Q is the annual water saving under material coverage, m^2; α is the evaporation inhibition rate under floating ball coverage, %; E is the annual evaporation of the test area, mm; S is the water surface area of the test area, m^2.

As shown in Table 3, it is the calculation of water saving and material cost under different coverage rates of floating balls. When the floating ball coverage rate is 25%, the laying area of the water surface is 1443.75 m^2, the material cost is 216600 yuan, and the annual water saving is 3006.67 m^3; when the floating ball coverage is 50%, the laying area of the water surface is 2887.5 m^2, the material cost is 433100 yuan, and the annual water saving is 5421.86 m^3; when the floating ball coverage is 75%, the laying area of the water surface is 4331.25 m^2, the material cost is 649700 yuan, and the annual water saving is 7524.88 m^3; when the floating ball coverage is 91%, the laying area of the water surface is 5255.25 m^2, the material cost is 788300 yuan, and the annual water saving is 9496.47 m^3.

As shown in Table 4, according to the records of the Turpan water pipe station, the average planting area of grape land per household is 13.22 mu. In combination with the output and sales price of grapes per mu, after deducting expenses such as construction cost, material cost, and labor cost, the annual sales volume is the net profit of 91700 yuan.

As shown in Table 5, it is the economic benefit analysis before and after water saving of the reservoir. The total income from planting grapes before laying floating balls is 91700 yuan. After the floating ball is laid, according to the agricultural irrigation water quota of 690 m^3/mu in Turpan, the output increase values of the reservoir under different floating ball coverage rates can be calculated as 30200 yuan, 54500 yuan, 75600 yuan, and 95400 yuan, respectively.

As shown in Table 6, the normal service life of floating balls is set to be 10 years, and the recovery life and income of floating balls with different coverage rates are shown in the table above. Combined with Table 5, the total income of different coverage rates after water saving is calculated. The output increase value of water conveyance irrigation needs to be multiplied by the project benefit sharing coefficient on the basis of the total income. By consulting relevant literature [18, 19], the coefficient is 0.6, and the profits generated by water-saving irrigation are 73100 yuan, 87700 yuan, 100400 yuan, and 112300 yuan, respectively. The recovery period of floating balls with different coverage rates is 3–7 years. Therefore, considering the early input-output ratio, when the coverage rate is 50%, it is the optimal coverage rate, and the output increase value is 87700 yuan.

To sum up, laying antievaporation floating balls in the reservoir can bring good economic benefits. At present, floating balls are only laid in small reservoirs. If antievaporation floating balls are laid in medium and large reservoirs, the water saved by the reservoir every year will be converted into economic benefits.

3.4. Sensitivity Analysis. The construction period of the floating ball on the reservoir is set as one year, and the normal service life is 10 years. Sensitivity analysis is conducted on the sales revenue and total investment. The benchmark discount rate is taken as 8%, in which the total investment includes the floating ball material cost, grape planting labor cost, garden construction cost, and material cost. The sales revenue is the total income after water-saving irrigation and yield increase. The cash flow of the basic scheme is shown in the table as follows:

As shown in Table 7, according to the calculation, the net present value NPV = 32800 yuan >0, and the internal rate of

Table 3: Material cost analysis.

Floating ball coverage %	Unit price yuan/ m^2	Coverage area m^2	Total price ten thousand yuan	Water saving rate %	Water saving amount m^2
25	150	5775 × 25%	21.66	18.3	3006.67
50	150	5775 × 50%	43.31	33.0	5421.86
75	150	5775 × 75%	64.97	45.8	7524.88
91	150	5775 × 91%	78.83	57.8	9496.47

Table 4: Economic benefits' analysis.

Cultivation mode	Park construction cost	Material cost yuan/ mu	Labor cost yuan/mu	Total cost yuan/mu	Yield Kg/ Mu	Unit price yuan/kg	Planting area mu	Net profit ten thousand yuan
Open field cultivation	498.62	1366.83	1174.78	3040.23	1500	6.65	13.22	9.17

Table 5: Calculation of revenue-raising benefits.

Floating ball coverage (%)	Project	Irrigation area mu	Total revenue ten thousand yuan	Total yield increase ten thousand yuan
	Before water-saving	13.22	9.17	
25	After water-saving	17.58	12.19	3.02
50	After water-saving	21.08	14.62	5.45
75	After water-saving	24.12	16.73	7.56
91	After water-saving	26.98	18.71	9.54

Table 6: Float payback period and revenue calculation.

Project	Floating ball coverage %			
	25%	50%	75%	91%
Payback period year	3	5	7	7
Income calculation ten thousand yuan	21.14	27.25	22.68	28.62

Table 7: Basic programme cash flows.

Particular year	0	1	2	3	4	5	6–10
Sales revenue ten thousand yuan	0	8.77	8.77	8.77	8.77	8.77	8.77
Total investment ten thousand yuan	43.61	3.74	3.12	2.44	1.71	0.92	0.26

Table 8: Table of sensitivity factors and critical point analysis.

Uncertainties	Rate of change %	Internal rate of return %	Sensitivity coefficient	Critical point %	Critical value
Basic scheme		10.07			
Sales revenue	+20	17.47	3.67	−19.94	7.02
	+10	12.62	2.53		
	−10	7.41	2.64		
Total investment	+10	7.65	9.27	6.66	12.25
	+5	14.73	−2.40		
	−10	12.89	−2.89		
	−20	16.28	−3.09		

return IRR = 10.07% > 8%. Since NPV is greater than zero, and the internal rate of return is greater than the benchmark discount rate, this scheme is economically reasonable. Carry out uncertainty analysis on the project, select sales revenue and total investment as uncertainty factors, and calculate the corresponding internal rate of return, respectively, as shown in the following table.

As shown in Table 8, the absolute value of the sensitivity coefficient of the total investment is large, and the absolute value of the percentage of the critical point is small, so the

total investment is a sensitive factor. It can be seen from the critical value that when the sales revenue drops to 70200 yuan, the internal rate of return of the project can still be guaranteed to be 8%. At the same time, when the total investment becomes 122500 yuan per year, the internal rate of return of the project can still be guaranteed to be 8%. Therefore, the overall sensitivity of the project is not strong. On the whole, the project has a strong ability to resist risks. According to the above research, it can be found that laying floating balls on the water surface can save water resources and bring considerable economic value to a certain extent. Therefore, the water-saving technology of plain reservoirs in arid areas covered by floating balls is feasible in both water saving and economic aspects.

4. Conclusion

In recent decades, materials and technologies for physical evaporation prevention have been constantly optimized and updated. EPS lightweight concrete slabs, color steel sandwich panels, benzene board composite partition boards [20–22], and plastic hollow slabs [16] in the early stage, as well as subsequent PVC floating plates [23], magnetic PVC floating plates [12], PE floating balls, and so on have good evaporation prevention effects. At the same time, the research on water surface antievaporation technology is also deepening. Therefore, on the basis of previous studies, the following conclusions are drawn through field tests:

(1) In the high evaporation period of the year, the evaporation capacity of the evaporators with floating ball coverages of 0%, 20%, 50%, 75%, and 91% were counted, respectively. With the increase in coverage, the water-saving rates were 18.3%, 33%, 45.8%, and 57.8%, respectively.

(2) Analyze the water-saving and economic benefits under the floating ball coverage and comprehensively consider the early input-output ratio, and when the coverage rate is 50%, it is the optimal coverage rate, the annual water-saving is 5421.86 m^3, and the output increase value is 87700 yuan. The recovery profit can be realized after the floating ball is operated on the reservoir site for 3–7 years.

(3) The economic sensitivity analysis is carried out for the large-area floating ball laying in the reservoir. The sales revenue and the total investment of the project are selected as the uncertainty factors for sensitivity analysis. After calculation, the total investment of the project is determined as the sensitivity factor, and the overall risk resistance ability of the project is strong.

This paper finds that the application of floating ball coverage in small reservoirs has practical significance for saving water resources and improving utilization efficiency and has reference significance for further study of water-saving resources in medium and large reservoirs. To sum up, the technology of floating ball covering to inhibit water surface evaporation can effectively improve the utilization rate of water resources and bring good economic benefits. It has important practical significance and promotion value. It is moving forward with the goal of large-scale promotion on the water surface of the reservoir. The floating ball coverage experiment in arid areas also provides reference basis and data support for the benefits of water resources and conservation technologies in other regions and effectively improves the utilization rate of water resources and technical advantages of our country.

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Authors' Contributions

All authors have seen the manuscript and approved for submission to your journal. The authors confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

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Research Article

Application of Low Bit Rate Coding Based on Nonlinear Data Prediction in Wireless Network Multimedia Communication

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In order to realize the application of low bit rate video coding in wireless multimedia communication, this paper analyzes the principle of video coding and highlights the importance of low bit rate in wireless multimedia communication. For this, the iterative optimization method of contour height map contour, B-spline curve approximate contour, and control points is carried out to ensure that hearing and vision can achieve the clarity of video under appropriate conditions. The results show that compressing the original video to a suitable size for decoding and completing the output in a compatible format can realize the operation efficiency of the encoder and improve the coding speed.

