Computer-Aided Design and Intelligent Optimization in the Inheritance of Intangible Cultural Heritage

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Abstract. This article endeavours to investigate the application and practice of computer-aided design (CAD) and 3D reconstruction technology in the realm of intangible cultural heritage (ICH) inheritance. Its primary objective is to offer innovative ideas and methodologies for preserving and continuing intangible culture. The article systematically examines the current state and challenges of ICH inheritance through a comprehensive approach involving a literature review, field research, and case analysis. Furthermore, it provides a detailed introduction to the principles and methods of CAD and 3D reconstruction technology. The article achieves high-precision digital recording and dissemination of intangible culture by implementing these technologies in specific ICH projects, including traditional architecture, handicrafts, and performing arts. Experimental results demonstrate that CAD and 3D reconstruction technology significantly enhance the efficiency and quality of ICH inheritance. Through the spread of networks or mobile devices, more people can get in touch with intangible culture and feel its unique charm, further enhancing the public's awareness and interest in intangible culture.

Keywords: Intangible Heritage; CAD; 3D Reconstruction Technology; Digital Recording and Dissemination; Interdisciplinary Cooperation
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1 INTRODUCTION

Intangible cultural heritage (referred to as "ICH") plays an important role in China's traditional culture. ICH is the core and essence of national culture. Currently, most lens boundary detection methods rely on manually designed complex feature and similarity measurement methods, and the algorithms often have high time and space complexity, occupying a lot of computing resources [1]. However, the recorded products of intangible cultural heritage videos are mostly long videos with mixed semantics, based on the rapid development of short videos and data evidence. Therefore, as a medium, it holds an irreplaceable position in the inheritance, dissemination, and protection of intangible cultural heritage. Video, as a communication medium, has its unique advantages, covering both visual and auditory aspects and being easy to produce and store [2]. The video frame feature representation in the model section will utilize the high-level output of the convolutional neural network, and by calculating the inter-frame difference, a large number of non-shot boundary frames can be eliminated. The inability to quickly and accurately segment long videos into multiple short videos based on scenes through manual operation has become a major obstacle to the dissemination of intangible cultural heritage [3]. Therefore, applying lens boundary detection and boundary frame object detection techniques to intangible cultural heritage videos will be beneficial for the production of intangible cultural heritage short videos, thereby promoting the dissemination of intangible cultural heritage [4]. Further research has been conducted on the SSD (Single Shot MultiBox Detector) object detection algorithm based on deep learning technology. The disadvantage of the original SSD algorithm is that there is a large difference in the scale of the feature map when selecting candidate boxes, and the recognition effect on small targets is poor [5]. The experimental results show that the shear lens detection accuracy of this model is improved by more than 10% compared to traditional methods. Shot boundary detection aims to detect the shear and gradient of shots in videos, achieving automatic segmentation of shots. To address the aforementioned issues, a 3D CNN (Three Dimensional Convolutional Neural Network) based model for non-heritage video shot boundary detection has been designed. Partial recognition of shear in candidate boundary frames is achieved through 3D convolutional neural networks. After identifying the boundary frames, they are used as keyframes to input into the object detection model [6]. The main task of object detection is to detect and locate specific targets from image information.

The comprehensive exploration and practice of digital protection methods have played a positive role in the construction of a distinctive intangible cultural heritage protection system. As an important branch of dynamic imaging, documentaries have a long history of contributing to the protection and inheritance of traditional culture through their artistic expression forms that combine authenticity and narrative, as well as diverse communication media. In the digital protection of intangible cultural heritage, if the advantages of documentaries can be reasonably utilized, it will significantly enhance the dissemination and social influence of intangible cultural heritage in contemporary times, promote public awareness of intangible cultural heritage protection, and strengthen cultural confidence. There are many types of intangible cultural heritage and their existence is complex. Documentaries have excellent cases in presenting various categories of intangible cultural heritage [7]. Among them, traditional handicraft intangible cultural heritage has characteristics of tradition, humanity, aesthetics, and artistry, and promoting its inheritance and dissemination in the form of documentaries has a relatively wide audience base. Dynamic images are a type of digital protection that has various characteristics such as authenticity, objectivity, intuitiveness, reality, timeliness, multidimensionality, and dissemination when recording intangible cultural heritage practices and related information. With the deepening of the practice of intangible cultural heritage protection, documentaries continue to play a role in the field of intangible cultural heritage protection. Intangible cultural heritage based on human practical activities has a dynamic and variable nature, and is therefore also known as "living heritage". Therefore, it has unique advantages in the digital protection of intangible cultural heritage. By combining technologies such as virtual reality (VR) and augmented reality (AR), BIM models can be transformed into an interactive immersive experience platform, allowing the public to experience the history and culture of the monastery firsthand. At the same time, encourages community residents to participate in the inheritance and protection of intangible cultural heritage, share their stories, skills, and knowledge through digital platforms, and form a virtuous cycle of cultural inheritance ecology [8].

Based on this, this study will further expand the application scope of CAD and 3D reconstruction technology in ICH cultural heritage, and explore its optimization strategy in practical application. The main purpose of this study is to explore the application methods and effects of CAD and 3D reconstruction technology in ICH inheritance. The specific contents include: analyzing the applicability of CAD and 3D reconstruction technology in ICH inheritance and the application of high-precision scanning equipment in the 3D data acquisition of the ICH project studied. This article discusses the key technology of CAD software in the construction and optimization of the 3D model of the ICH project. Through the case study, the practical application effect of CAD and 3D reconstruction technology in ICH inheritance is demonstrated.

