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Computer-Aided Design AND APPLICATIONS

Constructing Digital Content of Intangible Cultural Heritage Based on Artistic Image Enhancement Algorithm

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Abstract. Intangible cultural heritage (ICH) not only represents the growth of human civilization, but also bears the spiritual and cultural values of human beings. In the digital protection of ICH, computer aided design (CAD) and virtual reality (VR) can provide efficient and accurate tools and methods for making digital content. In this article, an artistic image enhancement algorithm based on deep learning (DL) is proposed. This algorithm can achieve super-resolution enhancement and color restoration of the image by extracting features and DL of art works, which provides high-quality image resources for the digital protection of ICH. The results indicate that this method has a good effect on improving the quality of graphic art, and provide users with an immersive artistic experience, which provides strong support for the digital protection and promotion of ICH. By analyzing the audience's assessment of digital ICH interactive experience, we can find the advantages of this algorithm in practical application.

Keywords: Virtual Reality; Computer Aided Design; Intangible Cultural Heritage; Numerical Protection
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1 INTRODUCTION

ICH not only represents the growth of human civilization, but also bears the spiritual and cultural values of human beings. Import the landscape design scheme into a virtual environment for

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simulation analysis, observe the effectiveness and potential problems of the landscape design, and revise and optimize the design scheme. Through simulation analysis, designers can more accurately grasp the terrain, topography, vegetation, and hydrological conditions of the coastline, thereby designing landscape plans more reasonably. After the implementation of the plan, it was found through drone aerial photography and on-site inspection that the design scheme effectively protected the ecological environment of the coastal zone, while improving the aesthetics and attractiveness of the coastal landscape. MR technology provides visitors with an immersive experience, improving the interactivity and attractiveness of the attractions. Bae et al. [1] explored the impact of mixed reality on satisfaction with cultural heritage sites. In the past few decades, the protection and inheritance of cultural heritage sites have received increasing attention from people. However, traditional cultural heritage display methods often lack interactivity and attractiveness, making it difficult to attract tourists' interest. The emergence of MR technology provides a new way to solve this problem. By overlaying virtual information with the real world, MR technology provides visitors with an immersive experience, enabling them to gain a deeper understanding of sites. However, due to the variety of ICH and the single traditional protection method, it is difficult to meet the needs of modern diversification. Moreover, with the growth of digital technology, digital protection has gradually become an important protection method. Geographic information methods and augmented reality technologies have provided new possibilities for the digital protection, inheritance, and display of cultural heritage. By combining geographic information methods with augmented reality technology, Barrile et al. [2] created a powerful cultural heritage application that provides the public with an immersive visiting experience and comprehensive cultural tour. Through GIS, it integrates various geographic information data of cultural heritage, including terrain fluctuations, vegetation distribution, hydrological conditions, etc. These data can be presented in three-dimensional form, allowing users to have a more intuitive understanding of the geographical environment of cultural heritage. Augmented reality technology can provide a new way of presenting cultural heritage applications. Through AR technology, we can overlay virtual information with the real world, allowing users to see virtual models. Specifically, AR technology can be implemented through smartphones or AR glasses. By downloading the cultural heritage application and enabling AR function, users can aim their phones or glasses at the cultural heritage and see the combination of virtual models and real scenes. Digital protection has the advantages of convenient storage, rapid dissemination and visual display, which can improve the inheritance and protection efficiency of ICH. Bernardi et al. [3] delved into the application prospects of digital transformation in strategic management of cultural heritage. Taking tourism analysis as an example, the application of digital transformation in cultural heritage strategic management has achieved significant results. Firstly, through literature review, summarize the current application status and challenges of digital transformation in cultural heritage strategic management. Secondly, questionnaire surveys and interviews were used to collect case study data to delve deeper into the logic of digital transformation. This study found that there are some obstacles and challenges to digital transformation in tourism analysis. Firstly, data security and privacy protection issues are prominent. Due to the openness and interconnectedness of digital technology, data leakage and information asymmetry often occur. Secondly, the cost of technological updates and maintenance is high, making it difficult for many organizations to bear the cost of continuously upgrading and maintaining digital technology. Finally, the digital transformation process may involve adjustments to organizational structure and business processes, bringing additional workload and adaptation period to employees. With the continuous progress of sci & tech, including culture and art. As an important part of human cultural heritage, the protection and inheritance of ICH has attracted wide attention. However, due to the variety of ICH and the single traditional protection method, it can not meet the needs of modern diversification. Moreover, with the growth of digital technology, digital protection has gradually become an important protection method.