1. Introduction

In the development of multimedia technology, a variety of moving image compression algorithms have emerged, which are mainly used in digital audio-visual systems with high definition. The redundancy of image data mainly includes spatial redundancy caused by the correlation between adjacent pixels in the image, the time redundancy caused by the correlation between different frames in the image sequence, and spectral redundancy caused by the correlation of different color planes or spectral bands. The purpose of data compression is to reduce the number of bits needed to represent data by removing these data redundancy. Video coding is a way to convert a video format file into another compatible video format file through specific compression technology. This compression technology may be slightly different from but very close to the original data. This compression belongs to lossy data compression, which discards as much data as possible to ensure that the file size is as small as possible. It is often used to compress sound, image, and video. Image compression can be lossy data compression or lossless data compression. Lossless compression is preferred for technical drawings, charts, or cartoons, because lossy compression methods, especially at low bit rates, will cause compression distortion. The compression ratio of audio can be achieved without perceptible quality degradation, and the compression ratio of video can be achieved across a large compression ratio with slight observation of quality degradation. When you observe carefully, you will notice the decline of visual and sound quality. The file itself is still largely similar to the original file, but the more compressed the file is, the worse the quality will be. Intraframe compression is also called spatial compression. When compressing a frame of image, only the data of this frame is considered without considering the redundant information between adjacent frames, which is actually similar to static image compression. The lossy compression algorithm is generally used in intraframe compression. Since there is no correlation between frames during intraframe compression, the compressed video data can still be edited in frames. Intraframe compression is generally not very high compression. In visual color, clarity and overall picture sense will also be reduced. Based on this, all kinds of audio and video signals are stored digitally. At the same time, the technologies of information compression coding, multimedia storage, and graphics synthesis and synchronization have developed rapidly. Multimedia communication has become an important means of information exchange. The

feasibility of multimedia data compression includes space redundancy and time redundancy existing in multimedia video signals. There are certain boundaries between the human eye's perception of image detail resolution, motion resolution, and contrast resolution. Multimedia conference and videophone have become popular means of communication. Under the condition of limited bandwidth, low bit rate video coding scheme is obviously the key to realizing high-quality multimedia communication. There will be some difficulties in high-speed transmission and real-time storage of a large number of images and data. With more and more innovative technologies and the demand for high-quality video in wireless communication, low bit rate video coding is an effective rate allocation algorithm. The video bit rate refers to the number of data bits transmitted per unit time during data transmission. In a popular sense, it is the sampling rate. The larger the sampling rate per unit time, the higher the accuracy, and the closer the processed file to the original file.

Guo et al. (2022) discussed that, in order to further improve the compression performance of efficient video coding, a quadratic coding optimization algorithm combining rate distortion dependence and rate distortion characteristics is proposed. The original video coding method is used to encode the current frame for the first time, so as to obtain the number of bits consumed by the current frame and the rate distortion model parameters of each coding tree unit. Video coding includes motion compensation, motion representation, and motion estimation. Motion estimation is a set of techniques to extract motion information from video sequences. Combined with time-domain-dependent rate distortion optimization, significant rate distortion performance improvement is obtained [1]. Jia et al. (2021) found that, compared with the previous standard methods, the efficient video coding standard improves the compression efficiency. On the premise of not affecting the quality of video coding, the application of multilayer feature transfer convolutional neural network greatly reduces the complexity of video coding [2]. According to Zhao and He (2022), there are relatively few data hiding schemes suitable for efficient video coding. Through the video data hiding method, the new video coding elements are embedded in different types of video frames. It has better embedding imperceptibility and higher embedding capacity and has little impact on the bit rate of video stream. Encrypted video has higher visual quality and smaller bit rate increase [3]. In order to improve the reliability of visible light communication link, Ding et al. (2022) actively explored the use of distributed light sources to construct repeated coding multi-input multioutput visible light transmission configuration. Through the simulation test, the transmission power is greatly improved [4]. Note that, compared with the wireless LAN, the "visible light communication" system can use indoor lighting equipment to replace the wireless LAN base station to transmit signals. Its communication speed can reach tens to hundreds of megabytes per second. In the future, the transmission speed may exceed the optical fiber communication. Using dedicated computers and mobile information terminals capable of receiving and transmitting signals, high-definition portraits and animation data can be downloaded and uploaded for a long time as long as they are in the place where the indoor lights shine. The system also has the characteristics of high security. According to Wengang and Feng (2021), today's highly developed social information makes the development of various network technologies more mature and perfect, and various intelligent work has obtained more new development space and power. Aiming at the practical application of multimedia communication technology, this paper deeply expounds the demand, current situation, and key technologies of wireless multimedia communication and explains in detail the application direction of wireless multimedia communication technology in real life [5]. Hu and Zhao (2021) pointed out that the storage and transmission of massive data put forward higher requirements for video coding technology. The application of video compression coding has gradually become a new research direction, which has injected vitality into the development of video coding field [6]. Ning (2022) pointed out that people's requirements for video transmission quality are constantly improving. Through video coding, data compression can be realized, so that video can be transmitted efficiently. In the information age, video codec standards are also constantly updated. This paper discusses the application and performance of new coding technology and looks forward to its future development prospect [7]. According to Song et al. (2021), real-time video communication has become an important research content in the video industry, providing better user experience and lower delay. Low delay video coding is a key part of real-time video communication applications. Reducing the coding delay can effectively reduce the overall delay of the system. The principle and model of rate distortion optimization technology are used to optimize the technical means of coding delay [8]. Image coding methods can be divided into two generations: the first generation is based on data statistics, and the data redundancy is removed, which is called low-level compression coding method, and the second generation is content-based, which removes the content redundancy. The object-based method is called the middle-level compression coding method, and the semantic-based method is called the high-level compression coding method.

2. Principle of Video Coding

The concept of coding is widely used in the field of communication and information processing. Its basic principle is to use some form of code stream to represent and transmit information according to certain rules. The commonly used information to be encoded mainly includes text, voice, video, and control information. For video data, the main purpose of video coding is data compression. This is because the amount of pixel representation data of dynamic images is extremely huge, and the storage space and transmission bandwidth cannot meet the needs of storage and transmission. Starting from an original video, the video is composed of a large number of continuously playing pictures. The content of one second contains 60–70 similar pictures. It needs a large storage space, which is unbearable

for its memory and bandwidth. At this time, we need video coding. Generally speaking, if the dynamic image data is used without compression, the amount of data is very large, which is easy to cause communication line failure and tight data storage capacity. Therefore, codecs must be used when sending dynamic images, when saving video content on DVDs, and when taking images with digital cameras or camera phones with small storage media capacity. Now all the videos we see are compressed by the computer, and the size will not be as exaggerated as the picture. This compression process is the process of video coding. Now the flowchart framework of this process is analyzed as shown in Figure 1.

The flowchart of video coding is shown in Figure 1. The video is divided into images, the image is divided into regions, and the data is intracoded and intrapredicted by the encoder. At this time, there will be some deviation between the predicted data and the original data. At this time, the obtained intraresidual signals are processed through transformation and quantization, and the obtained data are fused into intraprediction. The segmentation prediction image frame appears, and finally the intraframe signal and the processed residual signal are output through the communication road. Image segmentation is the technology and process of dividing an image into several specific regions with unique properties and proposing interesting objects. It is a key step from image processing to image analysis. The existing image segmentation methods are mainly divided into the following categories: threshold-based segmentation methods, region-based segmentation methods, edge-based segmentation methods, and segmentation methods based on specific theories.

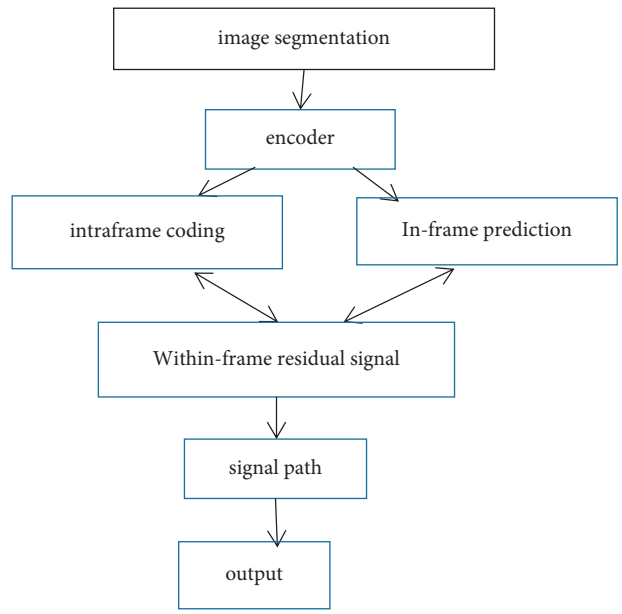

Figure 1: Flow framework of video coding.

3. Importance of Low Bit Rate Video Coding in Wireless Multimedia Communication

People's eyes have different sensitivity to difficulty and color. The change of brightness has a greater impact on the eyes than the change of color. It is difficult to intuitively feel a small amount of color changes in video images. Through multimedia computer technology, according to the visual characteristics of the eyes, a certain color distortion is used to extract the compression of data, and most of the bandwidth is allocated to brightness and a small part to color. In this way, the eyes are comfortable to see these pictures. The interval between two adjacent frames of an active image is very short. Under the premise of a certain error range, most pixels remain unchanged, and the activity has great correlation in time. Therefore, when the image motion is small, using the pixels at the corresponding position of the previous frame to predict the current frame picture can obtain a good effect, in other words, the background picture at the adjacent time point in a video. Many contents in the two frames are the same. When the background picture is not moving and there is only the microwave animation surface of the main picture, the recording can be slightly relaxed when storing or transmitting the video. The complete information of the two frames only needs to retain the recording part. At the same time, the image is composed of pixels, and a large number of repeated pixels will appear for these pixels. When an object is moving rapidly, when the image seen by the human eye disappears, the human eye can still retain its image for about 0.1–0.4 seconds. This phenomenon is called visual persistence, a property of the human eye. When the human eye looks at an object, it is imaged on the retina and input into the human brain by the optic nerve to sense the image of the object. At this time, one pixel can be used to replace most of the same pixels, which can be more convenient in video compression. Transform coding is used to eliminate the redundant information of pixels in the image to release the storage space. The flow frame diagram of this process is analyzed, as shown in Figure 2.

