Analysis of the Diverse Values of 3D Animation Technology for Historical Buildings in Cultural Heritage Preservation

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Abstract Innovative protection of cultural heritage plays a crucial role in enhancing national cultural confidence. This paper proposes a refined three-dimensional animation reconstruction framework for historical buildings based on three-dimensional laser scanning and photogrammetry, enabling component-based information management driven by point cloud data. Through key technologies such as establishing an independent coordinate system, point cloud slicing, and real texture mapping, high-precision modeling of complex components in historical buildings is achieved. Research findings indicate that the maximum planar error and elevation error in 3D animation modeling of historical buildings are only 0.011m and 0.008m, respectively. MEAN, RMS, and STD are all below 0.005m, EOA is below 0.300%, and modeling time does not exceed 12 seconds. In expert and public evaluations, satisfaction with the preservation of the historical appearance of historical buildings was the highest, reaching 0.939 and 0.912, respectively, demonstrating the significant effectiveness of modeling technology in assisting historical building conservation.

Index Terms 3D laser scanning, extinct point method, point cloud processing, component-based management, historical buildings

I. Introduction

Historical architectural cultural heritage embodies profound historical and cultural significance, bearing witness to a city's centuries-long journey through time. With its unique architectural styles and rich cultural connotations, it serves as a custodian of traditional culture and exquisite craftsmanship, and a testament to the wisdom of ancient civilizations [1], [2]. However, with the rapid development of urbanization and modernization, many precious architectural heritage sites are now at risk of being destroyed or forgotten [3], [4]. Against this backdrop, the protection of architectural cultural heritage has become a key focus of national cultural heritage conservation efforts. With the rapid evolution and application of surveying and mapping technologies, cultural heritage conservation has entered a phase of digitalization and informatization, and standards and regulations for the protection of architectural cultural heritage have been preliminarily established [5]-[7]. The work of protecting architectural cultural heritage is continuing to develop in a scientific and standardized direction. The protection of architectural heritage not only helps to preserve a nation's historical and cultural traditions but also plays a positive role in promoting tourism and economic development [8], [9].

Architectural cultural heritage is not immortal and cannot be regenerated; it has been continuously eroded by natural environments and damaged by human activities over the course of history [10]. All we can do is strive to protect it, delay its disappearance as much as possible, and pass on its spirit. As people's awareness of the importance of architectural cultural heritage grows, how to preserve it long-term without damaging the buildings themselves has become particularly important. However, due to the existence of historical issues such as an incomplete management mechanism for architectural cultural heritage, a lack of clear norms and standards for surveying and repair work, a shortage of professional talent, and funding constraints, the development of architectural cultural heritage protection has been constrained [11]-[13]. Traditional data recording methods primarily rely on carriers such as drawings, text, and photographs. The emergence of CAD technology has transformed the mapping methods used in architectural cultural heritage protection from traditional manual drawing to digital mapping [14]. With the rapid development of informatization and digitization, the development of digital technologies related to architectural cultural heritage protection has garnered widespread attention, and more modern technologies have been applied to architectural conservation, significantly improving work efficiency. Architectural cultural heritage protection has begun to transition from information preservation to information management [15], [16].

Three-dimensional animation recreation technology is an integrated technology combining three-dimensional reconstruction technology and animation generation technology. Among these, three-dimensional reconstruction technology refers to the process of reconstructing the three-dimensional form of an object from image, video, and lidar data sources using mathematical methods, computer technology, and imaging technology [17]. Three-dimensional animation, on the other hand, is characterized by precision, realism, and operational convenience. In practical applications, it is rarely constrained by temporal or spatial conditions and can vividly and accurately depict various complex and abstract concepts [18], [19]. In cultural heritage preservation, three-dimensional animation reconstruction technology is widely applied, and through an analysis of its multifaceted value, it provides theoretical references for the field of heritage preservation.