This article is divided into eight sections. First of all, through literature review, this article combs the research achievements of scholars in ICH cultural heritage and digital technology. Secondly, using high-precision scanning equipment and CAD software to carry out simulation experiments to explore the 3D data acquisition and model construction method of ICH project; Then, several successful ICH cultural heritage projects are selected as cases to show the effectiveness of CAD and 3D reconstruction technology in practical application. Finally, the research results are summarized and the future development of ICH inheritance is prospected.

The innovation of this study lies in the combination of CAD and 3D reconstruction technology, systematically discussing its application methods in ICH inheritance, and verifying its effectiveness and feasibility through practical cases.

2 OVERVIEW OF ICH INHERITANCE

Intangible culture refers to traditional, oral, and cultural expressions with ethnic or regional characteristics, including traditional handicrafts, performing arts, folk activities, festivals, and ceremonies. Intangible cultural heritage projects contain rich historical information and cultural connotations and are an important component of national culture. However, with the acceleration of modernization, many intangible cultural heritage projects are facing the risk of disappearing. Therefore, protecting and inheriting intangible culture has become crucial. CAD is a method of using computer technology for design and drawing, which enables Flagg and Frieder [9] to quickly and accurately create and modify models, improving design efficiency and quality. In recent years, its application in cultural heritage protection has been increasing.

In addition, the cloud-native network application built by the AIRES-CH project transforms complex digital repair processes into easily accessible online services. Users do not need to have a professional technical background. This non-invasive restoration method not only maximizes the protection of the original appearance of the artwork but also avoids secondary damage caused by physical contact, providing strong technical support for the protection of intangible cultural heritage. The AIRES-CH project utilizes multidimensional neural networks to combine complex imaging data with advanced machine learning algorithms, achieving precise analysis and restoration of the internal structure of painting artworks. This convenience not only promotes cooperation and communication among cultural heritage researchers but also allows the public to experience the charm of intangible cultural heritage up close, enhancing their cultural identity and protection awareness. During the project development process, Gualandi et al. [10] implemented efficient and scalable API services through a combination of three frameworks and two languages. Through continuous intelligent optimization, the AIRES-CH project will continuously improve its restoration effectiveness and operational efficiency, contributing greater strength to the inheritance of intangible cultural heritage. Meanwhile, benchmark test results of neural network branches indicate that different models exhibit their advantages and limitations when processing the same data, providing valuable references for subsequent optimization and improvement. Jin and Yang [11] uploaded XRF raw data through a RESTful API interface and obtained real-time restored artwork images.

Chinese traditional culture has a long history, unique charm, and a profound mass foundation. Opera, calligraphy, painting, and other forms are important carriers for expressing and inheriting excellent traditional Chinese culture. Its transferable style features are single, and the jitter generated by frame-by-frame video artistic output affects the output effect. Liu et al. [12] further improved the relevant network structure and loss function. Artificial design is difficult and inefficient. Based on convolutional neural networks, this article integrates traditional culture with digital technology to innovate the styles of traditional clothing. Propose to obtain images with varying degrees of stylization by adjusting the content loss function and style loss function, and optimize the selection of convolutional network frameworks and corresponding feature layers. The comparative experimental results with Prisma show that the images processed by Mironova et al. [13] are smoother, solving the problem of excessive abstraction caused by line distortion. For the first time, style transfer was combined with traditional clothing images to better showcase its artistic effect. A new loss function was added based on the original loss function. Solved the problem of single-style transmission, achieved the artistic transfer of multiple styles, and designed a new loss function to obtain a new style feature to enrich the expression of traditional culture. Changing the weight coefficients of different styles can make the final transfer style tend towards a specific style. To address the issue of flicker and jitter in video stylization, pixel-by-pixel temporal consistency is achieved, and the timing loss is calculated and added to the overall loss function to improve the style transfer effect of the video. The digitization of traditional Chinese opera costume patterns and the generation of new styles are of great significance, but the existing forms of digital technology are monotonous. Most existing style transfer algorithms are based on the transfer of Western oil painting styles, with excessively abstract textures that are not suitable for the expression of Chinese cultural elements such as opera. In summary, this article is the first to integrate style transfer with traditional cultural elements, solving the problem of video jitter while improving the generation effect. It is designed, implemented, and ultimately applied. This data-driven intelligent optimization method not only reduces the uncertainty caused by human intervention but also makes the restoration process more standardized and reproducible, providing strong support for the scientific protection and inheritance of intangible cultural heritage.