Figure 2 shows the extraction of important information of your picture when using change coding. When the background picture is the same, according to the video with small change in the main content of the picture, when the picture distinction between each frame is very small, you cannot keep the record of this time but you only need to encode the changed part in the adjacent video frame, so as to reduce the storage capacity.

The latest development of low bit rate video coding and video compression combines the elements of coding, which is mainly based on the principle of segmentation. The basic idea of region growth is to assemble pixels with similar properties to form regions. Specifically, first find a seed pixel for each region to be divided as the starting point of growth, and then merge the pixels with the same or similar properties in the neighborhood around the seed pixel into the region where the seed pixel is located. Region growth needs to select a group of seed pixels that can correctly represent the desired region, determine the similarity criteria in the growth process, and formulate the conditions or criteria to stop the growth. Allowing the decoder to reproduce the required information shape from the previously received information, a low bit rate video coding technology is

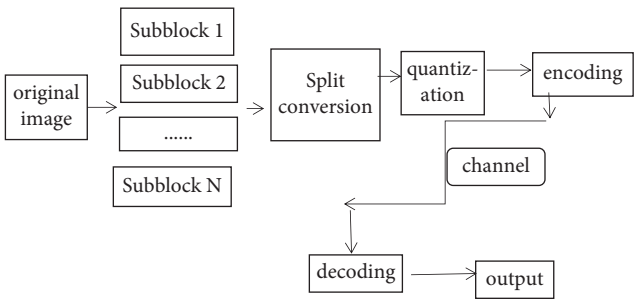

Figure 2: Flowchart of the transformation encoding.

adopted. The efficiency of low bit rate video coding technology compared with other methods in compression efficiency is shown. The principle of low bit rate coding stipulates that the time information can be used to further reproduce the bit rate of the contour information. In wireless multimedia communication, the assets of multimedia objects can be decoded and low bit rate video coding technology can be used to retain useful information.

In wireless multimedia communication, video coding is an indispensable part. To realize the real-time transmission and processing of video and audio signals, its powerful function and broad application prospect are worth popularizing. It can effectively store and transmit the information required by multimedia, and the fusion of voice and audio, image, video, text, and data can retain and record useful information according to the fluctuation of code rate. For the auditory perception correlation of this composite information, the real-time performance requirements are higher. To ensure the quality and normal progress of communication, it is necessary to effectively compress the multimedia data. The development of information technology is to realize big data sharing, which can actively promote the continuous development of social economy, produce immeasurable value for social development, comprehensively promote social progress, and improve people's quality of life. Data comes from all aspects and data formats are diversified. In the era of information technology, low bit rate video coding plays an important role in wireless multimedia communication. The trends of big data include the resource of data, the deep integration with cloud computing, the breakthrough of scientific theory, the establishment of data science and data alliance, and data management becoming the core competitiveness.

4. Method and Verification

According to the contour height map contour, the contour effect is directly created to realize the interactive feedback of animation and pictures. The digital contour can be accurately defined as an ordered set of eight connected pixels located on the object boundary. Contour coding techniques and methods need to be universal as much as possible. Bit rate allocation makes it possible to effectively allocate it to various types of information, which can be encoded as texture, motion, or contour. The lossy algorithm or approximate algorithm can be retained according to the mentioned required features, less dependent on the symbol and position of the contour in the contour direction, and will not affect the starting point. Specifying the contour quality according to the maximum value of the approximate contour is not always appropriate to deviate from the original error. The method must be flexible enough to adapt to a wider variety of contours that may be encountered in the model failure region of natural objects and code rate coding features. The main image area is drawn according to the image segmentation, and then the corresponding image processing is carried out to effectively remove the interference signal, which directly simplifies the calculation complexity and saves the operation time and storage space. Compared with other image segmentation methods, histogram-based methods are very effective image segmentation methods, because they usually only need one passing pixel. In this method, the histogram is calculated from the pixels in the image, and the peaks and troughs of the histogram are used to locate the clusters in the image. Color and intensity can be measured.

Based on B-spline curve contour approximation, a discrete contour can be well approximated by using a polynomial of two-dimensional $p(i) = [x(i), y(i)]$. Describe a uniform cubic B spine, which can continuously run through the first and second derivatives. To a large extent, the largest S control term and points (Ci, x, Ci, y) ($i = 1, s$) (I = 1, s) are required. The initial definition of B-spline curve is based on difference quotient. This definition method contains complex mathematical formulas, and the results are numerically unstable. Deboor uses the recurrence relation of B-spline as the starting point to define B-spline, which is a definition formula completely different from the difference quotient method. B-Spline can be divided into uniform B-spline basis function and periodic B-spline basis function according to different nodes. Each segment shares at least three main control points with the segment of N, and it is easy to obtain the main contour in the locally available spline. The best definition of B-spline cubic spline is the formula: $x(i) = 1/6 [C_i - 1(1-u)^3 + C_{\mathrm{i}}(3u^3 - 6u^2 + 4) + C + 1(-3u^3 + 3u^2 + 3u + 1) + C_{\mathrm{I}} + 2u^3]$, where ($i$) approximates the number of segments required for a given counter and the relationships existing between the subsets of samples collected on the original profile. The attitude measurement is made by the approximate contour and the original contour in the outline given by the formula. A B-spline assessment for the maximum deviation was obtained, as shown in Table 1.

Table 1 shows the B-spline evaluation with a maximum deviation of 1 pixel for the external object encoded by the condition chain and the internal object of the external object. In the low bit rate video coding of wireless multimedia communication, transmission to the decoder occurs, and the approximate spline does not need to be manufactured to pass through the original contour points starting from the endpoint of the line segment. The continuity of nonuniform rational splines includes position continuity, tangent continuity, curvature continuity, and geometric continuity.

The data signal can be divided into single-pixel mode and double-pixel mode. The data is divided into two transmission processes: odd pixels and even pixels. At

Table 1: A B-spline assessment of the maximum deviation.

Objects	Chain codes which are conditional	Best spline cases (with and without VLC)	Best case for splines (with and without)	Best spline cases (with and without the VLC)
Block	1.07	0.8/0.56	0.62/0.53	0.76/0.17
Model area of failure	1.64	1.75/1.32	1.51/1.76	0.19/1.23
Hand	1.54	0.92/0.78	0.87/0.73	0.77/0.57
Contour	1.32	1.09/0.16	0.65/0.56	0.67/0.76
Average over 16 objects	1.50	1.05/0.87	1.02/0.53	1.02/0.67

present, the block, contour, model area failure, and hand object of single-pixel and double-pixel data are compared, as shown in Table 2.

Table 2 shows the values of single-pixel deviation and double-pixel deviation of different objects. The deviation value of a single pixel widens the gap on the fault model area and the average of more than 16 objects, and other deviation values are not obvious. There are little differences between the deviation values of two pixels. In order to better observe the failure of single-pixel deviation and two-pixel deviation in blocks, contours, model areas, and the comprehensive comparison of hand objects, the above table data is visualized, as shown in Figure 3.

Figure 3 shows the comparison of data information of single pixel and double pixels in different modules. It can be seen more clearly and intuitively that there is no obvious difference between data in block and contour module. The gap is opened in the area module of fault model. Block coding is a method defined in the protocol for web users to submit data to the server. When the server receives data in chunked coding, it will allocate a buffer to store it. If the size of the submitted data is unknown, the client will submit data to the server in a negotiated block size.

For the iterative optimization of control points, it is necessary to adopt a more carefully considered method to take the average of the square distance between the approximate value and the original B-spline. When dealing with the new low bit rate video coding technology, we need to more carefully consider making the contour adapt to the specific characteristics of local objects, highlight it more, and ensure higher definition. The deviation of approximate contour is usually so significant, and rapid and more intensive sampling is used. When the deviation between the original contour and the approximate contour is obvious, the sampling rate can be quickly captured. In adjacent frames, the previous frame and the next frame may lead to the deviation between the original contour and the approximate contour. Finally, merge the main screen in the guarantee screen.

In wireless communication systems, due to distortion, it is easy to obtain high bandwidth signals and a large amount of bandwidth availability, that is, in optical networks. For wireless communication, the great availability of different spectrum limits many service providers to encoding at a constant low bit rate to meet the huge demand of customers in the increasingly limited bandwidth frequency range.

5. Discussion

In recent years, with the rapid development of digital communication and computer technology, multimedia services have further developed. When transmitting video information, we will face a large amount of original image signal data, which will further promote the innovation of memory storage capacity, communication channel bandwidth, and computer processing speed. Using advanced video compression technology, we can improve the accuracy of captured motion compensation, improve the pixel accuracy, make full use of the correlation of motion vector to improve the prediction quality, reduce the fast module effect, and simplify the coding of some additional information. It saves storage space and improves the transmission efficiency of communication, which can meet different users in network communication, speed up the algorithm, and further speed up the coding efficiency of the encoder to realize the real-time transmission of video. Yuan et al. (2021) proposed a fast search algorithm based on rate distortion optimization to improve the speed of video coding and reduce the computational complexity, so as to significantly improve the coding speed without sacrificing the rate distortion performance [9]. Wang et al. (2013) proposed a real-time transmission and compression scheme of low bit rate remote monitoring video based on fixed background in view of the existing signal transmission problems in the case of extremely narrow wireless communication channel. The moving object extraction and interframe motion compensation under fixed background are improved to improve the compression and transmission efficiency of video image and realize the real-time transmission of remote monitoring video [10]. Gong et al. (2021), aiming at the problem of low coding efficiency encountered by the rate control algorithm in the efficient video coding standard, proposed an efficient video coding image level rate control algorithm considering the reference dependence of the whole frame. According to the reference dependence between frames, a distortion model of surveillance video considering the reference dependence between frames is constructed, the optimized target rate allocation weight corresponding to each image is obtained, and an image level rate control algorithm suitable for surveillance video is proposed [11]. According to Cheng (2022), with the development of social economy and science and technology, people have ushered in the Internet information age. In this era, modern communication

Table 2: Module object comparison between single pixels and two pixels.