Literature [20] considers scenes, characters, and stories to propose a 3D technology-supported ancient building animation design scheme, using 3D technology to construct a virtual world of the building. Literature [21] combines depth cameras and 3D reconstruction technology to explore the protection of the Great Wall of China, using depth cameras to capture the features of the Great Wall in real time, extracting local sparse features and global dense features from the Great Wall images, and performing real-time 3D reconstruction of the Great Wall. Literature [22] utilizes 3D point cloud reconstruction AI and generative adversarial network AI to establish a digital framework applicable to architectural heritage restoration, thereby protecting heritage. Literature [23] employs unmanned aerial vehicles, building information modeling, and virtual reality to collect architectural heritage point cloud data, construct 3D point cloud models, and perform 3D architectural heritage restoration. Literature [24] employs a three-dimensional modeling method for industrial heritage buildings using iterative reconstruction optimized by genetic algorithms, and integrates the reconstructed models into a three-dimensional model management system to accurately record the spatial form and structural features of the buildings. Literature [25] uses a single-frame unmanned aerial vehicle to collect architectural heritage data, employs three-dimensional reconstruction technology for architectural reproduction, and combines a multi-view stereo network based on deep learning to design software for architectural reproduction.

This paper uses 3D laser scanning to obtain high-precision point cloud data of historical buildings, and establishes a basic component-based animation model through filtering and compression, feature registration, and independent coordinate system construction. For single-image data, the vanishing point perspective principle is used to calculate building dimensions, obtain 3D information of historical buildings, fill in historical data gaps, and enhance modeling details. A parametric component library was developed using geometric descriptive language, enabling detailed semantic associations of building models on the H-BIM platform, providing additional information references for the conservation and restoration of historical buildings. Through error calculations, comparative experiments, and questionnaire surveys, the effectiveness of the model's construction and its practical application value in conservation were validated.

II. Application Analysis of 3D Animation Technology for Historical Buildings

II. A.Analysis of the 3D animation reconstruction process of historic buildings

II. A. 1)   Detailed 3D animation reconstruction of historical buildings

Figure 1 shows the overall architecture of this study. The three-dimensional reconstruction of historical buildings employs a three-dimensional laser point cloud refinement modeling method. Refinement modeling simplifies the reconstruction process for similar types of buildings while detailing the fine features of special components, providing the spatial information foundation for component-based management.

Multi-level component-based management of 3D reconstruction models is tailored to the characteristics of historical buildings, organizing spatial information within the reconstruction model. Through component-based management, on one hand, it reduces spatial information redundancy for components of the same type and style while retaining the detailed spatial information of refined special components; on the other hand, it provides an information carrier and organizational basis for the attribute information of historical buildings.

After completing multi-level component-based management of spatial information, integrating attribute information from different levels based on spatial information enables the management of historical information, protection information, and inspection and intervention information. The detailed 3D reconstruction and component-based management of historical buildings can preserve detailed records of historical buildings, simulate their actual states, and achieve the goal of protecting architectural cultural heritage.
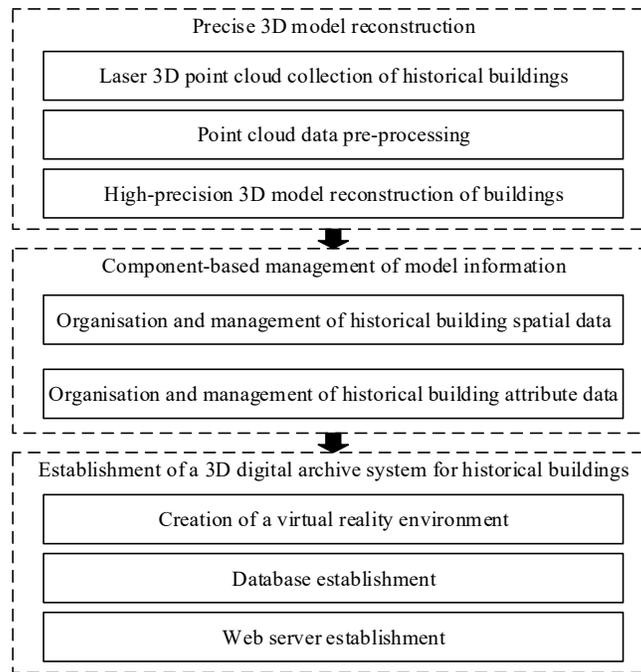
Figure 1: Research the overall framework