Especially in the fields of historical education and heritage visualization, augmented reality technology provides people with a new perspective and method to understand and understand historical culture. Challenor and Ma [4] provide an overview of the application of augmented reality

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in historical education and heritage visualization from the perspective of multimodal technology and interaction. Through AR technology, historical scenes can be restored, allowing students to learn and understand historical events in a simulated historical environment, improving the fun and effectiveness of learning. In addition, through AR technology, historical relics can also be digitized, thereby improving their understanding of the value of cultural relics. There are also some problems and challenges in the application of augmented reality in historical education and heritage visualization. The superposition of virtual information and the real world may affect people's perception of reality and requires careful handling. The introduction of VR technology and CAD principles provides new ideas and methods for digital protection of ICH. It makes users immerse themselves in the virtual environment by simulating human sensory experiences such as audio-visual, tactile and so on. VR technology provides new ideas and methods for digital protection of ICH. For example, by constructing virtual scenes and character models, the historical background and manifestations of ICH can be reproduced; Through VR technology, the immersive experience and interactive display of ICH can be realized, and the user participation and inheritance effect can be improved. CAD is a digital design method, which can edit and process design elements such as graphics and images by computer software. In the digital protection of ICH, CAD can provide efficient and accurate tools and methods for making digital content. For example, digital conversion and processing of art works can be realized through CAD; Mass production and diversified display of ICH digital content can be realized through CAD. The purpose of this article is to improve the digital protection level of ICH by constructing ICH digital content based on VR and CAD principles. Frutiger et al. [5] establishes a computer model that can describe the process of molecular products. Simulate the established model using Monte Carlo method. Monte Carlo method is a statistical simulation method that estimates the possible behavior of a system by randomly selecting samples from a probability distribution. We take various possible properties of the product as inputs and run simulations to obtain the expected output for each property. In the past few decades, product process design has received widespread attention and research. Many researchers have proposed various algorithms and models to optimize process flow, improve product quality and production efficiency. However, due to the existence of property uncertainty, these methods encounter many limitations in practical applications. The changes in these factors may lead to the instability of product properties, which in turn affects the effectiveness of process design. Most existing optimization methods are based on deterministic mathematical models, making it difficult to handle complex nonlinear relationships and uncertain factors. This method uses Monte Carlo simulation technology to simulate the probability distribution of process parameters, thereby obtaining a more comprehensive process design plan. Using Monte Carlo simulation, multiple random samples are taken from each sample point to simulate different production conditions and environmental factors, resulting in a series of product quality data.

With the continuous development of technology, augmented reality intelligent glasses (ARSG) have become an emerging technology in the tourism field. Especially in cultural tourism, ARSG tourists can gain a deeper understanding of cultural heritage and historical culture, improving their experience and satisfaction. Han et al. [6] explored the application advantages and development prospects of ARSG in cultural tourism. In museums, visitors can browse high-definition images of exhibits through ARSG to obtain more information about the exhibits, such as historical background, production techniques, etc. In addition, ARSG can also provide 3D virtual models of exhibits, allowing tourists to observe the exhibits from different perspectives and improve the visiting experience. ARSG can also provide 3D models and virtual scenes of scenic spots, allowing cultural value of scenic spots. When using ARSG, tourists should pay attention to the surrounding environment to avoid collisions and falls. It is recommended to use in a safe environment, such as indoors or outdoors in open spaces. The duration of using ARSG should be reasonably controlled to avoid discomfort symptoms such as eye fatigue or dizziness caused by excessive use. It is recommended to take a break after a period of use to alleviate eye fatigue, which can realize super-resolution enhancement and color restoration of the image through feature extraction and DL of art works, and provide high-quality image resources for the digital protection of ICH. Then,

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combining VR technology and CAD principles, the framework of ICH digital content is constructed. The framework includes digital resource collection, processing, storage and display modules, which provides a comprehensive solution for the digital protection of ICH. The innovation of this article mainly includes the following aspects:

(1) A DL-based artistic image enhancement algorithm is proposed. The algorithm can realize super-resolution enhancement and color restoration of images through feature extraction and DL. This method can significantly improve the image quality of ICH digital content and provide high-quality image resources for the digital protection of ICH.

(2) Combining VR technology and CAD principles, the framework of ICH digital content is constructed. The framework includes digital resource collection, processing, storage and display modules, which can realize comprehensive digital protection of ICH.

The following is the structural arrangement of the article: firstly, this article puts forward the importance and demand of digital protection of ICH; Then the application and advantages of VR technology and CAD in digital protection of ICH are analyzed. Then, the basic principles of DL and image enhancement algorithms are introduced, and the construction method of ICH digital content based on VR and CAD is proposed. Experiments verify the feasibility of the method. Finally, the main work and contribution of this paper are summarized.

2 RELATED WORK

Han et al. [7] introduced how to use RNN (Recurrent Neural Network) to learn 3D global features through attention aggregation sequence views. RNN can capture time dependencies in time series data. Therefore, RNN has tasks such as natural language processing and time series prediction. Attention aggregation sequence view is a learning method that aggregates information in a sequence by assigning different weights to each time step. This method allows RNN to have better performance and interpretability when processing sequence data. After preparing the dataset and model parameters, it selects different hidden layers and gates to achieve optimal performance. After establishing the network structure, we use attention aggregation sequence views to train the dataset to learn 3D global features. The performance and accuracy of the trained RNN network were evaluated. The performance of the model, it is necessary to compare different model parameters and architectures. When analyzing and evaluating the results, we need to consider the importance and advantages of 3D global features. Digital interpretation and presentation technology have brought unprecedented possibilities for tourists to experience cultural heritage sites. Liu [8] takes the ancient city as an example to evaluate the tourist experience of digital interpretation and presentation technology, aiming to gain a deeper understanding of tourists' cognition, feelings, and feedback on these two technologies. Digital interpretation plays a crucial role in the display of ancient cities. Through digital technology, various forms of information such as text, images, audio, and video can be integrated into the ancient city, providing tourists with a more vivid and comprehensive travel experience. In the digital interpretation and presentation technology of ancient cities, interaction is the key to improving the tourist experience. The survey found that tourists generally have good feedback on interactive links, believing that these links increase the fun and participation of the tour. For example, participating in ancient city puzzle games through mobile applications or interacting with virtual characters in AR scenes can help tourists gain.