Object	Deviation of a single pixel (with and without VLC)	The deviation of double pixels (with and without the VLC)
Block	0.7/0.61	0.65/0.51
Model area of failure	1.97/1.25	1.23/0.95
Hand	1.05/1.09	0.61/0.63
Contour	0.96/0.75	0.53/0.52
Average over 16 objects	1.15/0.87	0.84/0.75

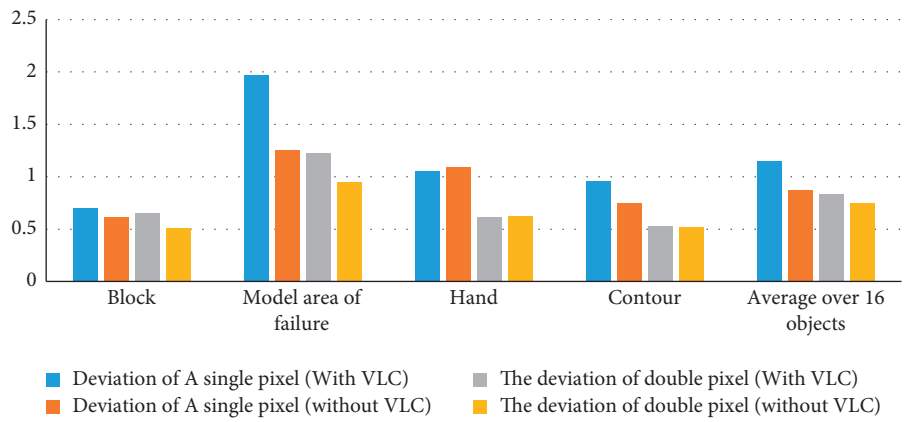

Figure 3: Visualization of module objects between single pixels and two pixels.

technology has been popularized and applied in many industries and has also become an indispensable part of people's life and work. With the popularization of wireless technology, it not only breaks through the limitations of traditional technology in time and space but also facilitates people's communication and interaction, which also promotes the development of communication technology to a great extent. It not only improves the problems of single communication application form and small coverage but also meets the diversified needs of people's information exchange [12].

6. Conclusion

Based on the wide application of video coding, the demand for video and audio has increased sharply, which has brought certain pressure to data storage and network transmission. Based on this, higher requirements are put forward for the stable and efficient storage and transmission of massive video data, so as to integrate sound, text, and image and provide users with a better sense of experience. This paper studies the application of improving the coding efficiency of video encoder under low bit rate in wireless communication. Through the iterative optimization method of contour height map contour, B-spline curve approximate contour, and control points, it is concluded that low bit rate video coding is a very profitable field in multimedia communication. In order to improve the compression of video coding and improve the technical guidance for future video coding standards, with the support of communication technology, we better promote the development of high-quality compression of video signals and have broader development prospects in wireless communication technology.

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Conflicts of Interest

There are no potential conflicts of interest regarding the publication of this paper. All authors have reviewed and approved the final manuscript. The authors confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

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Research Article

Application of Patent Right and Trademark Right in Packaging Design Based on Computer Nonlinear Prediction Systems for Virtual Reality Technology

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Comprehensively strengthening the protection of intellectual property rights (IPRs) and stimulating the vitality of innovation to foster a new development paradigm, innovation is the primary driving force behind development, and protecting IPR is equal to protecting innovation. China is changing from Chinese products to Chinese brands, the need to comprehensively strengthen IPR protection from the perspective of national strategy, so as to promote the building of a modernized economy, stimulate the innovation vitality of the whole society, and foster a new development paradigm. This paper is based on application of patent right and trademark right in packaging design based on computer nonlinear prediction systems for virtual reality technology; from the perspective of intellectual property protection and innovation promotion, combining with several cases of packaging design in computer nonlinear prediction system, this paper expounds different forms of intellectual property creation in packaging design practice, and the irreplaceable important role that intellectual property protection plays in the follow-up market operation of products. At the same time, the combination of computer nonlinear virtual reality technology and packaging design can provide more powerful support for the creation and experience of commodity packaging virtual world, emphasizing the importance and urgency of the creative industry to improve the knowledge level of intellectual property, and the ability to create, apply, and protect intellectual property.

1. Introduction

As an important part of the product packaging process, packaging design plays a pivotal role in the presentation of products. At present, the packaging design of many products in the market is mostly focused on the use of flat visual elements, and the homogeneity of such innovation is high, and the possibility of innovation is limited. Virtual reality technology is a highly integrated technology, with strong industry extension and high innovation-driven value. It is very important to master the development and evolution trend of virtual reality technology [1]. Virtual reality (VR) integrates immersion, interactivity, and imagination, using software and hardware devices to provide users with simulated reality experience. Virtual reality technology is widely used in education, architecture, entertainment, and tourism [2]. In order to improve the competitiveness of virtual reality industry, it is necessary to correctly forecast and guide the development trend of virtual reality industry with the support of industrial policy [3].

As the core of intellectual property, patent is the carrier of virtual reality technology innovation. In the global competition of science and technology, it is of great significance to obtain important strategic information of science and technology through patent analysis and formulate the development policy of virtual reality industry scientifically [4]. Chinese scholars select virtual reality technology patents to conduct empirical analysis, understand the trend

of technology research and development, find gaps in technological innovation, and effectively predict the trend of industrial development [5].

With the gradual popularization of the concepts of "big data" and "data nonlinearity," traditional industries in China begin to pay more and more attention to the cross-border integration with the Internet [6]. This trend is very significant in recent years. However, in the era of big data, the globalization, openness, and data sharing characteristics of Internet bring certain risks to individuals and enterprises in the process of trademark registration [7]. The traditional trademark registration strategy has been unable to provide effective protection for the business security of enterprises, and the incidence of trademark infringement cases is gradually rising [8]. Therefore, corresponding solutions should be formulated.

The nonlinearity of trademark information data is the basic premise for the effective application of trademark big data technology [9]. Although there are certain differences between digital and digitalization, it will certainly promote the process of trademark information digitalization [10]. At present, China has made some achievements in many aspects, such as nonlinear electronic trademark data and network interaction mode, but the trademark information system in China is still lagging behind compared with developed countries, and the data interaction mode and network inquiry system need to be optimized.

Computer virtual reality technology is a comprehensive information technology developed in the twentieth century. This technology not only inherits the connotation of traditional artistic beauty but also integrates multiple factors such as three-dimensional and thinking space. Some industries even integrate touch and smell [11]. And the enterprise is the main body of innovation, to stand firm in the increasingly fierce market competition must have the core technology and intellectual property rights based on continuous innovation. Enterprises need to find another way to constantly dig new innovative points to impress consumers [12]. With the help of IP-assisted design innovation, it will play an irreplaceable and critical role in the future design innovation process.

2. Materials and Methods

In the era of rapid development of science and technology, intellectual property rights are increasingly valued by everyone. Intellectual property is a lever for the state to weigh the relationship between the inventor and the public interest by legal means. On the one hand, perfect legal system and innovative environment stimulate the enthusiasm of innovators to invent and create, so that the wisdom achievements can be properly protected. On the other hand, through the way of disclosing technical solutions for protection, the public can understand new technologies and inventions in the industry, and finally activate the market economy and promote the development of social economy.

Depending on the type of innovation results, intellectual property rights are broadly divided into industrial property rights, which protect the form, structure, and technical solutions of industrial products, and copyrights, which protect works of art and fine arts (Table 1).

Table 1: Intellectual property type.

Type	Intellectual property type	
	Type	Protection object
Industrial property	Appearance patent rights	Appearance
	Utility model rights	Product structure
	Patents for inventions	Technical solutions
Copyright	—	Fine art works Art works

The purpose of intellectual property protection is not only to protect but also to improve the core competitiveness of products in the market economy through the protection of wisdom results so that the market can be dominated and profits can be made [13].

At the same time, the use of intellectual property tools and knowledge is also the key for businesses to avoid price wars to do differentiated good products. Intellectual property is a weapon to defend rights and a tool for product marketing. Therefore, intellectual property is a systematic thinking from application and protection to use.

Then, understanding the differences in the objects of various types of intellectual property protection at the beginning of the design can provide a clearer creative direction for the design. This forward thinking will greatly enhance the innovative value of the design.

2.1. Graphic and Packaging Design. Most of the packaging used by the vast majority of businesses in the market today are mostly IP images, illustrations, patterns, and patterns arranged on the box. The focus is on the graphic content of the flat class presented in the various parts of the box. Such designs can be protected by design patents in the form of six views of the box's appearance, or by copyright in the form of artwork of the box's unfolding diagram (Figure 1). The different combinations of such graphic elements make the packaging design content homogeneous, and it is difficult to judge the originality of the content elements. Therefore, these types of designs are easy to be copied [14].

(1) Design patent right: design patent belongs to the same type of industrial property as utility model patent and patent for invention in intellectual property. Appearance design refers to the new design, which is full of beauty and suitable for industrial application made on the shape, pattern, or its combination of products and the combination of color, shape, and pattern. The appearance design focuses on protecting the creativity and uniqueness of the shape embodied in the appearance of the product, and attaches greater importance to the presentation of the aesthetics of the product. The functional structure of some products determines the appearance of the product form [15].

Figure 1: Content packaging design.

(2) Copyright: the object of copyright protection is the work, not the product. It is an intellectual achievement in the field of literature, art, and science that is unique and can be reproduced in some tangible form. Copyright protection focuses on the originality and aesthetic value of the work.