II. A. 2) The process of detailed 3D model reconstruction of historic buildings

Detailed 3D animation model reconstruction of historical buildings. First, high-density 3D point cloud data of historical buildings is obtained through ground-based 3D laser scanning technology. Then, based on the structural characteristics of historical buildings, a detailed reconstruction plan is implemented to obtain a high-precision geometric model, which is then assigned high-precision measured texture information. Finally, a high-precision reconstruction model that meets the accuracy requirements for building protection is obtained. Figure 2 illustrates the technical workflow for the precise 3D model reconstruction of historical buildings based on ground-based laser scanning, which primarily includes three steps: 3D point cloud data collection, 3D point cloud data preprocessing, and 3D model reconstruction.

During the 3D point cloud data collection process, the number and distribution of scanning stations must be carefully considered. A reasonable layout of scanning stations ensures a high-precision overall model, reduces data redundancy, and lowers the overall workload. Key factors influencing station layout include: the scanning range of the 3D laser scanner, the degree of data overlap between stations, the number and position of target spheres, and non-target obstructions.

3D point cloud data preprocessing includes point cloud filtering, smoothing, compression, and registration processing. Point cloud filtering, smoothing, and compression processing can reduce noise caused by environmental or instrument-related factors, decrease the amount of data to be processed during 3D model reconstruction, and reasonably compress point cloud data while ensuring building features, thereby improving data readability and reliability. This is particularly important for point cloud data used in detailed modeling. Point cloud data registration uses target spheres or building feature points to convert point cloud data from different observation stations into the same coordinate system, preparing the data for 3D model reconstruction.

Three-dimensional model reconstruction is the foundation of spatial information for historical buildings. Its accuracy determines the completeness of historical building protection information. Considering the uniqueness and complexity of historical building facade features, this paper establishes geometric three-dimensional models using methods based on building feature points to construct regular geometric models and surface models, and then maps real texture information onto these models. The three-dimensional model reconstruction of historical buildings primarily employs multiple key technologies to enhance model reconstruction accuracy.

1) Establish an independent coordinate system for the building. Based on the symmetry, regularity, and unique architectural characteristics of the building, an independent coordinate system is established to maintain the vertical orthogonality of certain structural components during the construction process and ensure the reproducibility of the modeling process.

2) Segmenting the entire point cloud data. Due to the complex structure of historical buildings, it is difficult to analyze the local characteristics and structure of the building within the large and dense point cloud data. By

segmenting the point cloud data, the building structure can be analyzed more clearly, improving modeling accuracy while reducing hardware requirements and enhancing operational efficiency.

3) Perform slicing processing on point cloud data. This operation involves arbitrarily slicing point cloud data into small units. By analyzing the causes of point cloud thickness, slices of different shapes and materials can be extracted for analyzing building structures and component layouts, yielding traditional floor plans and cross-sections. This allows for the identification of subtle structural features while also detecting minor damage or deformation, facilitating subsequent conservation and restoration work.

4) Real texture information mapping. Conduct a comprehensive analysis of the real texture information collected on-site, process, classify, number, and establish a database based on texture location, and apply it to the geometric 3D model. The texture rendering of the model establishes a corresponding relationship between texture information and different types of components as well as each specific component, thereby accurately reflecting the state of the building and providing a basis for building repair and maintenance.
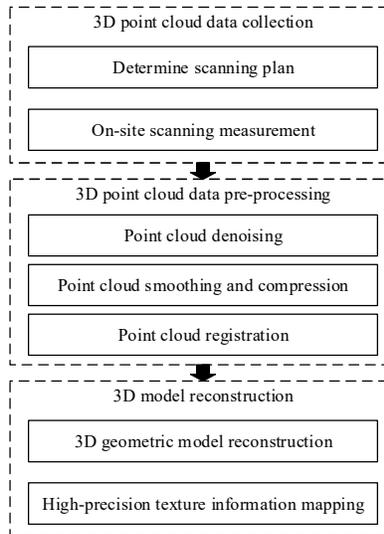