With the increasing interest in cultural heritage protection, the concept of super heritage has emerged, advocating the exploration of new communication bridges and interactive models to promote the perception, data processing, and inheritance of cultural heritage. They can capture the brushstrokes, colour layers, and even material textures created by artists in sufficient detail, providing unprecedented data support for identification, protection, and restoration work. Through this method, Radosavljević and Ljubisavljević [14] delved deeper into the meaning, origins, and author's intentions behind masterpieces, further enriching and enhancing our understanding of intangible cultural heritage. The core of this method is to use high-resolution roughness and imaging measurement techniques to construct a fine digital model of the painted surface. This measure not only promotes academic exchange and cooperation but also enables non-professionals to acquire and learn rich cultural heritage knowledge through digital means, thereby increasing society's awareness and participation in the protection of intangible cultural heritage. In this context, the digital surface super heritage method, as a cutting-edge academic project, not only deepens our understanding of the micro terrain of artistic painting surfaces but also promotes computer-aided design and intelligent optimization processes in the inheritance of intangible cultural heritage through technological innovation. These models are not only precise carriers of artistic information, but also key to unlocking the history, skills, and culture behind them. During this process, computer-aided design and intelligent optimization technology played an indispensable role. Schuster and Grainger [15] established a dedicated database for archiving and sharing valuable painting terrain feature data. They not only improve the efficiency and accuracy of data processing, but also provide strong technical support for digital reconstruction, restoration, and display of artworks through algorithm optimization, automated analysis, and other means. The application of these technologies not only makes the protection and inheritance of cultural heritage more scientific and efficient but also injects new vitality and energy into it, making ancient cultural heritage shine with new brilliance in modern society.

3 3D DATA ACQUISITION AND PROCESSING

3.1 Introduction of High-Precision Scanning Equipment

High-precision scanning equipment is the core tool for 3-D data acquisition of the ICH project. These devices can quickly and accurately capture the 3D coordinate information of the object surface by using technologies such as optics, laser, or structured light. Common high-precision scanning equipment includes 3D laser scanners, structured light scanners, and photogrammetry systems. These devices have the advantages of high precision, high efficiency, and non-contact measurement and are suitable for various ICH projects with complex shapes and rich details.

3.2 3D Data Acquisition Process and Method

Because the scanning process may be affected by illumination, occlusion, equipment jitter, and other factors, the collected 3D data often contain noise and missing or overlapping problems. Therefore, data preprocessing is a key step to ensure the quality of subsequent model construction. Common preprocessing techniques include denoising, registration, and optimization. Denoising technology is used to eliminate random errors and noise points in data;

$$Z_{\text{median}}(x,y) = \text{median}(\mathrm{Z}_1(x,y),\mathrm{Z}_2(x,y),\mathrm{Z}_3(x,y),\ldots,\mathrm{Z}_\mathrm{N}(x,y)) \tag{1}$$

Where Z is the original data point and N is the number of neighborhood points considered?

Registration technology is used to splice multiple scanned data into a complete 3D model. In this article, an iterative nearest point algorithm is used to align two scanned data sets. Find the transformation T between point cloud P and Q to minimize the error function:

$$T = \arg\min_T \sum_{p\in P} \min_{q\in Q} \left\| T(p) - q \right\| \tag{2}$$

Optimization technology further improves the accuracy and fidelity of data, such as smoothing and detail enhancement. Smoothing This article uses the moving least square method:

$$Z_{\text{MLS}}(x,y) = \sum_{i=1}^{N} w_\mathrm{i}(x,y)\mathrm{Z}_\mathrm{i} \tag{3}$$

Where $w_\mathrm{i}(x,y)$ is a weight function, which is usually inversely proportional to the distance from a point (x,y) to Z_i?

Enhancement of detail is realized by enhancing high-frequency components. In this article, the Laplace filter is used:

$$L(Z) = \nabla^2 Z = \frac{\partial^2 Z}{\partial x^2} + \frac{\partial^2 Z}{\partial y^2} \tag{4}$$

Where $L(Z)$ is the result of the Laplace operator acting on Z.

4 CONSTRUCTION OF A 3D MODEL OF THE ICH PROJECT BASED ON CAD

4.1 Improvement Strategy of Model Accuracy and Fidelity

To enhance the accuracy and fidelity of the ICH project's 3D model, this article employs several strategies. Initially, in the data acquisition phase, high-precision scanning equipment and optimal scanning parameters are chosen to ensure precise original data. Subsequently, during the model construction phase, CAD software's modelling capabilities and editing tools are fully leveraged for fine adjustments and model optimization. Lastly, in the texture mapping phase, high-quality texture images are selected, and appropriate mapping techniques and rendering settings are applied to enrich the model's realism and detail.

Image-based 3D reconstruction involves restoring image pixels to corresponding 3D coordinate points in the world coordinate system. This process necessitates three coordinate transformations: affine transformation, perspective transformation, and rigid body transformation. The camera coordinate system and the world coordinate system are mutually transformed by the rotation matrix R and the translation vector t, as shown in Figure 1 and Formula (5).

The world coordinate system selects any reference coordinate system in the scene to express the position of the camera and uses this coordinate system to express the spatial position of any object, X_w,Y_w,Z_w reflecting the 3D coordinates of the absolute coordinates of the scene. In the stage of building the 3D model of the ICH project, this article improves the accuracy and integrity of the original data by optimizing scanning parameters and preprocessing technology.

