Retraction Notice

The Editor-in-Chief and the publisher have retracted this article, which was submitted as part of a guest-edited special section. An investigation uncovered evidence of systematic manipulation of the publication process, including compromised peer review. The Editor and publisher no longer have confidence in the results and conclusions of the article.

SM and ZG did not agree with the retraction.

Digital immersive interactive experience design of museum cultural heritage based on virtual reality technology

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Abstract. With the upsurge of urban construction, public buildings such as museums have attracted more and more attention as the business card of the city. The museum business is developing rapidly, and the artistic concepts appearing in museums are gradually differentiated and conceptualized, paying more attention to the experience and feeling of the visitors. With the continuous intervention of high technology and new media, the visual expression of museums has become more diverse. With the advent of virtual reality (VR) technology, more and more technological means have been introduced into the design of museum exhibits. It eliminates the boring feeling of the general public about the original exhibition method of the museum, while enriching the fun of visiting the museum. To provide visitors with an immersive experience in which virtual and reality intersect, we study the design of a digital immersive interactive experience for museum cultural heritage based on VR technology. By combining current technological development and policy advantages, we describe the innovative ideas and design schemes of museums applying VR and augmented reality technology and discuss the practical value and importance of establishing designs through experiments. The experimental data show that the use of VR technology to digitally design the cultural heritage of museums enhances the immersion and interaction of tourists in the experience, and the score for the VR model was 9.23% higher than that of the traditional forms, which shows that VR promotes the dissemination of the cultural heritage of museums. © *2022 SPIE and IS&T* [DOI: 10.1117/1.JEI.32.1.011208]

Keywords: museum cultural heritage; virtual reality technology; digital design; immersive interactive experience; virtual display; three-dimensional modeling.

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1 Introduction

Twenty years have passed since the digital museum was launched in the 1990s. In general, the digital development and construction of many museums have achieved very good results, and some digital projects have driven the local economic improvement, creating digital museums with unique living characteristics. With the continuous development of intelligent technology and the expansion of the Internet, the new digital virtual imaging function has become one of the popular choices for the development of digital museums. However, the application of VR technology in museum displays is still in the developing stage, and how to best combine VR technology with the design of museum exhibits has become a topic that requires in-depth exploration and practice.

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There have been many studies on museum display design. Goli et al.[1] conducted a series of laboratory tests on commercial equipment for active relative humidity control of display cases to evaluate the machine's ability to control medium format museum display cases. They simulated extreme museum environments with large fluctuations in relative humidity and temperature and produced varying air leakage rates on specially crafted display cases. Studies have shown that the machine shows very efficient work in humidification and dehumidification under very good to moderate sealing conditions. Mohan and Rodgers[2] explored taxonomic schemes for collecting, researching, and displaying objects in a museum setting from a general theoretical perspective and laid the groundwork for case studies, which involve complex exhibitions of history and ethnography in several museums. He et al.[3] established a multielectrode mathematical and physical model of a wire-plate solid fan for a museum display case and conducted an in-depth analysis of its performance. The simulation results showed that there was an optimal distance (d) between the discharge electrodes, corresponding to the maximum average wind speed (ua) at the exit of the simulated area. Under the same power consumption, ua has a monotonically increasing relationship with the vertical height (H) from the discharge electrode to the dust collection electrode. Starting from the historical and contemporary context of the current "gender revolution," Chapin et al.[4] surveyed museum professionals in the field to explore how the body can be represented through the use of mannequins in museum exhibition spaces. Dan[5] built the museum display model Queen Anne's revenge. Andriana and Gunawan[6] adopted a new approach that combined the interpersonal communication model of Bandung's cross-studio museum with the mass communication model, which can work in real life. Ryhl-Svendsen[7] reviewed the main air pollutants related to heritage conservation. Air pollutants can come from outdoors or indoors, including corrosive vapors from building materials used for museum displays. Air pollution may corrode certain metallic objects, or oxidize, or cause acid hydrolysis in organic materials. Control methods include better shielding from the outdoor climate and testing indoor building materials for the potential release of hazardous substances before using them near susceptible museum objects. However, the traditional display form of the museum's physical exhibition items plus text and picture descriptions is not strong, and it is necessary to introduce information technology to enhance the interest and interactivity of the display.[8]