Figure 2: Processes of data collection, preprocessing and model reconstruction

II. B. Principles of 3D animation modeling based on single photographs of historic buildings

II. B. 1) Extinction point method camera calibration principle

In perspective projection, parallel lines in space converge to a single point on the image plane, which is called the vanishing point. When the surface of the subject contains abundant, regular linear information, the vanishing point method can be used for camera calibration. When taking a single photograph of a regular cubic building, three orthogonal vanishing points X_∞, Y_∞, and Z_∞ are constructed based on the geometric constraints of the building itself. Figure 3 shows the spatial relationship among the three vanishing points. Figure 4 illustrates the geometric relationship between the three vanishing points and the Z_∞ components of the image's internal and external orientation elements in the spatial coordinate system.
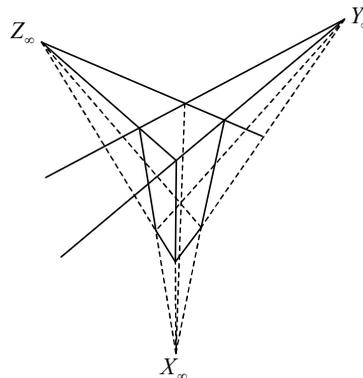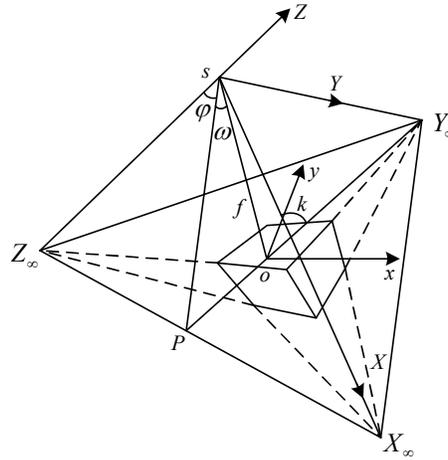

Figure 3: Vanishing Point Diagram

Figure 4: The relationship between vanishing points and exterior elements

The vanishing points in three orthogonal directions are X_∞, Y_∞, and Z_∞, which constitute three-point perspective. The photographic center is s, o is the camera principal point (x_0, y_0), and f is the camera focal length. P is the intersection point of the extension line of o and Y_∞ with the line segment $X_\infty Z_\infty$. The three exterior angle elements are $\varphi = \angle PsZ_\infty$, $\omega = \angle Pso$, and $\kappa = \angle yoY_\infty$. The line connecting the vanishing point and the camera center is parallel to the spatial parallel line forming the vanishing point. The three orthogonal directions X, Y, and Z must lie on the corresponding coordinate axes. Therefore, $s - X_\infty Y_\infty Z_\infty$ forms a right-angled triangular pyramid, and s is perpendicular to the triangle $X_\infty Y_\infty Z_\infty$. Thus, the camera principal point o is the centroid of the triangle $X_\infty Y_\infty Z_\infty$.

Image principal point: the centroid o of the triangle formed by the three vanishing points:

$$(x_0, y_0) \tag{1}$$

Focal length:

$$f^2 = -\left(x_{X_\infty} - x_0\right)\left(x_{Y_\infty} - x_0\right) + \left(y_{X_\infty} - y_0\right)\left(y_{Y_\infty} - y_0\right) \tag{2}$$

In right triangles ΔosY_∞, ΔosX_∞, and $\Delta sX_\infty Y_\infty$,
Geometric relationships:

$$f^2 + oY_\infty^2 = sY_\infty^2; f^2 + oX_\infty^2 = sX_\infty^2 \tag{3}$$

$$sY_\infty^2 + sX_\infty^2 = X_\infty Y_\infty^2$$
$$2f + oX_\infty^2 + oY_\infty^2 = X_\infty Y_\infty^2 \tag{4}$$

Convert to coordinate relations:

$$oX_\infty^2 = x_{X_\infty}^2 + y_{X_\infty}^2; oy_\infty^2 = x_{Y_\infty}^2 + y_{Y_\infty}^2 \tag{5}$$

$$X_\infty Y_\infty^2 = \left(x_{X_\infty} - x_{Y_\infty}\right)^2 + \left(y_{X_\infty} - y_{Y_\infty}\right)^2 \tag{6}$$

The focal length formula can then be derived.