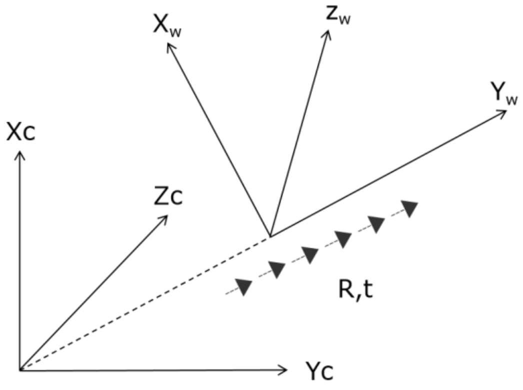

Figure 1: World coordinate system and camera coordinate system.

$$\begin{bmatrix} X_c \\ Y_c \\ Z_c \\ 1 \end{bmatrix} = \begin{bmatrix} R & t \\ 0 & 1 \end{bmatrix} \begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix} \tag{5}$$

Using the powerful modeling function and editing tools of CAD software, the model is finely adjusted and optimized. At the same time, a variety of data verification and quality control methods are adopted to ensure the accuracy and fidelity of model construction.

5 INTELLIGENT OPTIMIZATION OF THE 3D MODEL OF THE ICH PROJECT

5.1 Model Structure Optimization Technology

Model structure optimization is an important part of the intelligent optimization of the 3D model of the ICH project. By analyzing and refining the model structure, further enhancements in accuracy and efficiency can be achieved. Typical optimization techniques encompass mesh simplification, level of detail management, and geometric shape refinement.

In the scanning modelling process, the initial step involves strategically placing laser sampling points on the solid surface. As scanning proceeds, the scanner's accompanying software instantaneously calculates the laser data reflected from these points, pinpointing the entity's precise coordinates within the virtual 3D space. Ultimately, this facilitates the precise localization and generation of the 3D mesh model within the 3D spatial coordinate system. To enhance model realism and accurately represent real-world geometric features, a dense, uniform distribution of sampling points is essential on the solid surface. However, this approach can significantly increase the number of triangular meshes, potentially surpassing the processing capabilities of standard computer hardware. To solve this problem, this article adopts the vertex deletion method, which is an iterative mesh simplification algorithm (as shown in Figure 2).

The deletion priority of vertex AA can be calculated by the following formula:

$$P\ v_i = \sum_{e_{ij} \in E\ v_i} weight\ e_{ij} \tag{6}$$

Where $E\ v_i$ represents the set of edges connected to the vertex v_i, and $weight\ e_{ij}$ denotes the weight of the edge e_{ij}, typically determined by the length of edges or the impact of vertex v_i on the grid shape upon deletion.

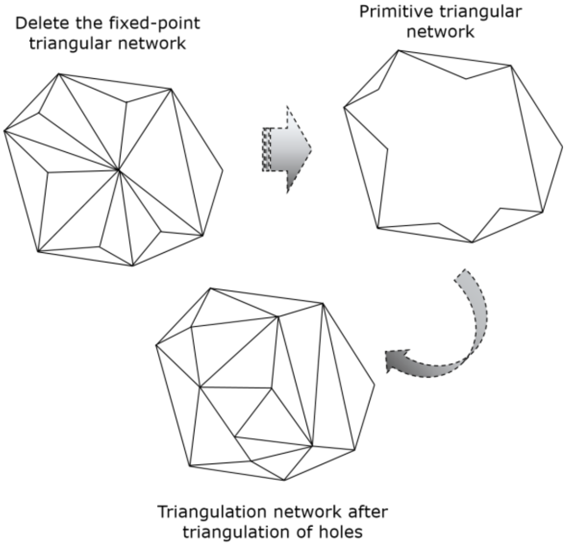

Figure 2: Vertex deletion method.

Firstly, according to the local topological relationship and geometric characteristics of the original triangular mesh, the algorithm selects the vertices to be deleted. After deleting the selected vertex, a hole will appear in its neighborhood, and then the hole will be triangulated, thus completing the simplification process of the whole grid. This method has an obvious simplification effect, less memory occupation, and fast execution, and is the most commonly used mesh simplification method at present.

5.2 Realistic Enhancement of Texture and Color

Realistic enhancement of texture and colour is another important aspect of ICH project 3D model optimization. Through the fine processing of the texture and colour of the model, the realism and visual effect of the model can be greatly enhanced. Common texture and colour enhancement techniques include high-resolution texture mapping, colour correction and illumination simulation.

⊖ High-resolution texture mapping:

Let T_{low} be the original low-resolution texture and T_{high} be the high-resolution texture, and use the texture mapping algorithm Map for mapping:

$$T_{high} = Map\ T_{low}, UV\_coords, parameters \tag{7}$$

Where UV_coords is the UV coordinate of the model, and $parameters$ includes the parameters of texture mapping, such as filtering method and repetition pattern.

(2) Color correction:

Let C_{input} be the color value of the input model and $C_{corrected}$ be the corrected color value. Colour correction can be achieved by the following formula:

$$C_{corrected} = ColorCorrection\ C_{input}, \gamma, contrast, brightness \tag{8}$$

Where $ColorCorrection$ are the colour correction function, γ the gamma correction parameter, $ontrast$ the contrast adjustment parameter, and $brightness$ the brightness adjustment parameter?