Digital technology allows for high-precision recording and archiving of cultural heritage, including architecture, artworks, archaeological sites, etc. This not only allows people to have a deeper understanding of detailed information about cultural heritage, but also provides valuable data support for future protection work. Through virtual reality (VR) and augmented reality (AR) technologies, people can more intuitively understand and experience cultural heritage. These technologies can allow users to directly observe the details of cultural heritage, even the historical stories behind it. Digital technology can also be used for the restoration of cultural heritage. Digital restoration can reduce damage to the original object, improve restoration efficiency, and ensure

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the accuracy of restoration. Masciotta et al. [9] emphasizes scientific understanding and respect for cultural relics. This includes understanding the historical, artistic, and scientific value of cultural relics, as well as the impact of their environment and natural factors on cultural relics. With the aim of providing useful references for related fields. The comprehensive digital based preventive protection method for cultural heritage has been successfully applied in the Heritage Care project. Through measures such as digital recording and modeling, data and organization, and digital preservation and dissemination, this project has effectively achieved the permanent protection of cultural heritage and the global dissemination of its value. By popularizing knowledge on cultural heritage protection, public awareness and participation have been increased, and technological innovation and cooperation have been promoted. Augmented reality technology can provide real-time navigation and location information, helping tourists find destinations more easily, reducing the possibility of getting lost in unfamiliar areas, and improving navigation accuracy and efficiency. In addition, enhanced translation technology can translate textual information into the language used by tourists in real-time, providing more convenient language services, reducing language barriers to tourism, and enhancing tourism experience and convenience. And virtual reality technology can allow tourists to enjoy various tourist attractions without leaving, thereby saving time and money for tourists. In addition, virtual reality technology can also provide more realistic and realistic travel experiences, enhancing tourists' sense of participation and experience. Moro et al. [10] analyzed the many positive applications of AR and VR technologies in the tourism industry. AR technology can overlay virtual information with the actual situation of tourist attractions through augmented reality, allowing tourists to have a more intuitive understanding of the information and historical background of the attractions. In addition, AR technology can also be used for tourism planning. For example, through AR maps, tourists can have a clearer understanding of the actual situation of tourist routes, as well as the distance and transportation situation between scenic spots, in order to better plan their own tourism routes. Virtual reality technology can also bring many positive impacts to the tourism industry. Firstly, VR technology can allow tourists to overcome the limitations of time and space and experience tourist attractions firsthand. Through virtual reality technology, tourists can experience the beauty of tourist attractions at home, saving a lot of time and money. In addition, VR technology can also be used for tourism training, tourism experience optimization, and other aspects. In addition, AR technology has also been applied to tourism planning, providing tourists with more intelligent route planning.

Cultural heritage is a treasure of human civilization and an important carrier of history and culture. With the advent, how to use modern technological means to protect, inherit, and utilize cultural heritage. Among them, building a cultural heritage geographic spatial semantic network is an effective solution. Nishanbaev et al. [11] aim to analyze the current situation, existing problems, and development trends of the cultural heritage geospatial semantic network through a survey, providing useful references for research and practice in related fields. Cultural heritage refers to the precious material and spiritual wealth created and passed down in human history, with precious historical, artistic, scientific, and cultural values. Geographic space refers to the spatial location and geographical characteristics of the Earth's surface, and is the carrier for the existence and inheritance of cultural heritage. The Semantic Web is an ontology based intelligent network that can understand human natural language and intelligently process and reason information. Utilize web crawler technology to crawl relevant websites and data, and obtain cultural heritage geographic spatial information. The intersection between culture and digital platforms is constantly expanding. The use of big data has had a particularly profound impact on this combination, while also providing unlimited possibilities for value creation. To achieve the value creation of big data in cultural and digital platforms, stakeholder consistency becomes a key factor. Pesce et al. [12] explored these two topics in order to provide useful insights for practitioners in related fields. The use of big data has played a huge role in the integration of culture and digital platforms. By analyzing and mining massive amounts of data, we can gain a deeper understanding of consumers' cultural needs and habits, thereby laying the foundation for precise promotion of relevant content. Big data helps optimize the user experience of digital

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platforms and meet their needs in a personalized manner. With the help of big data technology, the cultural industry can achieve reasonable resource allocation and maximum value, providing support for industrial upgrading and transformation. With the virtual reality (VR) technology has provided a new perspective and experience for the inheritance of cultural heritage and tourism. In the field of digital tourism, a user centered virtual reality heritage system can provide users with an immersive tourism experience, better protecting and inheriting cultural heritage. Poux et al. [13] explored the preliminary design of the system. The display function can bring users into virtual cultural heritage scenes through VR glasses. The interactive function enables users to interact with virtual cultural heritage, such as rotating, scaling, and other operations. The entertainment function allows users to learn about cultural heritage in a relaxed and enjoyable atmosphere through rich interactive games and activities. In terms of scene design, the virtual reality heritage system needs to be personalized and customized according to different tourist attractions and historical and cultural backgrounds. For example, for ancient towns with a long history, VR technology can be used to reproduce the original appearance of the town, allowing tourists to experience its charm. To address the discomfort symptoms such as dizziness that users may experience during the experience, improvements can be made by optimizing image rendering techniques and reducing frame rates.