II. B. 2)   Obtaining 3D information about buildings
Images captured by a camera follow the laws of linear perspective. In other words, the width and height of an object will decrease proportionally as the distance between the object and the camera increases. For a rectangular image, the width and height of an object will decrease at different rates depending on the distance between the object and the camera. This rate is determined by the focal length of the camera and is derived from the pinhole model:

$$d = \frac{wf_x}{x} \tag{7}$$

$$h = \frac{yd}{f_y} \tag{8}$$

where, x is the width of the object in the image, unit: m; w is the actual width of the object, unit: m; y is the height of the object in the image, unit: m; f is the focal length of the camera, unit: pixels; d is the distance from the object to the camera, unit: m; h is the actual height of the building, unit: m.

Assume that an image has no scale error in the x direction, and the scale normalization coefficient in the y direction is $1+d_s$. At this point, if the principal distance of the image in the x direction is f_x, then the principal distance of the image in the y direction f_y is:

$$f_y = \frac{f_x}{1+d_s} \tag{9}$$

x and y are measured from the image. In some photos, it is not possible to measure w on-site. Ultimately, when reconstructing lost buildings, width information can be obtained from local floor plans and scales. Using formula (7), the distance d between the object and the camera can be calculated, and substituting this into formula (8) yields the actual height h of the building. Since the camera model used to take the single-image old photograph cannot be determined, the values of f_x and f_y in the above equations are unknown. Therefore, they are replaced with the focal length $f_y = f_x = f$ obtained through vanishing point calibration. This is the key to this method.

II. C.Historical Building Information Modeling Construction Process

When it comes to historical buildings classified as cultural heritage, the construction of information models is more complex. This is because the physical shapes and characteristics of such buildings are not well represented in software libraries. In H-BIM, parametric objects are constructed based on historical data (surveys, analyses, and literature), monitoring data, and structural information. The purpose is to map elements onto point cloud data and image survey data. This process is a reverse engineering solution, where parametric objects representing architectural elements are mapped onto laser scan or photogrammetry data. Concurrently, a matching parametric library must be established, which is composed of historical literature and architectural drawings. These parametric objects are constructed using the software's embedded scripting language, which can be referred to as "Geometric Description Language" (GDL). After the 3D animation model is created, the next stage involves integrating the 3D animation model into a Geographic Information System (GIS) for further analysis and combining semantically rich models to construct a detailed historical building information model. The information model constructed possesses all physical and functional construction characteristics across multiple dimensions, such as three-dimensional coordinate systems, time, and non-architectural information, which is essential for the management and protection of historical buildings classified as cultural heritage. When addressing spatial relationships and information queries, GIS enables users to create interactive queries, analyses, and spatial information editing, a technology widely applied in urban modeling. The challenge in modeling historical buildings compared to general modeling lies in their complex components, and traditional methods can further complicate the issue. Additionally, the resulting model should have varying levels of detail to accommodate the needs of different audiences. The CityGML solution provides an interoperable framework for establishing three-dimensional modeling, semantic, topological, and appearance attributes. The framework includes core modules such as buildings, vegetation, transportation, water bodies, and land, each with specific semantic definitions, attributes, and relationship frameworks to ensure model interoperability. CityGML has a detailed semantic framework for urban objects and allows information to be stored as attributes or converted into external reference content.

III. Construction of 3D animation models of historic buildings and their application in auxiliary protection

III. A. Historical Building Image Collection and Modeling Accuracy Analysis

III. A. 1) Historical Building Image Collection

Select Building C, a large historical structure in City A, as the subject of study. Based on the interior layout and overall structure of Building C, this 3D animation reconstruction project employed two shooting methods—fixed-point panoramic shooting and equal-baseline shooting—to collect the building's image data. Table 1 lists the specific parameters used for fixed-point panoramic shooting. Table 2 lists the specific parameters used for equal-baseline

shooting. Fixed-point panoramic shooting was conducted in 7 rows per session, covering angles from -50° to 50°, with 300 photos taken per row and a pause time of 2 seconds. For baseline-equal photography, the camera pixel size is 0.0007 mm, with resolution dimensions of 6,065 mm and 4,173 mm for the long and short sides, respectively. The focal length is set to 25 mm, with an image overlap rate of 85%, and the shooting distance is 1,500 mm.