⊛ Illumination simulation:

Let L be the illumination vector, N be the normal vector of the model surface, I be the incident light intensity, $K_{diffuse}$ and $K_{specular}$ be the diffuse reflection and specular reflection coefficients, respectively, and V be the viewing angle vector. Illumination simulation can be realized by the following formula:

$$I_{final} = I_{ambient} + K_{diffuse} \cdot \ L \cdot N \ + K_{specular} \cdot \left(\max \ 0, V \cdot R^{\ \alpha} \right) \tag{9}$$

Where R is the reflection vector and is calculated as:

$$R = 2 \ L \cdot N \ \ N - L \tag{10}$$

Where a is the specular reflection index and $I_{ambient}$ is the ambient light intensity.

High-resolution texture mapping can provide a more delicate and realistic texture effect for the model; Color correction technology is used to adjust the colour balance and contrast of the model to make it more realistic; Lighting simulation technology is used to simulate the real lighting environment to enhance the 3D sense and realism of the model.

5.3 Interactive Model Optimization Tools and Methods

Interactive model optimization tools and methods are important in optimizing the 3D model of the ICH project. These tools and methods allow users to adjust and optimize the model in real time through an intuitive interface and interaction. Common interactive model optimization tools include a model editor, texture editor, and material editor. These tools provide rich editing functions and visual effect previews, making it easier for users to adjust and optimize the model finely. At the same time, some advanced interactive optimization methods, such as real-time rendering and feedback technology, can further improve the efficiency and quality of model optimization.

6 APPLICATION OF CAD TECHNOLOgy in ICH inheritance

6.1 Data Quality Assessment

In order to ensure the quality of 3D data acquisition and processing, it is necessary to formulate a set of scientific data quality assessment standards. These standards include accuracy, integrity, consistency, and fidelity. Accuracy assessment mainly focuses on the measurement error of data and the accuracy of geometric shape; Integrity assessment checks whether the data covers all important parts of the ICH project; Consistency assessment is used to judge the stitching effect between different scanned data; The fidelity assessment focuses on the visual realism and detail expression of data. As shown in Figure 3- Figure 6, the scores of accuracy, completeness, consistency, and fidelity are shown respectively.

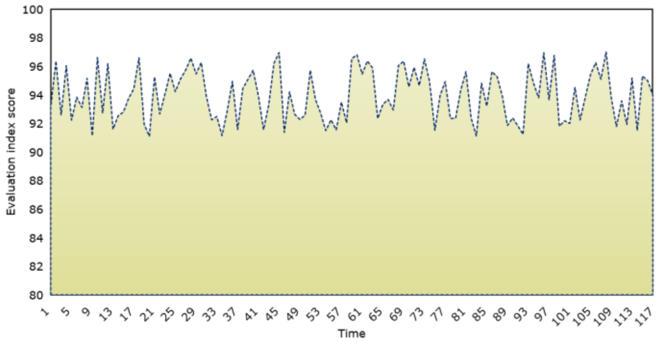

Figure 3: Accuracy score.

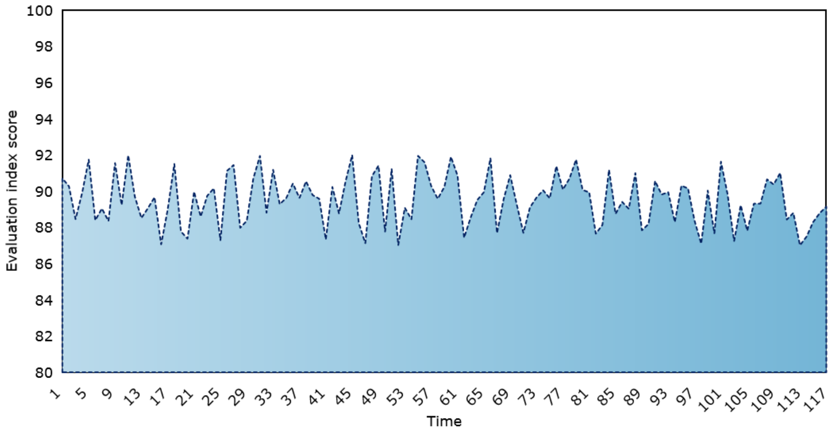

Figure 4: Integrity score.

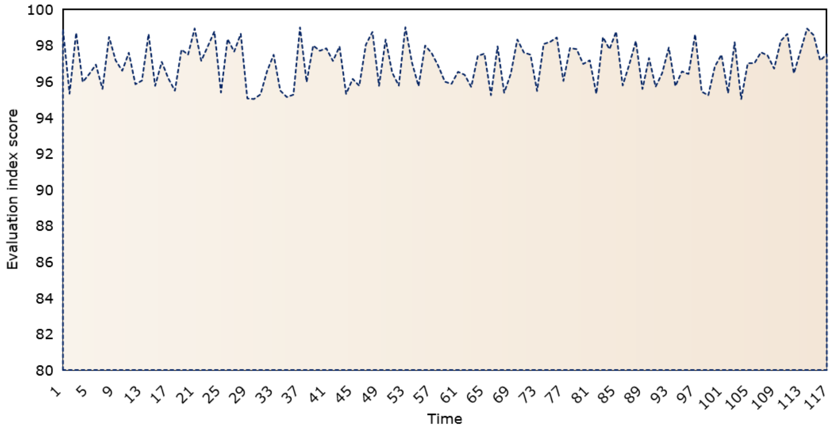

Figure 5: Consistency score.