In China, the principle of "automatic generation and voluntary registration" is applied to copyright. Most businesses use illustrations, patterns, IP images, and other forms of packaging generated by the focus on the aesthetic value of the packaging. At present, most product packaging, hand-drawn drafts, and drawings are recognized as art works, and many enterprises have given priority to adopt copyright to protect product packaging because of the quick timeframe and short cycle of copyright processing. And the packaging for copyright protection can be in the form of package development drawings (Figure 2).

Figure 2: Copyright protection form of packaging box development drawings.

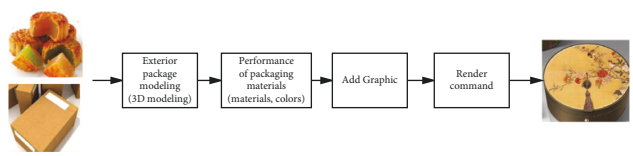

Figure 3: The process of packaging design model.

2.2. Three-Dimensional Symbols and Packaging Design. Today, with the rapid economic development, packaging design has become a product that cannot be ignored. Computer virtual reality technology is a computer system that combines computer technology, multimedia technology, and interactive design technology. It can provide a better operating platform for packaging designers and consumers. Technically speaking, virtual reality technology is used, but visually, it is more artistic [16]. Successful packaging design can promote the development of enterprises and open up a new sales market. The use of computer virtual reality technology can be combined with packaging design, which can realize union, intersection, difference, and other operations to a certain extent, and provide designers with more calculation results so that designers can produce more creativity. The specific design model is shown in Figure 3. First of all, finish modeling the appearance package in 3Dmax, then express the package material (material, color), add graphics according to the modeling, and render the output.

In the complex 3D virtual scene, this paper proposes a two-level clipping algorithm, which uses the fade-in and fade-out level of detail algorithm for the first level clipping, and then uses the slow culling algorithm for the second level clipping, so as to speed up the rendering speed. Now, assume that when switching from one level to another, a vertex is switched from p to p', the height difference is Δh, and the total transition time is t. In the switching process, this paper first compensates for the height and then switches between levels. As shown in equation (1), where Δt is the current transition time,

$$h_{P_t} = h_p + \frac{\Delta t}{t}.\Delta t. \tag{1}$$

In a large-scale virtual scene, the hierarchical detail algorithm can effectively crop out the model outside the set field of view, and the model can be selected for fine or coarse crop according to the proportion of the model in the field of view, so the fade-in and fade-out hierarchical detail algorithm is used for the first layer of crop.

The traditional culling algorithm mainly calculates the 3D vectors, and the phenomenon of "abrupt crossing" occurs when culling the invisible. The "abrupt crossing" phenomenon is solved by using opacity.

The calculation of two-dimensional vector is mainly to normalize the coordinates of the field of view vector to $\overrightarrow{T} =$

$(0, 0, 1)$ through projection transformation. Assuming that a certain triangular patch is ΔABC, where the coordinates of points A, B, and C are (x_1, y_1, z_1), $(x_2, y_2, z_2))$, $(x_3, y_3, z_3))$ respectively, the calculation of the normal vector $\overrightarrow{n}$ of ΔABC is shown in formula (2):

$$\overrightarrow{n} = \overrightarrow{AB} \times \overrightarrow{BC} = \begin{vmatrix} \overrightarrow{x} & \overrightarrow{y} & \overrightarrow{z} \\ x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ x_3 - x_1 & y_3 - y_1 & z_3 - z_1 \end{vmatrix}. \quad (2)$$

Multiply point $\overrightarrow{n}$ by field of view vector $\overrightarrow{T} = (0, 0, 1)$ as shown in equation (3):

$$\overrightarrow{n}, \overrightarrow{T} = (x_2 - x_1)(y_3 - y_1) - (y_2 - y_1)(x_3 - x_1). \quad (3)$$

It can be seen from equation (3) that the point multiplication result at this time is independent of the z-axis coordinates, which is converted into the calculation of two-dimensional vector coordinates. At this time, the angle is calculated by equation (4):

$$\overrightarrow{n}, \overrightarrow{T} = |\overrightarrow{n}| \times |\overrightarrow{T}| \times \cos\theta. \quad (4)$$

Judge which faces are visible and which faces need to be removed according to θ.

The three-dimensional symbol type of packaging design will continue to simplify and condense the appearance of the product packaging form into a visual symbol with significant brand differences, and by obtaining the exclusive rights of the three-dimensional trademark to empower the product packaging, to ensure the smooth operation of its products in the subsequent market operation process.

The practical application of registering packaging as a body mark has been very successful in the market. Italy Ferrero Co., Ltd. filed a trademark application for chocolate three-dimensional shape in December 2012 in China (Application No. 11839757) and the three-dimensional trademark was approved for registration in February 2014, allowing its use in the 30th category of pastries, sweets, chocolate, and other categories. In 2015, Shanghai Golden Monkey Food Co., Ltd. counterfeited its three-dimensional registered trademark without the permission of Italy Ferrero Co., Ltd., and was ordered to immediately stop production, confiscate infringing goods, and fined 1.93 million yuan (Figure 4). This case is the first three-dimensional trademark infringement case broken by Shanghai, and it is also the trademark infringement case with the highest administrative penalty in Shanghai in recent years.

There are many other cases like this, such as the familiar Estee Lauder small brown bottle, Coca-Cola bottle, Martell XO wine bottle, that are not just packaging, but three-dimensional trademark. Moreover, more and more mature enterprises are beginning to focus on the application of three-dimensional trademarks in product packaging. This kind of packaging not only fully considers the beauty of product packaging from the visual form but also protects the packaging with three-dimensional trademark as early as possible, which has the forward-looking thinking of preventing intellectual property infringement in the market operation, and this form of application combining packaging and intellectual property is worth learning and using for reference.

Application number 11839757

Goods / Services: Pastries, sweets, chocolate cocoa products
Similar groups: 3001, 3004.3006s 3013
Application data: December 04, 2012
International classification: 30
Announcement data of first trial: February 20, 2014

Trademark form: three-dimensional trademark
Applicant Name (Chinese): Ferrero Co.,Ltd.

Figure 4: Ferrero licensed three-dimensional trademark.

(a) Three-dimensional trademark: so what is a three-dimensional trademark? What are the evaluation criteria for the approved registration of a three-dimensional trademark?

(b) Trademark: trademarks are legal marks that are used to distinguish products and services from other similar brands in the same industry. Trademark right is the exclusive right protected by national law, and in the process of market economy operation, trademark is the fundamental for the survival of the enterprise, and also the basis for the enterprise to be able to develop and grow continuously in the market economy. It can be said that the trademark is the enterprise's "business base, the source of living business" [16]. The acquisition of a trademark requires a series of rigorous legal processes of application-examination-approval, and the trademark rights can be obtained only after the examination and approval by the State Intellectual Property Office. Trademark rights entitle the trademark applicant to enjoy semipermanent and exclusive rights. The acquisition of trademark rights is more beneficial for the applicant to obtain the initiative in the market.

(c) Constituent elements of trademarks: the constituent elements of a trademark usually consist of a combination of words, graphics, English, numbers, colors, and sounds. In Figure 5, common types of trademarks are single trademarks, combination trademarks, sound trademarks, and three-dimensional trademarks. Significance is the core evaluation criterion for whether a trademark can be approved for registration. The trademark needs to have a distinctive difference that distinguishes other corporate logos in the same industry.

(d) Three-dimensional trademark: the trademark law defines three-dimensional trademark as a three-dimensional sign or a trademark consisting of a three-dimensional sign containing other signs. The three-dimensional trademark reinforces the characteristics of the brand's products and services with the help of the shape of the goods themselves, the packaging or other three-dimensional signs.

Figure 5: Trademark type.

Figure 6: Binggrae banana milk three-dimensional trademark.

In Figure 6, the picture shows the packaging container design of Korean Binggrae banana milk. This design applied for a design patent in South Korea on May 31, 1975 and has been patented. The validity of the design patent was maintained for the next ten years. However, annual fees are required to maintain the appearance patent rights, and once the patent rights disappear, the technology becomes public knowledge and is used by the general public. As a result, Korean Binggrae applied for a trademark in 2001 and was approved for registration in 2003. Korean Binggrae applied for a three-dimensional trademark in 2004 and a color trademark in 2009, and have continued to use their trademark rights to protect their product packaging [17]. Such efforts not only clarify the brand's impression characteristics in consumers' hearts but also better maintain the brand image. At the same time, this differentiated feature is obviously separated from competing products. At the market level, improving consumers' purchasing decisions has achieved good results. The unified visual identity system on the cylindrical container, such as packaging appearance, color, and font, especially the Binggrae banana bottle logo, is continuously strengthening the image of the product in the minds of consumers, thereby increasing customer loyalty and brand value.

2.3. Structural Innovation and Packaging Design. Another direction of application of packaging is the innovation of packaging structure. Niannian Youyu Koi lantern is a couplet stocking gift box designed by Shenzhen MSHC Wenchuang Technology Development Co., Ltd. in 2020, which runs the cultural allusion "Yu Chuan Chi Su" into the product contents and packaging. In ancient times, every holiday, the letter will be stuffed into the belly of the fish to friends and relatives, to express the feelings of longing. The fish is the package and the Chi Su is the content.