Table 1: Parameters used for fixed-point surround shooting

Project	Line 1	Line 2	Line 3	Line 4	Line 5	Line 6	Line 7
Shooting Angle	-50°	-25°	-10°	0°	10°	25°	50°
Number of photos	300	300	300	300	300	300	300
Distance	355	355	355	355	355	355	355
Motor speed(s)	10	10	10	10	10	10	10
Pause time(s)	2	2	2	2	2	2	2

Table 2: Parameters used for equal-baseline shooting

Equipment parameter items	Use parameter values
Pixel size (mm)	0.0007
The long side of camera resolution	6065
Short side of camera resolution	4173
Focal length (mm)	25
Ground resolution (mm/ pixel)	0.894
Model accuracy (mm)	2.981
Photo overlap degree	85%
Shooting distance (mm)	1500

III. A. 2)   Statistical Analysis of 3D Modeling Accuracy for Historic Buildings

Three-dimensional laser scanning was performed on the historical building images captured during filming, and a three-dimensional animation model was constructed. To verify the quality of the three-dimensional laser scanning results obtained in this paper, eight feature points were selected on the historical building, and the coordinates of all feature points were measured using a Leica TCR402 prism-less total station. These coordinates were then compared with the coordinate values measured in the three-dimensional animation model. Table 3 shows the statistical results of the accuracy errors of the 3D animated model of the historical building. The maximum planar position error of the 10 feature points was 0.011 m, and the maximum elevation error (ΔZ) was 0.008 m, meeting the accuracy requirements of no more than 0.06 m for planar position errors and no more than 0.03 m for elevation errors at the building's inspection points. Furthermore, since the maximum planar position error and elevation error for 8 feature points are both less than 0.01 m, it can be concluded that the 3D laser scanning accuracy in this study is very high.

Table 3: Accuracy error of 3D animation models of historical buildings

Dot number	Error(m)			
	ΔX	ΔY	Plane	ΔZ
1	0.001	0.004	0.005	0.002
2	0.005	0.006	0.011	0.004
3	0.006	0.001	0.007	0.001
4	0.003	0.007	0.010	0.006
5	0.009	0.000	0.009	0.003
6	0.005	0.006	0.011	0.006
7	0.003	0.004	0.007	0.002
8	0.007	0.005	0.012	0.008

III. B. Comparison of modeling effects using different methods
III. B. 1)   Comparison of modeling accuracy

To evaluate the effectiveness of the proposed extinct point method in constructing 3D animation models of historical buildings, the building data processed from point clouds were modeled multiple times, and the regional growth algorithm was selected for comparison. Quantitative metrics included the mean (MEAN), root mean square (RMS),

standard deviation (STD), and area of error (EOA) between the models generated by the two methods and the actual building. Table 4 presents a comparison of modeling accuracy among different methods. Among the six models generated by the two methods, the MEAN, RMS, and STD of the extinct point method were all less than 0.005 m, and the EOA was less than 0.300%. In contrast, the MEAN, RMS, and STD of the regional growth algorithm were all above 0.020 m, and the EOA was 1.000%. The extinct point method demonstrated higher modeling accuracy and was able to restore more historical building texture information.

Table 4: Comparison of algorithm accuracy evaluation

3D model	Algorithm	MEAN(m)	RMS(m)	STD(m)	EOA(%)
Model 1	Eliminating the point	0.005	0.003	0.002	0.291
	Region generation	0.028	0.026	0.037	1.253
Model 2	Eliminating the point	0.004	0.001	0.004	0.102
	Region generation	0.035	0.013	0.051	1.261
Model 3	Eliminating the point	0.001	0.002	0.001	0.136
	Region generation	0.036	0.015	0.026	1.769
Model 4	Eliminating the point	0.001	0.003	0.004	0.147
	Region generation	0.037	0.031	0.038	1.598
Model 5	Eliminating the point	0.002	0.005	0.004	0.173
	Region generation	0.064	0.043	0.056	1.675
Model 6	Eliminating the point	0.001	0.004	0.003	0.104
	Region generation	0.057	0.029	0.062	1.278

III. B. 2) Modeling Time Comparison

Further comparison of the model construction efficiency of the two methods. Table 5 shows the comparison of information extraction time between the two methods. In the six animated models of three-dimensional reconstruction, the time taken by the extinguishing point method ranged from 10.29s to 11.51s, with a maximum of no more than 12s. In contrast, the region growing algorithm took between 36.93 seconds and 42.04 seconds, all exceeding 35 seconds, making it a time-consuming process. Therefore, the point extinguishing method selected in this study can more quickly extract building information from a single photograph and complete three-dimensional animation modeling.