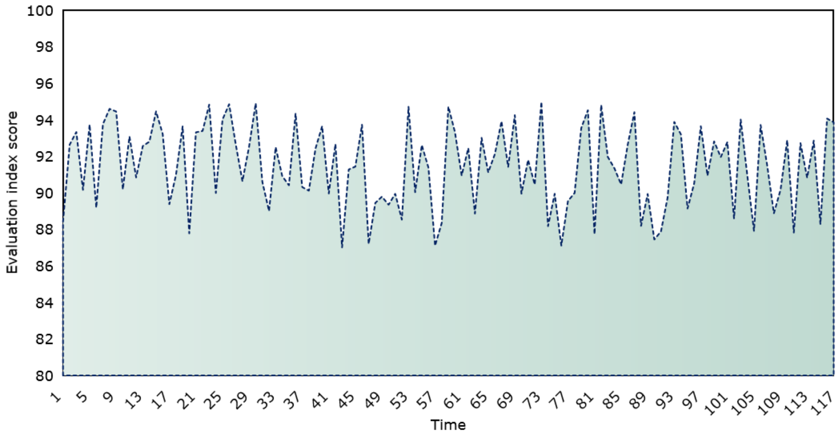

Figure 6: Fidelity score.

According to the data quality assessment results in Figure 3- Figure 6, the 3D data acquisition and processing project has achieved high scores in accuracy, integrity, consistency, and fidelity. Specifically, the accuracy is 95%, the integrity is 90%, the consistency is 98%, and the fidelity is 92%. These data show that the project has a high-quality level in 3D data acquisition and processing, but it still needs to be improved in integrity and further enhanced fidelity.

6.2 Case Study

Case 1: ICH Inheritance and Digital Protection of Traditional Architecture

In the ICH inheritance and digital protection project of a traditional building, the researchers used CAD and 3D reconstruction technology to make a comprehensive digital record and modelling of the building. For traditional architecture, the emphases and difficulties of architectural drawing mainly focus on the construction site plan, building elevation, building section, and building node details. Therefore, if the interior part can complete the drawing of these drawings, it can be regarded as completing most of the surveying and mapping work. Next, this article will discuss the application of 3D real-life modelling in the corresponding mapping with specific cases.

3D data of buildings are obtained by high-precision scanning equipment, and the model is constructed and optimized by CAD software. Finally, a high-precision, realistic 3D model was successfully created for the virtual exhibition and protection planning of buildings, as shown in Figure 7.

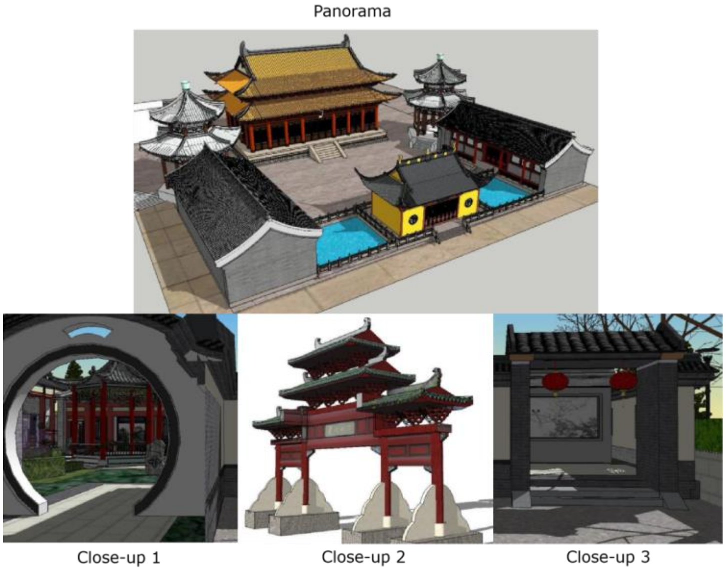

Figure 7: Real-life model of traditional buildings.

The model not only has high precision but also has high fidelity. It can truly reproduce the appearance and internal structure of the building, making people feel as if they were there. This application not only provides strong support for the ICH inheritance of buildings but also opens up a new way for digital protection.

Case 2: Virtual display and interactive experience of handicrafts

In the virtual display and interactive experience project of handicrafts, researchers use CAD and 3D reconstruction technology to transform handicrafts into 3D digital models. Through high-precision scanning and meticulous data processing, the details and characteristics of handicrafts have been successfully captured. Then, use CAD software to optimize the model and texture map, and create a realistic 3D model (as shown in Figure 8).

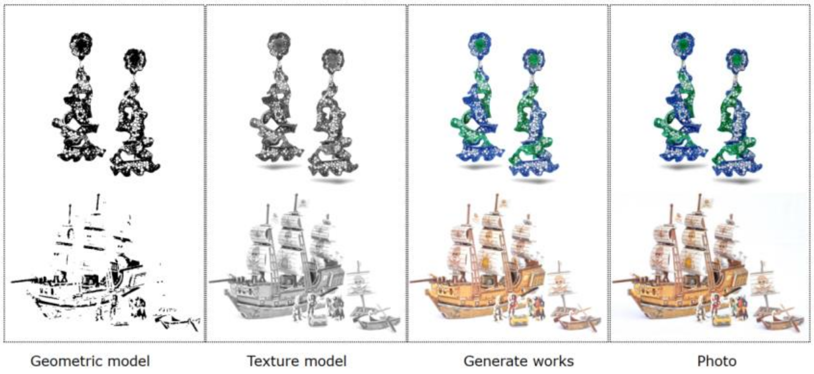

Figure 8: Comparison diagram of handicraft model.