Computer assisted intelligent assembly modeling is an important component of modern product design, which can effectively capture and understand the design intent of designers, thereby generating more refined and practical product models. Among them, product information modeling is a key link, which enables computers to understand and operate these data through comprehensive description and expression of product information, achieving automated or semi-automated assembly. Product information modeling refers to the process of expressing and organizing product information through mathematical models and computer programs. This includes all physical attributes and functional characteristics of the product, such as shape, size, color, material, weight, function, etc. Product information modeling is the core of computer-aided intelligent assembly modeling, as it provides a specific operational platform for capturing design intent. In terms of specific operations, product information modeling is usually achieved using 3D modeling software such as SolidWorks, CATIA, etc. Shancong et al. [14] transformed the design intent into specific 3D models through this software, and detailed the various information of the product during this process. This information is then used to drive the intelligent assembly process. Trunfio et al. [15] analyzed the entry of tourists' head-worn devices into a virtual three-dimensional environment, which is a reproduction or restoration of real cultural heritage. Through this technology, tourists can visit cultural heritage at any time and place, without being limited by time and space. In addition, VR technology can also provide a multi angle and multi perspective observation experience, allowing tourists to observe cultural heritage from different perspectives, thereby gaining a deeper understanding of its history and cultural value. Through these technologies, tourists can gain a deeper understanding of cultural heritage and interact with it, thereby improving their experience and satisfaction. In addition, some studies have shown that VR and AR technologies can improve visitor engagement, interactivity, and learning outcomes. Through statistical analysis, it was found that VR and AR technologies have a positive impact on the overall experience and satisfaction of tourists. Specifically, these technologies have improved visitor engagement, interactivity, and learning outcomes, thereby increasing visitor satisfaction with the service model of cultural heritage museums. Zhang et al. [16] provide people with immersive visual experiences, enabling them to gain a deeper understanding and interaction with the virtual world. Sensing VR/AR has further improved the user experience. Image recognition is part of sensing technology, and its application in VR/AR can help users interact more conveniently with the virtual world. Through image recognition technology, users can interact with virtual objects through gestures or facial expressions, thereby achieving more natural human-machine interaction.

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3 METHODOLOGY

3.1 Artistic Image Enhancement Algorithm Based on DL

DL is a kind of machine learning, which is based on neural network model, and automatically extracts features by training a large quantity of data, thus achieving high-level abstraction and pattern recognition. The core idea of DL is to learn from the original input data and discover the potential feature representation of the data through multi-level nonlinear transformation. By training the deep neural network, we can realize the tasks of super-resolution enhancement and color restoration of images. Among them, convolutional neural network is one of the most commonly used DL models. CAD is a digital design method, which uses computer software to edit and process design elements such as graphics and images. CAD can complete the design task efficiently and accurately, and realize the digital display of the design results. In the digital protection of ICH, CAD is mainly applied to the production and processing of digital content, such as the digital conversion of art works, the construction of virtual scenes and character models.

VR makes users immersed in the virtual environment by simulating people's sensory experiences such as audio-visual, tactile and so on. VR technology mainly relies on interactive devices such as head-mounted display, handle and sound. In the digital protection of ICH, VR technology can be used to reproduce the historical background and manifestations of ICH. Through VR technology, users can browse and experience virtual scenes from the first-person perspective and feel the charm of ICH. In addition, VR technology can also realize the immersive display and interactive experience of ICH digital content, and improve user participation and inheritance effect.

Applying VR technology and CAD to ICH digital protection has the following advantages:

Improve the level of digital protection: By introducing new technical means and methods, we can realize high-quality digital protection of ICH and improve its inheritance and protection efficiency. Provide immersive artistic experience: Through VR technology, users can feel the charm of ICH in immersive experience and improve its communication and promotion effect. Promote interactive display: CAD can realize interactive display of ICH digital content, so that users can understand and experience ICH more deeply. Diversified display: Through CAD, diversified digital content can be produced, including two-dimensional art works, three-dimensional scenes and character models, to meet the needs of different users.

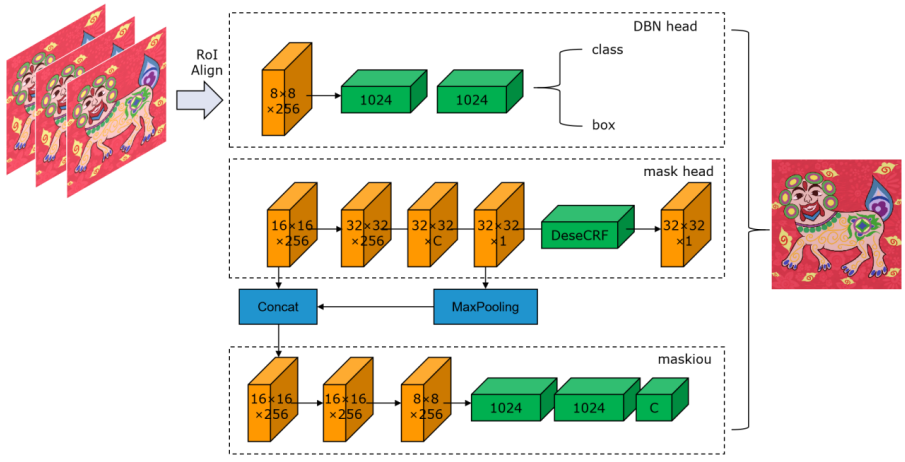

Figure 1: DBN network structure.