Niannian Youyu couplet stocking gift box deeply excavates the innovation of packaging structure on the basis of content. As shown in Figure 7, it uses the packaging package to simply transform a box into a Koi lantern without changing or adding structure, leaving a carp in the home to signify abundance in the coming year. Using this clever format, the value of the product continues from the festive symbolism of the couplet to the fun experience of the New Year, while achieving 0 waste in packaging. Meanwhile, this Koi lantern applied for a utility model patent in 2019 called "deformable multi-purpose packaging box," using the cultural core to create a good product both inside and outside. From the content to the structure is the continuous improvement of innovation ability so that the product stands out in many stocking gift boxes, with the help of innovative structural design, improves the differentiation of the product, enhances the core competitiveness on the commercial battle, and ultimately enhances the market value of the product [18].

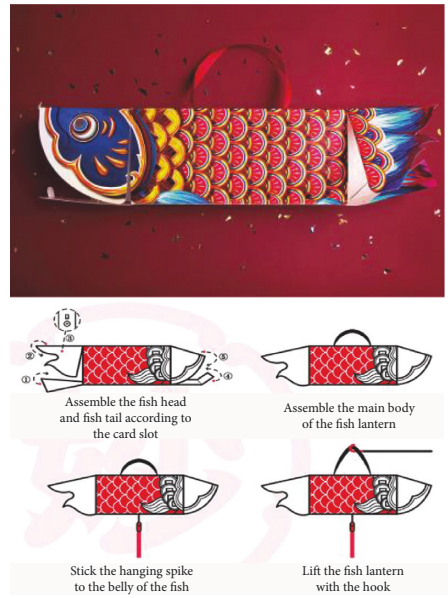

Figure 7: Niannian Youyu.

3. Results and Discussion

An understanding of the various types of intellectual property can provide more clear design direction for design practice. So what are the differences between patent right and trademark right mentioned earlier? How should we differentiate and make a choice?

3.1. Different Protection Objects. A design patent protects an industrial product that is aesthetically pleasing for industrial mass production, and the scope of protection is limited to the six views of the designed product submitted in pictures or photographs. A utility model patent protects the structure of an industrial product and requires the creativity or novelty of the product's exterior form or product structure (Table 2).

Unlike patents, trademarks do not take into account originality or novelty. However, because its constituent

Table 2: Various types of intellectual property.

Type	Comparison of the objects of protection of various types of intellectual property		
	Appearance design	Utility model	Trademark
Object	Shapes, patterns or their combination and the combination of color, shapes, and patterns	Product structure	Combination of text, graphics, English, numbers, colors, and sound composition

Table 3: Approved standards for of intellectual property.

Type	Approved standards for various types of intellectual property infringement		
	Appearance design	Utility model	Trademark
Time limit	Novelty	Innovativeness	Significance

elements form a remarkable overall image in the composition of a series of visual recognition systems such as text, graphics, and form, it is unique and has nothing to do with the functionality of commodities, after a long period of use and a lot of publicity; it has the function of identifying the source of its goods and belongs to the scope of trademark protection. The scope of trademark protection is relatively broad, and its protection covers not only on approved goods or services but also the use of a trademark identical or similar to its registered trademark on the same goods or similar goods. Trademarks mainly distinguish different sources of the same or similar goods or services based on their principles of significance and identification, so as to realize the maximization of commercial interests in commercial competition. By granting exclusive rights, trademarks emphasize more on ensuring the maintenance of proper commercial order than remuneration and compensation [19].

3.2. Different Standards of Infringement Approval. The standard for judging patent infringement is whether the overall visual effect between the sued product and the design patent is similar, and whether the product structure is similar to that of the utility model patent to judge infringement (Table 3).

The standard for determining trademark infringement is whether the accused logo is likely to cause confusion among general consumers compared with the overall text, graphic,s and combinations thereof of the trademark, and if it causes confusion among consumers, it constitutes infringement [20].

4. Conclusions

More and more packaging designs focus on the cultural content itself. Symbols, patterns, and stories are active in the two-dimensional space. The single reinforcement method starting from "shape" is the most common, but few people jump out of the two-dimensional dimension to think and explore new ideas. Through the application of computer virtual reality technology, it can bring more visual effects to packaging design, and through the combination of computer digital technology and virtual reality technology, it provides a brand-new and distinctive product design method for the development of enterprises. Creativity today is inseparable from the understanding and use of intellectual property. Future designers should have the ability to apply design skills, technology, and legal rules to realize the commercial value and strategic application of products. To embrace computer nonlinear virtual reality technology, we must rely on the virtual reality industry. Take technology as the fundamental driving force for development, break through the key core technologies of virtual reality, identify cutting-edge technologies of virtual reality, and establish a complete virtual reality industry chain. Virtual reality technology enables users to gain immersion, interactivity, and imagination, and is used in the fields of intellectual property and trademarks. The development of virtual reality has broad prospects and has attracted attention and from all walks of life. As the driving force of innovation economy, virtual reality technology must be in line with international standards, occupy an important position in the global industrial value chain, and follow the path of international competition and development. In short, the value of data needs to be released by relying on innovative analysis. After data sharing, society will get more datasets related to economic and social indicators that can be analyzed, which is a challenge and an opportunity for government agencies.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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Research Article

Research on Taekwondo Teaching Reform in Colleges and Universities Based on Nonlinear Data Prediction Analysis

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With the all-round development of quality education in China, the development of new courses has been continuously added. The problems of Taekwondo education in colleges and universities in China have gradually emerged, which has hindered the development of Taekwondo. Taekwondo is a very important part of physical education in colleges and universities. It plays an important role in the teaching reform in colleges and universities. The fact of Taekwondo Teaching can meet the demands of students' diversified sports. However, at present, there are some problems in the course of Taekwondo in colleges and universities, such as insufficient attention, lack of professional teachers, lack of professional venues, one-sided teaching ideas, unreasonable evaluation system, and so on. It is necessary to further implement the concept of education, optimize the teaching environment, strengthen the construction of teachers, innovate teaching methods, improve the evaluation mechanism, and give better play to the educational function of Taekwondo. The traditional view of physical education teaching is centered on teaching, which leads to students only understanding skills and tactics, and cannot meet the needs of modern society and schools in many aspects and levels. In order to study the teaching reform of higher education, based on the prediction and analysis of nonlinear data, this paper compares the specificity, sensitivity, early warning, and overall effect of teaching reform. It can be seen that the comprehensive effect of Taekwondo Teaching reform is better under the prediction and analysis of nonlinear data, and puts forward corresponding improvement countermeasures, in order to provide some help for the improvement of Taekwondo Teaching levels in colleges and universities, and promote the all-round development of college students.

1. Introduction

With the continuous progress of the social economy and the continuous improvement of China's overall living standards, people have gradually shifted from the basic focus of daily life to spiritual life. Taekwondo is now an official event of the modern Olympic Games. Now, many colleges and universities have carried out courses on Taekwondo. Tong [1] mentioned that Taekwondo originated from South Korea and is an ancient martial art. Taekwondo usually involves kicking and falling; Fist means to strike with a fist; Tao is an art. Kai proposed that the teaching of Taekwondo in colleges and universities generally has four characteristics as follows: the learning process is mainly based on legs and combined with fists; pay attention to the exercise of internal and external forces; breaking bricks, formwork, etc., by hands and

feet; strength training through training competitions [2]. Arong proposed that Taekwondo advocates the martial spirit of "starting with ceremony and ending with ceremony." It is a very attractive sports event and enjoys a high reputation in many countries around the world. With the deepening of Taekwondo publicity, Taekwondo has been added to sports courses in major universities to provide students with choices [3]. Caoguifang proposed that in college teaching, Taekwondo not only competes with each other but also allows students to cooperate with each other. After such a long time of evolution, Taekwondo has its spiritual and cultural core [4]. Xiaolang proposed that under the modern physical education reform, enhancing the physical fitness of college students is one of the important goals of the current college physical education reform [5]. Xiang proposed that after Taekwondo entered China, it has played a very positive role in improving the physical quality and moral cultivation of contemporary students, because after all, as a foreign culture, affected by some factors, the teaching situation in colleges and universities is not very optimistic [6]. Ning proposed that teaching reform must be necessary for the teaching of Taekwondo elective courses in major colleges and universities, which can promote the health of contemporary college students and cultivate their comprehensive quality, so as to promote the development of education [7]. Li proposed that nonlinear technology accounts for an increasing proportion of professional practice courses. The course pays attention to the cultivation of students' logical thinking and practical ability, and often provides students with reliable technical means in creative competitions so that students can achieve the purpose of applying what they have learned [8]. Yang's nonlinear teaching method is different from the linear teaching method. It is believed that the generation of movement technology changes due to changes in the environment, and the acquisition of movement technology is not prescriptive and procedural, which is the result of students' adaptation to the sports environment [9]. Zhihong proposed the improvement of the teaching quality and efficiency of Taekwondo in higher vocational schools, the characteristics and current teaching situation of Taekwondo, and the significance of reforming Taekwondo Teaching in Higher Vocational Colleges [10]. Minjin proposed that Taekwondo course teaching can not only meet the diversified needs of students' sports but also promote the development of students' sports ability and comprehensive quality. For the current situation of Taekwondo Teaching Reform in colleges and universities, systematic comprehensive, and targeted teaching reform and optimization strategies are proposed to promote the long-term development of college physical education [11]. Shuxian pointed out the problems existing in Taekwondo Teaching in colleges and universities, increased teaching investment and construction, optimized Taekwondo teaching environment, reformed teaching forms and means, stimulated students' learning enthusiasm, strengthened teaching training and exchange, and improved teachers' professional level to broaden teaching channels and forms, and create a good teaching atmosphere [12]. Junqian believes that under the background of quality education in the new era, college Taekwondo Teaching should focus on cultivating students' humanistic spirit, strengthening the publicity of Taekwondo spirit, increasing humanistic feelings in Taekwondo Teaching, creating a taekwondo cultural atmosphere, integrate the cultivation of humanistic spirit, improve the proportion of humanistic spirit in Taekwondo teaching, and promote the progress of teaching effect [13]. Qingguo first analyzed the existing problems of Taekwondo Teaching in colleges and universities. On this basis, he explored from multiple angles, striving to implement innovative, reasonable, and effective solutions, improve the quality of Taekwondo Teaching in colleges and universities, and promote the physical and mental health development of college students [14]. In essence, education is a humanistic process in which people are the center and the root. Taekwondo courses in colleges and universities not only have the value of general physical education courses to strengthen the body but also contain cultural attributes different from Western sports. Taekwondo Teaching Reform in colleges and universities from the perspective of humanistic spirit will effectively give play to the value of Taekwondo.