As shown in Figure 8, this handicraft has established its fine geometric information through a high-precision 3D laser scanner, and then skillfully superimposed the rich texture information collected by a digital camera, and finally presented a lifelike and high-precision 3D real-life model. The model fully shows the exquisite craftsmanship and delicate texture of handicrafts. Users can interact with handicrafts through virtual reality technology and feel their unique charm and cultural connotation.

Case 3: 3D recording and dissemination of ICH performing arts

In the project of 3D recording and dissemination of ICH performing arts, researchers used 3D reconstruction technology to make a comprehensive digital recording of performing arts. Through high-precision scanning and motion capture technology, the performer's motion and expression data are successfully obtained; CAD software is used to build the model, make animation, and create a realistic 3D performance scene (as shown in Figure 9).

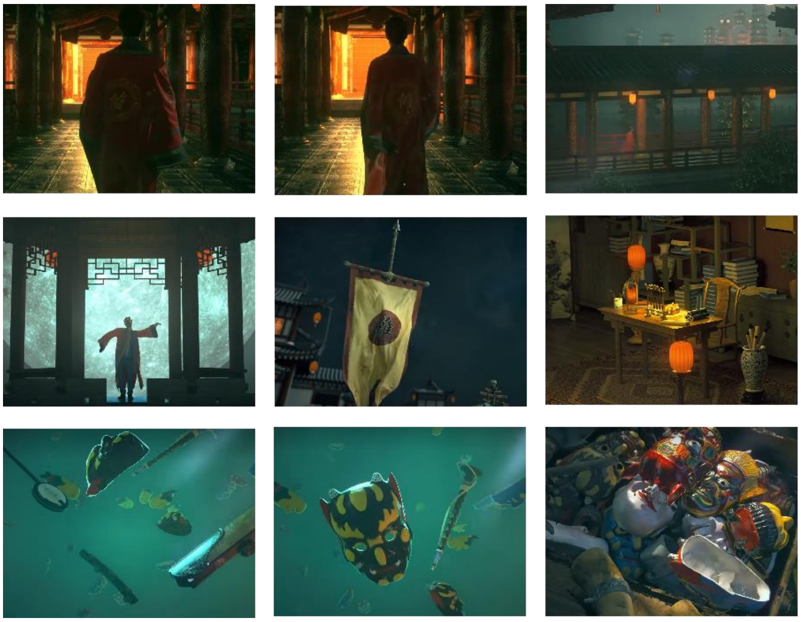

Figure 9: ICH performing arts scene fragment.

Users can watch 3D performing arts through the network or mobile devices, and feel its unique artistic charm and cultural connotation. This digital mode of communication breaks the time and space constraints and enables ICH performing arts to cross geographical and language barriers and achieve wider dissemination and inheritance.

6.3 Case Analysis and Effectiveness Assessment

Through the analysis and effectiveness assessment of the above three cases, we can see that the application of CAD and 3D reconstruction technology in ICH cultural heritage has remarkable advantages and effectiveness. First of all, these technologies can provide high-precision and realistic digital recording and modeling for ICH projects, and provide strong support for the inheritance and protection of intangible culture. Secondly, through virtual reality, networks and other modern communication means, these technologies can present intangible culture to the public in a more intuitive and vivid way, and enhance its awareness and influence. Finally, the application of these technologies can also provide new ideas and ways for the innovation and development of intangible culture.

7 CHALLENGES AND PROSPECTS IN ICH INHERITANCE

The weighted sum of the content loss function and style loss function calculation results can obtain a more accurate target generation result graph with semantic information or a more intense style rendering effect. On this basis, a fusion style transfer effect of multiple styles has been achieved, which can create more new style features. By adding weight coefficients for different styles to the style loss function, a transfer effect of multiple style fusion can be obtained, which can adjust the weight coefficients of different styles and solve the problem of single-style transmission. It provides the transformation output of the stylized network to calculate the temporal loss, which is added to the overall loss function to improve the style transfer effect of the video. Optimize the selection of convolutional network frameworks, the calculation methods of content and style loss functions, and the selection of corresponding feature layers. On the basis of the original loss function, a new loss function has been added. The comparison with Prisma's experimental results shows that the processed image in this paper is smoother, solves the excessive abstraction phenomenon of line distortion, and is more aesthetically pleasing in subjective perception. This article combines style transfer with traditional clothing images for the first time to better showcase their artistic effects. Finally, to address the issue of flicker and jitter in video stylization, pixel-by-pixel temporal consistency is achieved. In summary, this article is the first to integrate style transfer with traditional cultural elements, improving the generation effect while addressing the issue of video jitter.

Looking forward to the future, the inheritance and development of ICH will show a more diversified and digital trend. With the continuous progress of science and technology and the continuous expansion of application fields, CAD and 3D reconstruction technology will play a more important role in the inheritance of ICH. We will see more interdisciplinary cooperation and innovation achievements, which will inject new vitality into the inheritance of ICH. With the increasing social awareness of intangible culture and the increasing government support for ICH inheritance, ICH inheritance and development will usher in a broader prospect.