This article will discuss how to build ICH digital content based on DL artistic image enhancement algorithm, combining VR technology and CAD principles. This method can not only improve the

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digital protection level of ICH, but also provide users with immersive artistic experience and promote the spread and promotion of ICH. The main goal of this algorithm is to enhance the super-resolution and restore the color of artistic images through DL technology, so as to improve their quality and visual effects. The Deep Belief Network (DBN) structure is shown in Figure 1.

First, you need to build a DBN model. DBN model is a DL model, which is composed of several restricted Boltzmann machines (RBM). In this study, two layers of RBM and one fully connected layer are used. In order to achieve super-resolution enhancement, sub-block splicing is adopted. Specifically, the artistic image to be enhanced is used as the input of DBN model to get the enhanced sub-blocks, and then the enhanced sub-blocks are spliced to get the enhanced image. This can improve the resolution of the image and make it clearer and more delicate. Taking the overall color of the artistic image to be enhanced as the input of DBN model, the enhanced image is obtained to realize color recovery. This can make its color more vivid and true.

The gradient of the traditional activation function quickly approaches zero outside the active domain. The activation function proposed in this article is as follows:

$$f(x)=\begin{cases}-a\left(e^{-\frac{x}{b}}-1\right), & if\ \ x\geq 0\\ c\left(e^{\frac{x}{d}}-1\right) & otherwise\end{cases} \tag{1}$$

Fexp maps the input to the range $(-c,a)$, because the output can be adjusted by parameters and is adaptive, so the function is more robust. The parameters of Fexp provide stronger offset correction function and accelerate the learning process. For simplicity, parameters are shared by layer. The derivative and local derivative of the activation function are:

$$\frac{\partial f}{\partial x}=\begin{cases}\frac{a}{b}e^{-\frac{x}{b}}, & if\ \ x\geq 0\\ \frac{c}{d}e^{\frac{x}{d}}, & otherwise\end{cases} \tag{2}$$

$$\frac{\partial f_i}{\partial w_i}=\begin{cases}\frac{af_{i-1}}{b}e^{-\frac{f_{i-1}w_i}{b}}, & if\ \ x\geq 0\\ \frac{cf_{i-1}}{d}e^{\frac{f_{i-1}w_i}{d}}, & otherwise\end{cases} \tag{3}$$

After the training is completed, the DBN model can be used to enhance the artistic images. The algorithm automatically extracts the features of artistic images by DL technology, and performs super-resolution enhancement and color restoration.

3.2 ICH Digital Content Construction

The construction of ICH digital content refers to the process of transforming, storing, spreading and displaying ICH through digital technology. Digital content construction includes data collection, editing and processing, quality inspection and publishing. In the process of data collection, data can be collected by shooting, video recording and text recording. For cultural heritages that need high-precision digital conversion, such as works of art, three-dimensional scanning and other technologies can be adopted to collect data. In the editing process, digital content needs to be optimized and improved. Digital content can be processed by image processing software, video editing software and other tools to achieve better visual effects and user experience. Moreover,

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the quality of digital content needs to be strictly checked. In the quality inspection process, digital content needs to undergo strict inspection and audit. Digital content can be checked by automatic detection and manual audit, so as to eliminate possible problems and errors.

CAD and VR have broad application prospects in ICH digital content construction. In data acquisition, CAD can be used to make digital drawings and models, so as to better show the structure and characteristics of ICH. In the editing process, CAD can be used to accurately edit and modify digital content to achieve better visual effects and user experience. In data acquisition, VR technology can let users feel the unique charm and cultural value of ICH through head-mounted displays, somatosensory devices and other devices. Moreover, VR technology can also carry out high-precision digital conversion. In the editing process, VR technology can edit and modify digital content more intuitively through virtual scenes and virtual objects.

$$R_t(p_{1t}, Q_t) = p_{1t} \cdot \min(I_t + Q_t, D_t) - (p_{0t} \cdot Q_t + C_t \cdot AI_t) + R_{t-1} \tag{4}$$

The vertex normal vector of vertex I_t can be calculated as follows:

$$I_{t+1} = I_t + Q_t - \min(I_t + Q_t, D_t) = \max(I_t + Q_t - D_t, 0) \tag{5}$$

The curvature AI_t of the vertex can be calculated:

$$AI_t = \frac{(I_t + Q_t)}{2} \cdot \frac{(I_t + Q_t)}{D_t} \tag{6}$$

Where $I_t + Q_t$ is the included angle between the vertex normal vector.