2. Analysis on the Present Situation of Taekwondo Teaching in Colleges and Universities

At present, Taekwondo Teaching in domestic colleges and universities is generally divided into two teaching methods, theory and practice. In terms of theory, teachers choose textbooks as the basis and write on the blackboard to understand, mainly teaching some basic theoretical knowledge about Taekwondo. In terms of practice, teaching is carried out in relevant venues. Students can better receive and practice through the teacher's demonstration actions and the combination of technology and understanding. The above two methods are the basic teaching methods for colleges and universities. This method is the mainstream teaching method in colleges and universities. This teaching method is too simple, and students will feel bored when they know more. This will lead to students' inability to raise their interest in Taekwondo in the process of learning, and they have no desire to understand and learn. This is not conducive to the sustainable development of Taekwondo courses, and efficiency is also greatly reduced. Taekwondo is a very competitive, confrontational, and practical sports activity. At present, most colleges and universities choose practical teaching for Taekwondo Teaching. This teaching mode ignores the cultural inheritance of Taekwondo and the importance of theoretical knowledge of Taekwondo. In such a teaching mode, students tend to understand Taekwondo in an aggressive way, which is too one-sided and only exists in the form of expression. Therefore, the usage rate of Taekwondo is low. Based on the analysis of the current teaching situation, Figure 1 is obtained.

Figure 1 shows the proportion of relevant data for each decomposition action in Taekwondo at present. From the data, it can be seen that in the study of Taekwondo in colleges

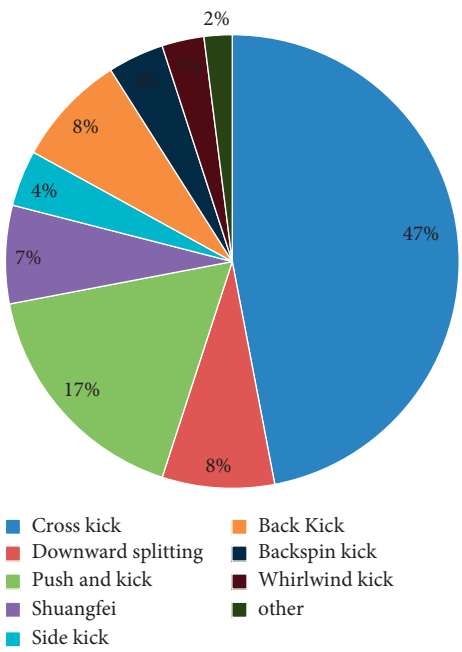

Figure 1: Analysis of the current situation of Taekwondo in colleges and universities (%).

and universities, the applicability and scores of horizontal kicks are the highest, followed by the data on pushing and kicking. The proportion of data on other decomposition actions has significantly decreased. Therefore, in the case of uneven scores for each action in Taekwondo in colleges and universities, it is more necessary to strengthen the training of Taekwondo students' comprehensive actions. To optimize Taekwondo teaching methods and promote students' active participation and interaction, it is necessary to innovate the traditional Taekwondo teaching, so as to improve the teaching quality of colleges and universities and the comprehensive quality of students.

3. Nonlinear Data Prediction and Analysis Technology

Linear data have one or more commonalities. Generally, one piece of common data is made according to the data, which is called linear data. Nonlinear data include physical phase data and many nonlinear data in nature. Nonlinear data have the characteristics of proportional law, irregularity, commonality law, etc. Nonlinear data can be analyzed through the law of physical thermodynamics statistics, and the law of phase transition in physical substances. Nonlinear data can be analyzed by a series of analyses, quantitative analysis and the rule generated between nonlinearity, and recording the value of the rule generated between nonlinear data.

4. Students' General Information and Class Classification

This study adopts the method of average grouping to randomly group 88 college students in two classes of the same grade in 2021 who study Taekwondo at a university. There are 43 students in the reference group of conventional Taekwondo teaching methods, 17 girls and 26 boys, with an average age of 18.9 years. There are 45 students in the observation group, 25 boys and 20 girls, whose average age is 20.8 years old.

5. Statistical Methods

This research needs to use a variety of basis function formulas to comprehensively analyze and calculate the research object in the Taekwondo teaching reform. Among them, it needs to use the arithmetic mean and standard deviation rate to calculate and analyze, as follows:

$$\sigma = \frac{1}{n-1}\sqrt{\sum_{i=1}^{n}(x_i-\mu)^2}, \mu = \frac{1}{n}\sum_{i=1}^{n}x_i. \quad (1)$$

Here, σ is the standard deviation rate calculation result of the basis function and μ is the arithmetic mean of the input sequence x of the basis function.

6. Application of Nonlinear Data Prediction Analysis in Taekwondo Teaching in Colleges and Universities

Is a linear process, which has a large number of problems, students' self-regulation ability to learn Taekwondo is not enough. Although the domestic curriculum model also has single loop feedback or double loop feedback, and because the operation of the learning system of Taekwondo courses is more complex, multiloop feedback should be adopted. This multiloop feedback can solve problems at multiple levels, timely adjust courses and increase learning flexibility. Compared with a linear process, nonlinear data can provide new ways and ideas for Taekwondo teaching, and let us reexamine the teaching mode of Taekwondo course. Nonlinear courses can make teaching more flexible. Nonlinear teaching no longer only abides by a certain educational goal. Educational goals change with the teaching cycle of Taekwondo. Students can make timely adjustments and feedback at each learning stage according to the course. Instead of setting fixed results, teaching courses are also constantly updated with teaching time.

Change continues to develop and gradually fits in with students' life. The networking of nonlinear courses has many factors affecting Taekwondo teaching, including the relationship between teachers and students and students' personality development. The networking of nonlinear courses needs to take more factors into account to have an all-round impact on the teaching courses. This impact will be fed back into the teaching structure and content of the courses. Taekwondo course itself is an open, nonbalanced, multi subsystem teaching system. In the teaching process, when the threshold of a certain aspect reaches the top, the system of the course will change. Secondly, the course is also related to the surrounding environment during the teaching process, resulting in changes. This change is unexpected, and it can make the teaching courses of Taekwondo reach another

level online, such as Taekwondo in freshman and Taekwondo in sophomore. Based on the above research, for nonlinear Taekwondo teaching, it is proposed that the Taekwondo course will be changing all the time. When the teaching reaches a certain node, the feedback will be adjusted locally or as a whole. These adjustments are the new starting point of the course, and the end point of the course will also change with the change. The starting point and end point of the course chosen by students are obviouslyinconsistent. At present, teachers and students are passive receivers in Taekwondo learning. Students' information about Taekwondo is not limited to the classroom. They can learn more about it and drive people around them to participate in the exercise. Taekwondo courses are not only limited to the closed classroom but should be more than the exchange of external information. The continuity of the course itself will also be affected by discontinuity. This discontinuity can generate new learning in the course and greatly enhance students' interests.

6.1. Analysis on the Specificity and Sensitivity of Different Teaching Courses in Taekwondo Teaching in Colleges and Universities. There are no clear standards for different teaching courses to correspond to the teaching objectives of each lesson. Therefore, in classroom teaching, we need to integrate the curriculum objectives with the core literacy, so that the classroom teaching has a core literacy generation direction and students have a clear literacy precipitation consciousness. Teaching system evaluation can not only integrate relevant theoretical knowledge but also introduce nonlinear data to establish the theoretical basis of the intelligent teaching evaluation system. While improving teaching evaluation methods, teaching ideas can be adjusted, which can better find a practical path for students in learning and education. It can adjust the teaching concept while improving the teaching evaluation methods, so as to find a practical path for students in learning and education. In this case, if we want to better play the role of the teaching system and improve teaching ability, we need to choose a reasonable teaching evaluation system. The evaluation system should not only assess the basic theoretical knowledge of teaching but also evaluate the comprehensive quality indicators of students in all aspects. In order to better analyze the different teaching courses of Taekwondo teaching in colleges and universities, this paper compares and analyzes the sensitivity and specificity of the two teaching methods of conventional course teaching and intelligent interactive Taekwondo teaching, as shown in Table 1.

Table 1 shows the comparison of sensitivity and specificity of College Taekwondo Teaching based on nonlinear data prediction analysis to different teaching methods. Before using nonlinear data for teaching, the sensitivity and specificity of nonlinear teaching are lower than those of conventional teaching. However, after using nonlinear teaching methods, the relevant data integrated into teaching methods are significantly higher than those of conventional teaching methods. There was a significant difference between the two groups after teaching, $T < 10.000$, $P < 0.05$. The comparison results had significant statistical significance.

In order to analyze and evaluate the nonlinear teaching effect more intuitively, the sensitivity of the conventional course teaching and intelligent interactive Taekwondo teaching method system is visualized, and Figure 2 is obtained.

Figure 2 shows the visual comparison of the sensitivity of the two groups of different teaching method systems, intuitively showing that the sensitivity effect is better after using the observation group teaching system, which also shows that the application of the observation group evaluation system is conducive to Taekwondo teaching in colleges and universities, can promote the sensitivity of intelligent interactive Taekwondo, and then improve the quality of Taekwondo teaching in colleges and universities.