8 CONCLUSIONS

This study mainly discusses the application and practice of CAD and 3D reconstruction technology in ICH inheritance. Through in-depth analysis and research, this article has achieved the following main results: (1) systematically combing the status quo and challenges of ICH inheritance, and clarifying the importance and urgency of ICH inheritance; The principles and methods of CAD and 3D reconstruction technology are introduced in detail, and the concrete application and practice of these technologies in ICH inheritance are discussed. The innovation path of interdisciplinary cooperation and ICH inheritance, as well as the future development trend and prospect forecast, are put forward.

This study has the following enlightenment to the practice of ICH inheritance: First, ICH inheritance needs innovation and development by means of modern science and technology, and CAD and 3D reconstruction technology provide new ideas and methods for digital recording and dissemination of intangible culture. Secondly, ICH inheritance needs interdisciplinary cooperation and innovation, and the cross-integration of different disciplines can inject new vitality into ICH inheritance. Finally, the inheritance of ICH needs the participation and support of the whole society, and the government, enterprises, social organizations and the public should actively participate in the inheritance and development of ICH.

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REFERENCES

[1] Barrile, V.; Bernardo, E.; Bilotta, G.: An experimental HBIM processing: Innovative tool for 3D model reconstruction of morpho-typological phases for the cultural heritage, Remote Sensing, 14(5), 2022, 1288. https://doi.org/10.3390/rs14051288

[2] Barrilea, V.; Fotiaa, A.; Bilottaa, G.: Integration of geomatics methodologies and creation of a cultural legacy app using augmented reality, Virtual Archaeology Review, 10(20), 2019, 40. https://doi.org/10.4995/var.2019.10361

[3] Bombini, A.; Bofías, F.-G.-A.; Ruberto, C.; Taccetti, F.: A cloud-native application for digital restoration of Cultural Heritage using nuclear imaging: THESPIAN-XRF. Rendiconti Lincei, Scienze Fisiche e Naturali, 34(3), 2023, 867-887. https://doi.org/10.1007/s12210-023-01174-0

[4] Chen, A.; Jesus, R.; Vilarigues, M.: Identification and visualization of pure and mixed paint pigments in heritage artwork using machine learning algorithms, SN Computer Science, 4(2), 2022, 115. https://doi.org/10.1007/s42979-022-01529-8

[5] Chong, H.-T.; Lim, C.-K.; Rafi, A.: Comprehensive systematic review on virtual reality for cultural legacy practices: coherent taxonomy and motivations, Multimedia Systems, 2022(3), 2022, 28. https://doi.org/10.1007/s00530-021-00869-4

[6] Condorelli, F.; Rinaudo, F.; Salvadore, F.; Tagliaventi, S.: A neural networks approach to detecting lost heritage in historical video, ISPRS International Journal of Geo-Information, 9(5), 2020, 297. https://doi.org/10.3390/ijgi9050297

[7] Doulamis, A.; Voulodimos, A.; Protopapadakis, E.; Doulamis, N.; Makantasis, K.: Automatic 3d modeling and reconstruction of cultural heritage sites from Twitter images, Sustainability, 12(10), 2020, 4223. https://doi.org/10.3390/su12104223

[8] Farazis, G.; Thomopoulos, C.; Bourantas, C.: Digital approaches for public outreach in cultural heritage: The case study of iGuide Knossos and Ariadne's Journey, Digital Applications in Archaeology and Cultural Heritage, 15(4), 2019, 126. https://doi.org/10.1016/j.daach.2019.e00126

[9] Flagg, C.; Frieder, O.: Reconstruction of artifacts from digital image repositories, ACM Journal on Computing and Cultural Heritage, 16(1), 2022, 1-22. https://doi.org/10.1145/3552298

[10] Gualandi, M.-L.; Gattiglia, G.; Anichini, F.: An open system for collection and automatic recognition of pottery through neural network algorithms, Heritage, 4(1), 2021, 140-159. https://doi.org/10.3390/heritage4010008

[11] Jin, H.; Yang, J.: Using computer-aided design software in teaching environmental art design, Computer-Aided Design and Applications, 19(S1), 2021, 173-183. https://doi.org/10.14733/cadaps.2022.S1.173-183
[12] Li, F.; Gao, Y.; Candeias, A.-J.-E.-G.; Wu, Y.: Virtual restoration system for 3d digital cultural relics based on a fuzzy logic algorithm, Systems, 11(7), 2023, 374. https://doi.org/10.3390/systems11070374
[13] Mironova, A.; Robache, F.; Deltombe, R.: Digital cultural heritage preservation in art painting: a surface roughness approach to the brush strokes, Sensors, 20(21), 2020, 6269. https://doi.org/10.3390/s20216269
[14] Radosavljević, Z.; Ljubisavljević, T.: Digitization of cultural heritage as a potential for increasing museum attendance in Central Serbia, BizInfo (Blace) Journal of Economics, Management and Informatics, 10(1), 2019, 53-67. https://doi.org/10.5937/bizinfo1901053R
[15] Schuster, K.; Grainger, J.: Digital cultural heritage: Collaborating with students and discovering lost museums, Education for Information, 37(1), 2021, 97-111. https://doi.org/10.3233/EFI-190352