Before VR modeling, ICH needs data acquisition and image processing. Data collection includes the collection of information, which can be collected by laser scanning and photogrammetry. Image processing includes noise reduction, restoration, smoothing and other processing of the collected data, so as to better establish and render the model. After the 3D model is established, it needs to be put into the virtual scene for rendering and display. Using VR technology can build a realistic virtual scene, which can show the environment and atmosphere of cultural heritage more truly. Moreover, the virtual scene can also include elements such as sound and light to provide a more immersive experience.

$$f(\omega, i_t) = \frac{\lambda}{2}\|\omega\|^2 + l\left(\omega, \left(x_{i_t}, y_{i_t}\right)\right) \tag{7}$$

Sub-gradient solution for the above formula:

$$\Delta_t = \lambda\omega_t - I\left[y_{i_t}\left\{\omega_t, x_{i_t}\right\} < 1\right] y_{i_t} x_{i_t} \tag{8}$$

$$\omega_{t+1} \le \omega_t - \beta_t \Delta_t \quad \beta_t = \frac{1}{\lambda_t} \tag{9}$$

Where $\beta_t = \frac{1}{\lambda_t}$ is an adaptive step factor.

One of the advantages of VR modeling is interactive operation. By designing interactive operation, users can have a deeper understanding and experience of cultural heritage. For example, a hot spot area can be set in the three-dimensional model, and when the user moves the mouse to this area, an introduction in the form of words, pictures or videos can automatically pop up; Virtual tour guides can be set up to provide users with automatic explanation and guidance. Through head-mounted displays, somatosensory devices and other devices, users can feel the unique charm and cultural value of cultural heritage in an immersive way. Moreover, the

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immersive experience can also let users know more about the details and essence of cultural heritage.

4 RESULT ANALYSIS AND DISCUSSION

The introduction of VR technology and CAD principles provides new ideas and methods for digital protection of ICH. In this article, the enhancement algorithm of digital ICH interactive experience is studied, and an image enhancement algorithm based on DL and super-resolution enhancement is proposed. By comparing the experimental results of this algorithm and Retinex algorithm, we can find that this algorithm has significant advantages in the feature prediction of ICH images (see Figure 2 and Figure 3).

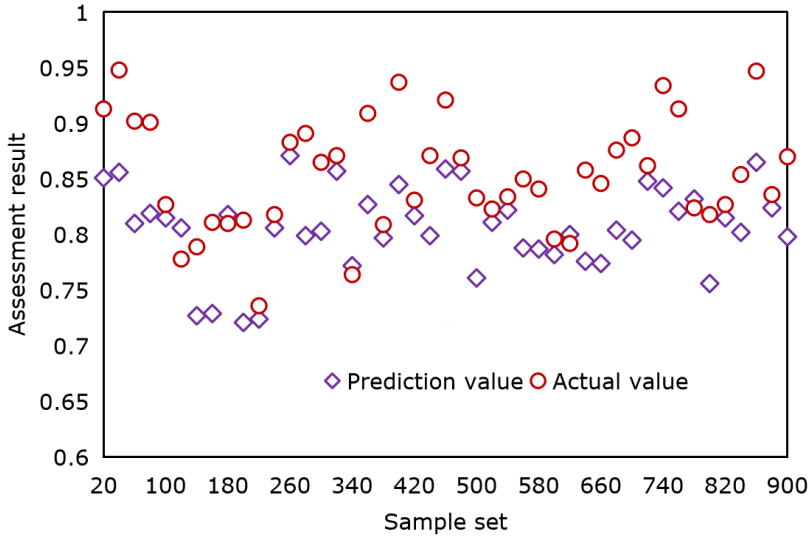

Figure 2: Feature prediction results of Retinex algorithm.

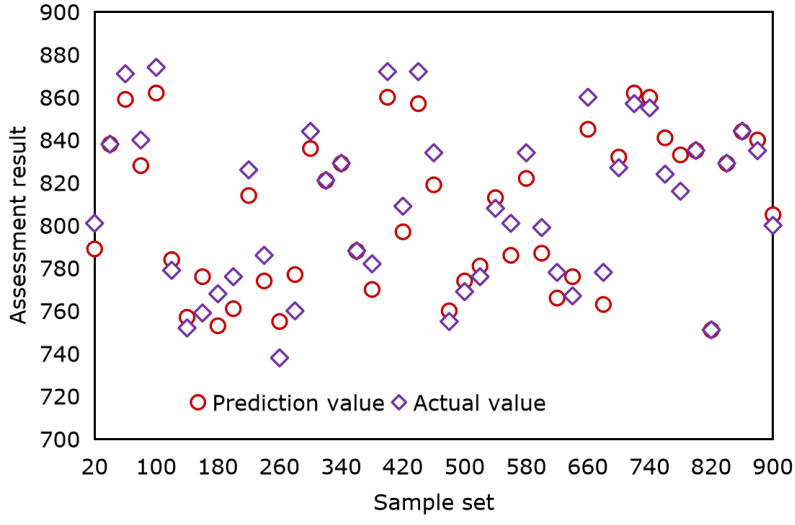

Figure 3: Feature prediction results of this method.