Table 5: Comparison of processing time of two algorithms

3D model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Eliminating the point(s)	10.29	11.51	10.63	10.72	11.09	10.25
Region generation(s)	36.93	39.65	40.71	42.04	40.82	39.08

III. C. Post-use evaluation of historical building restoration based on 3D animation models
III. C. 1) Expert Assessment Results and Analysis

Based on the constructed 3D animation model of the historical building, analyze the damage and other issues present in the historical building and carry out conservation and restoration work. After completing the conservation and restoration work, reopen the historical building to experts and the public, and invite 10 experts and 10 members of the public to evaluate the reopened historical building through a survey questionnaire. This evaluation will serve as the basis for assessing the effectiveness and application value of the 3D animation model of the historical building. Table 6 shows the weight vector of expert evaluation indicators. Based on the weight of the three-level evaluation indicators, the satisfaction of experts with each indicator and their perceived importance of the indicators are calculated. Figure 5 shows the expert assessment of satisfaction and importance. In the assessment results, the importance and satisfaction of historical appearance continuity (C1) are the highest, reaching 0.737 and 0.939, respectively, indicating that the three-dimensional animation model of historical buildings has a very prominent effect in assisting the restoration of the historical appearance of buildings. Next is Architectural Form (C5), with an importance of 0.723 and expert satisfaction of 0.926, indicating that the 3D animation model of historical buildings also has a good effect in assisting with the restoration of architectural form. The lowest importance and satisfaction scores were for sense of belonging (C16), at 0.449 and 0.552, respectively. The reason for this may be that the role of 3D animation models of historical buildings is more focused on the physical protection and restoration of buildings, and their effectiveness in assisting with spiritual protection is not as evident.

Table 6: Expert evaluation index weight vector

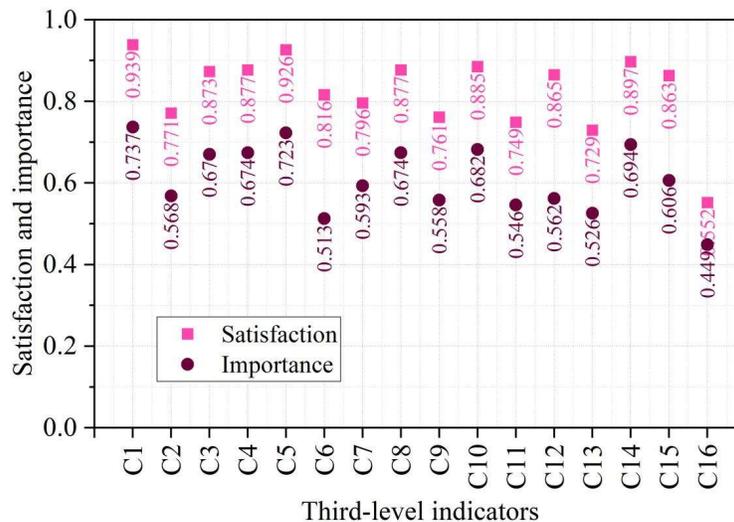| First-level indicator	Weight	Secondary indicators	Weight	Third-level indicators	Weight
Venue (A1)	0.258	Layout (B1)	0.150	Continuation of historical features (C1)	0.100
				Partitioning and entity layout (C2)	0.050
		Environment (B2)	0.108	Furniture landscape, paving (C3)	0.052
				Public space (C4)	0.056
Monomer (A2)	0.462	Appearance (B3)	0.200	Architectural form (C5)	0.105
				Door and window styles and materials (C6)	0.095
		Space (B4)	0.131	Function matches the space (C7)	0.075
				Indoor space utilization efficiency (C8)	0.056
		Structure (B5)	0.131	Reasonable building structure (C9)	0.067
				Structural quality and safety (C10)	0.064
Special Project (A3)	0.144	Interior design (B6)	0.048	Interior design and decoration restoration degree (C11)	0.048
		Identification (B7)	0.048	Orderly manner of identification system (C12)	0.048
		Lighting (B8)	0.048	Lighting system (C13)	0.048
Economy (A4)	0.076	Cost (B9)	0.076	Operation and maintenance costs (C14)	0.076
User (A5)	0.060	User emotion (B10)	0.060	Sense of belonging (C15)	0.030
				Identity (C16)	0.030