6.2. Early Warning Analysis of Different Taekwondo Teaching Methods. The data coupling results of different Taekwondo teaching methods through different algorithms can predict and analyze the teaching method on the basis of high sensitivity big data collection of nonlinear data. With reference to different influencing factors, the analysis of this teaching method is shown in Table 2.

In order to better reflect the prediction sensitivity of nonlinear data in the application, the data comparison results in Table 2 are visualized, and Figure 3 is obtained.

Table 2 and Figure 3 show the prediction results of the teaching methods of the two groups of analysis objects. The results show that the teaching method using nonlinear prediction is better than the traditional teaching method. The nonlinear prediction method has higher early warning data and better early warning ability, which is conducive to improving the teaching application of Taekwondo in colleges and universities.

6.3. Comprehensive Effect Analysis of Taekwondo Teaching Courses in Colleges and Universities. In the practical application of the relevant teaching evaluation system, it can combine various practical teaching in the classroom, optimize the teaching methods, increase the interaction in the classroom and the learning initiative of students, enable students to quickly invest in Taekwondo courses, help to cultivate students' physical quality, and improve students' will quality in the process of Taekwondo learning. By analyzing and comparing the sensitivity and specificity of different teaching methods in Taekwondo in colleges and universities, the comprehensive scores of students with different teaching methods are compared to better analyze the impact of nonlinear data prediction on Taekwondo teaching, as shown in Table 3.

Table 3 shows that under the nonlinear data prediction teaching, the scores, teaching modes, classroom effects, and teaching achievements of students in traditional teaching have been significantly improved. There is a significant gap between the comprehensive scores of students in the two teaching methods. The comprehensive scores of nonlinear

Table 1: Analysis of specificity and sensitivity of different courses in Taekwondo teaching.

Group	n	Sensitivity		Specificity	
		Before reform	After reform	Before reform	After reform
Reference group		68.32	83.12	76.41	92.32
t value		3.328	3.684	5.259	5.685
P value		0.005	0.006	0.007	0.008

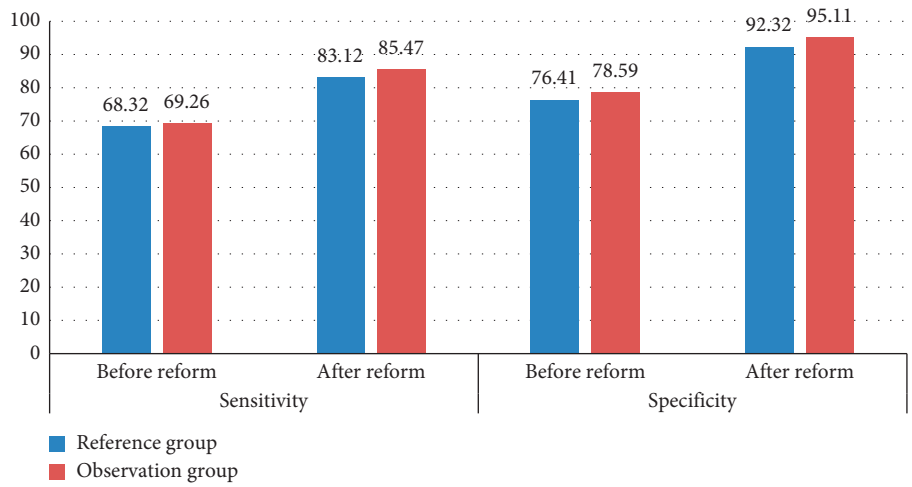

Figure 2: Visual diagram of sensitivity and specificity of different teaching courses.

Table 2: Comparison of prediction sensitivity of different Taekwondo teaching methods.

Group	n	Predictability	
		Before use	After use
Reference group	16	96.2 ± 5.9	98.9 ± 4.6
Observation group	16	97.1 ± 5.5	99.2 ± 2.3
t value		6.982	7.823
P value		0.008	0.009

data prediction teaching are significantly higher than those of conventional courses.

In order to more intuitively analyze the teaching of Taekwondo in colleges and universities on the prediction of nonlinear data and visualize the students' comprehensive scores, Figure 4 is obtained.

Figure 4 shows the comparison of Taekwondo scores under different teaching methods. It can be seen more

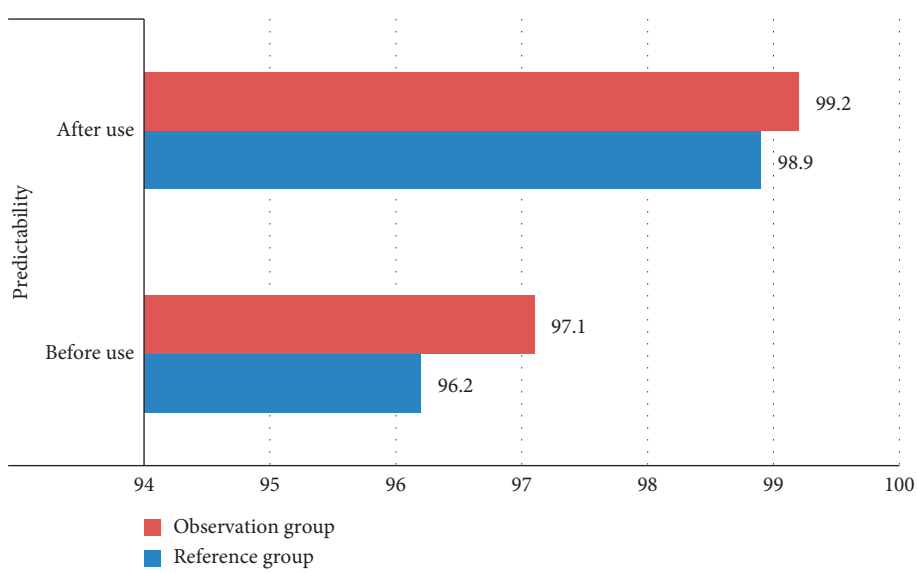

Figure 3: Visual comparison of prediction sensitivity of different Taekwondo teaching methods.

Table 3: Comprehensive effect data analysis of Taekwondo teaching courses in colleges and universities.

Grouping	n	Teaching methods	Teaching method	Skill practice	Physical fitness test
Reference group		7.43 ± 0.49	8.09 ± 0.65	8.23 ± 0.45	7.59 ± 0.51
Observation group		7.69 ± 0.53	8.56 ± 0.52	8.57 ± 0.36	7.85 ± 0.48
t value		6.325	7.303	8.036	6.984
P value		0.005	0.007	0.008	0.006

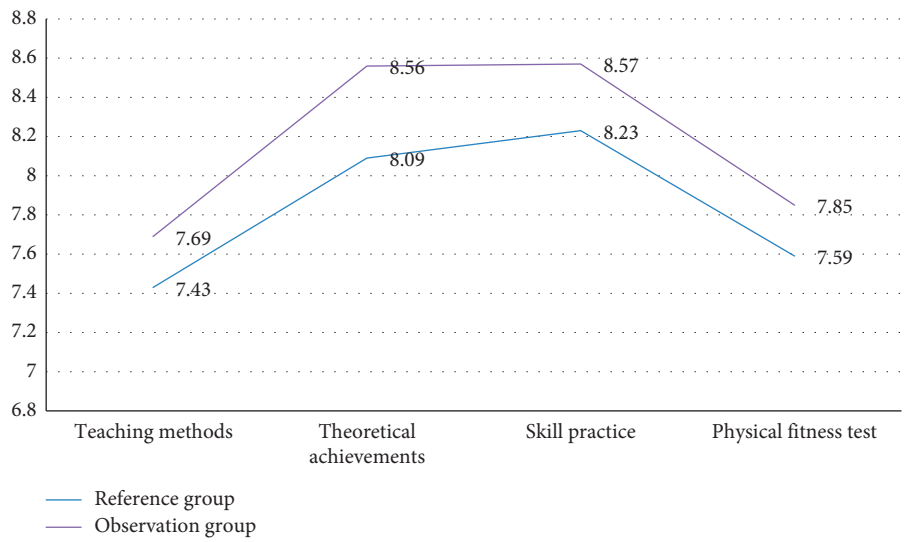

Figure 4: Comprehensive effect data visualization of Taekwondo teaching courses in colleges and universities.

intuitively that the comprehensive effect of teaching methods based on nonlinear data prediction is better. Students' scores in all aspects are significantly higher than those of students using conventional courses, so as to improve the effectiveness of the teaching evaluation system and promote the all-round development of students' morality, intelligence, and physical beauty.

7. Summary

With the development of the social economy, Taekwondo is a popular sport integrating fitness, competition, entertainment, and art. Taekwondo is popularized in society. Taekwondo elective courses are offered in colleges and universities across the country to activate the old teaching mechanism, which plays a positive role in improving students' physical quality. The promotion of Taekwondo teaching in colleges and universities plays an important role in cultivating students' fighting spirit and exercising good physical quality. At present, due to various reasons, there are many problems with the teaching methods and promotion of Taekwondo in colleges and universities, which restrict the popularization of Taekwondo projects.

Therefore, this study uses nonlinear data to predict and analyze the teaching reform of Taekwondo in colleges and universities, stimulate more students' love for Taekwondo, and bring the new learning experience to students through this teaching method. The overall optimized curriculum system ensures the key to the standardized and scientific implementation of classroom teaching and strengthens the construction of the Taekwondo curriculum and team, which is conducive to enriching their after-school life and improving their self-cultivation. Sports have no national boundaries people of all ages have the right to pursue sports. With the progress of science and technology, it is believed that people will find more learning models for sports and fitness in the future.

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Conflicts of Interest

The authors declare that there are no potential conflicts of interest.

Authors' Contributions

All authors have seen and approved the manuscript for submission.

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