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In this article, the algorithm uses DL model to enhance the ICH image. Compared with the traditional manual feature design method, DL model has stronger feature learning and abstraction ability. Through the training of a large quantity of data, DL model can adaptively extract the key features of the image and use these features to make predictions. The advantage of this method is that it can better adapt to various complex image features and textures, thus improving the accuracy of image enhancement and prediction. Retinex algorithm is a classic image enhancement algorithm, which can enhance the image by separating the color and brightness information of the image. However, this algorithm may have some limitations when processing ICH images, such as the inability to effectively restore the details and color fullness of the images. In contrast, this algorithm adopts DL model and super-resolution enhancement strategy, which can overcome these limitations to a great extent.

The assessment of image enhancement algorithm is mainly based on the visual effect and objective indicators of the enhanced image, such as contrast, brightness, saturation and so on. These indicators can be calculated and assessed by image processing software or algorithms. In this article, by comparing the experimental results of our algorithm and Retinex algorithm, we can find that our algorithm has significant advantages in improving image accuracy, as shown in Figure 4.

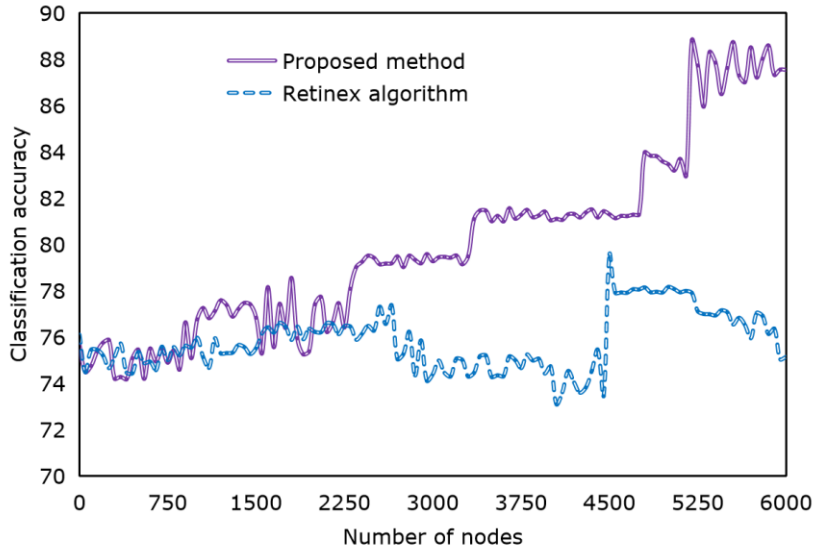

Figure 4: Accuracy test of different algorithms.

The algorithm adopts super-resolution enhancement strategy to improve the quality and visual effect of VR images of cultural heritage. This strategy can effectively enhance the details and color fullness. In contrast, Retinex algorithm may be difficult to achieve the same enhancement effect when processing VR images of cultural heritage. This article has high accuracy in VR image enhancement of cultural heritage. This is mainly due to the powerful feature learning of DL model and the effective application of super-resolution enhancement strategy.

F1 value is one of the commonly used indexes to assess the performance of image enhancement algorithm, which combines the performance of accuracy and recall, and can reflect the overall performance of the algorithm. According to the experimental results, compared with Retinex algorithm, this algorithm has significant advantages in F1 value, as shown in Figure 5.

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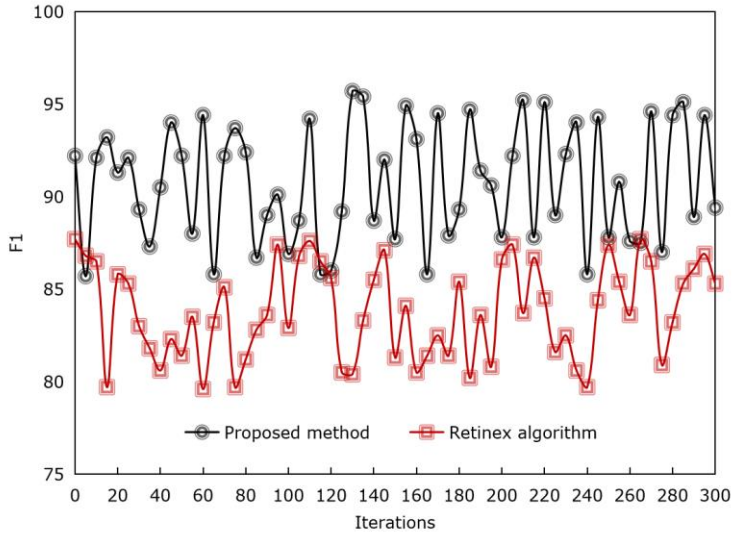

Figure 5: Comparison of F1 values.

By comparing the F1 values of different algorithms, which shows that it has significant advantages. In contrast, the F1 value of Retinex algorithm is low, which indicates that there may be some limitations.

Image processing error is another important index to assess the performance of image enhancement algorithm, which reflects the fidelity of the algorithm. According to the experimental results, compared with Retinex algorithm, this algorithm shows some advantages in image processing error, as shown in Figure 6.