Figure 5: Experts assess satisfaction and importance

III. C. 2) Public Assessment Results and Analysis

Table 7 presents the descriptive statistical results of the public assessment of the use of historical buildings for preservation. Figure 6 illustrates the public assessment of satisfaction and importance. The highest average score in the public assessment was for the preservation of historical character (C1), reaching 4.056 points, with a satisfaction rate of 0.912, indicating that the public places the greatest emphasis on the historical character of the building when experiencing it. Overall, the average scores for the 16 indicators ranged from 3.501 to 4.056, all exceeding 3.5 points, indicating that the public is generally satisfied with their experience of the historical building. The use of three-dimensional animation models of historical buildings to assist in conservation and restoration has yielded good results.

Table 7: Descriptive statistics of public assessment

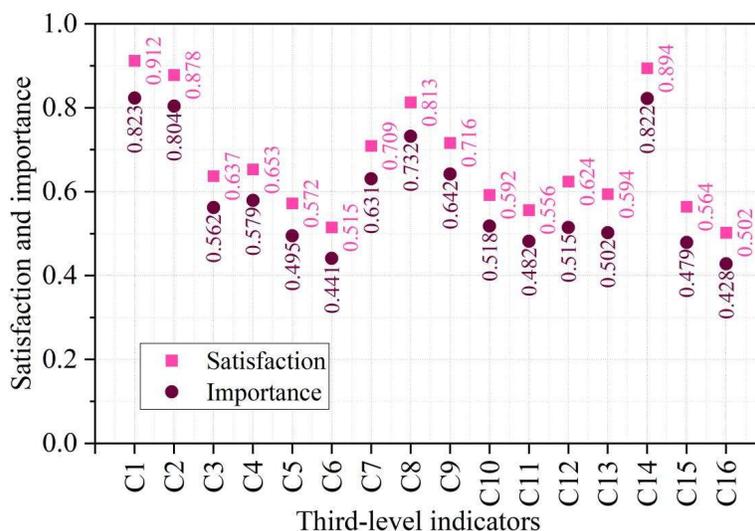| Secondary indicators	Average value	Third-level indicators	Average value	Standard deviation	Mode
B1	4.022	C1	4.056	0.010	4
		C2	3.978	0.005	3
B2	3.656	C3	3.658	0.017	3
		C4	3.654	0.032	3
B3	3.573	C5	3.573	0.010	3
		C6	3.573	0.092	3
B4	3.802	C7	3.790	0.017	3
		C8	3.814	0.065	3
B5	3.677	C9	3.761	0.062	3
		C10	3.593	0.014	3
B6	3.557	C11	3.557	0.025	3
B7	3.641	C12	3.641	0.071	3
B8	3.595	C13	3.595	0.018	3
B9	3.895	C14	3.895	0.009	3
B10	3.533	C15	3.565	0.015	3
		C16	3.501	0.023	3
Total average score			3.663		

Figure 6: The satisfaction and importance of public assessment

IV. Conclusion

This paper employs 3D animation reconstruction technology to achieve the modeling and conservation-restoration of historical buildings. The feature point error of the constructed 3D animation model is less than 0.01m, outperforming comparison methods in all four error metrics, and the modeling time required is less than 12 seconds. Experts rated the satisfaction level of historical buildings restored using 3D animation models as high as 0.939. Public satisfaction scores ranged from 3.501 to 4.056, indicating a high level of satisfaction. In the future, efforts should be made to optimize the texture mapping performance of complex curved components in historical buildings to enhance the realism of 3D animation modeling.

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