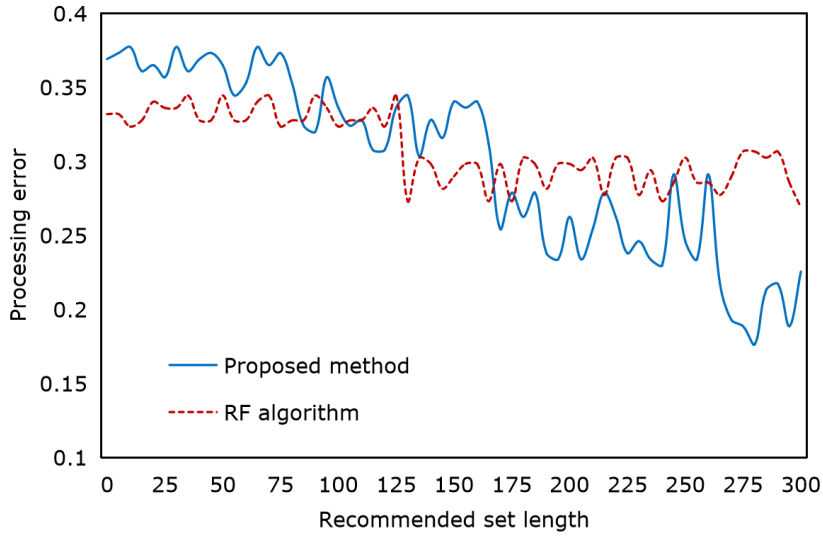

Figure 6: Image processing errors.

The audience assessed the interactive experience of digital ICH from the following three aspects: interactive experience. This assessment mainly focuses on the diversity and depth of interactive experience. Content presentation experience. This assessment mainly focuses on the quality and

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accuracy of the content of cultural heritage after digitization. Knowledge learning experience. The audience's assessment of digital ICH interactive experience also includes the knowledge they gained through interactive experience. The assessment results are shown in Figure 7.

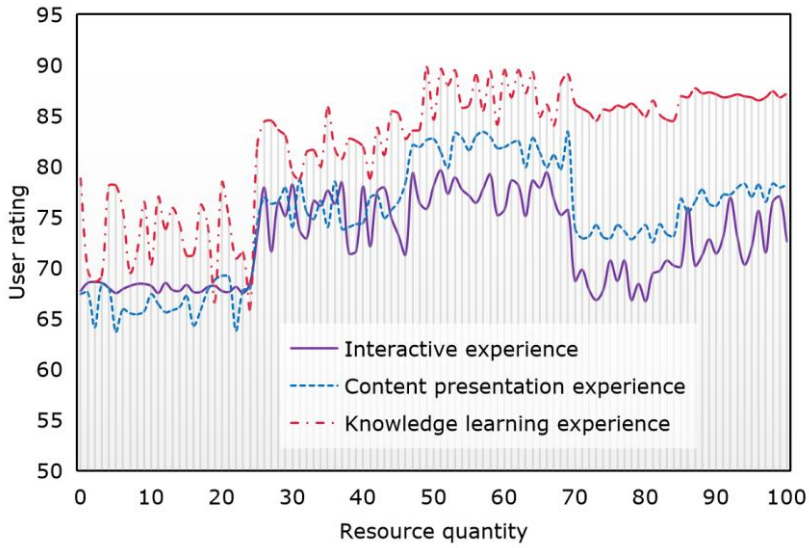

Figure 7: Viewer's rating of digital ICH interactive experience.

From three aspects: interactive experience, content presentation experience and knowledge learning experience, the audience has a high assessment of digital ICH interactive experience. This is mainly due to the effective application of DL model and super-resolution enhancement strategy adopted in this algorithm, which improves the image quality, visual effect and interactive experience. These achievements are of great significance for improving ICH's visual experience and understanding its cultural value.

In this article, strategies such as super-resolution enhancement and color restoration are adopted to improve the quality and visual effect of ICH images. These strategies can effectively enhance the details and color fullness. These enhancement effects are of great significance for improving users' visual experience and understanding the cultural value of ICH. This article shows significant advantages in super-resolution enhancement and color restoration.

5 CONCLUSION

The introduction of VR technology and CAD principles provides new ideas and methods for digital protection of ICH. In this article, the enhancement algorithm of digital ICH interactive experience is studied, and an image enhancement algorithm based on DL and super-resolution enhancement is proposed. Experimental show that this algorithm has obvious advantages in prediction results, F1 value and image processing error compared with Retinex algorithm and other image enhancement algorithms. Moreover, the audience's assessment of interactive experience, content presentation and knowledge learning experience of digital ICH is also high, which proves the effectiveness of the algorithm in improving ICH's visual experience and understanding its cultural value. The effective application of super-resolution enhancement strategy also improves the details and color fullness of the image. This algorithm not only improves the overall performance and quality of images, but also helps to improve users' visual experience and understand the cultural value of cultural heritage. By analyzing the audience's assessment of digital ICH interactive experience, we can find the advantages of this algorithm in practical application. The audience has

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a high assessment of interactive experience, content presentation and knowledge learning experience, which further proves the effectiveness and practicability of this algorithm.

Although this algorithm has obvious advantages in super-resolution enhancement and color restoration, there is still room for improvement. Future research directions can include: further optimizing DL model to better adapt to the characteristics of VR images of cultural heritage; Research more effective super-resolution enhancement strategy to improve the image enhancement effect; And explore other advanced image processing technologies to provide more support for the protection and inheritance of ICH.

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