Virtual reality (VR) technology can use computers to create interactive three-dimensional (3D) dynamic scenes and is widely used in various fields. By reviewing the existing literature on VR technology (VRT) in chemistry, Aliyu emphasized the importance of VRT for chemistry teaching, when chemistry teachers are teaching abstract chemistry content and knowledge, such as organic structure, molecular structure, chemical reaction and stoichiometry, VRT can effectively assist chemistry teachers in teaching, solve some problems faced in the course, he also discussed the latest applications of VRT in educational settings.[9] Maples-Keller reviewed the history of VR-based technology and its application in psychiatry, empirical evidence for VR-based therapy, and the benefits of using VR for psychiatric research and treatment.[10] Li, Yu, and Shi investigated the application of VR technology in clinical medicine with the aim of evaluating the effectiveness of red blood cell distribution width (RDW) in deep vein thrombosis (TJA) in patients undergoing total joint replacement. A total of 110 patients (55 deep vein thrombosis patients and 55 control individuals who received TJA) were included in this retrospective cross-sectional study.[11] Liang and Shuang studied value identification and traditional village protection based on VR technology. Traditional villages have unique regional cultural characteristics and important cultural values. Digital protection will become a future development trend. Through the realization of the VR platform, it can not only better serve the tourism and publicity aspects of ancient villages but also improve the accuracy of the protection planning and design of ancient villages.[12] Using the powerful NVIDIA application engine, Opti X-ray scanner, SceniX scene management camera, and PhysX camera, Zhang designed a commercial design of the interior design software, explored real-time interactive performances based on VR technology, and created realistic interior scenes.[13] Lai briefly introduced the application of VR technology in medical education and training. The application of VR technology in science education is virtual anatomy. Virtual human projects have been extensively studied in universities and institutions around the world. In clinical practice training, VR technology provides surgeons with a very realistic visual, auditory, and tactile imaging environment, and residents and trainees can repeat various operations in the system without limitation.[14] Mousavi et al.[15] conducted a computational and experimental study on the performance of a novel damage detection method based on empirical wavelet transform (EWT) and artificial neural network (EWT-neural network); the results showed that the method based on time-domain signal features can effectively identify truss damage location and damage degree under shock load excitation. Kordestani et al.[16] proposed a two-stage time-domain output damage detection method based on the energy-based damage index, and the results show that the method can be accurately estimated from acceleration data without any prior knowledge of input loads or damage characteristics of location/number of injuries. Beale et al.[17] developed a feasible structural health monitoring technology for operating condition monitoring of wind turbine blades. To enhance the immersion and interactivity of museum display and increase the sense of participation of visitors, this paper will study the digital immersive interactive experience design of museum cultural heritage based on VR technology.

Through the research on the museum cultural heritage display design and the related content of VR technology, this paper fully combines its concept, content, and characteristics and uses VR technology to carry out the digital design of museum cultural heritage. It scores VR, CAD models, traditional models, and animations from four aspects, including 3D rendering, dynamic imaging, real-time rendering, and immersive effects, to verify the advantages and feasibility of digital design of museum cultural heritage.

2 Digital Design of Museum Cultural Heritage Based on VR Technology

2.1 *VR Technology*

VR (virtual reality) technology was introduced in the 1980s by Forcadel et al.[18] Generally speaking, VR refers to the technology of simulating interactive information generated by high-performance computers, interacting with users through vision, hearing, touch, etc., and disseminating information to achieve immersive enhancement. The reality felt by the human body is actually formed by the various sensory stimuli of the human body transmitted to the brain through nerves. Its essence is the real image formed in the mind through the stimulation of the human body from the outside world, which can be virtualized. If the senses provided to the user are real and any interaction the user creates in it is real and natural, then the user cannot distinguish between virtual and real.

VR technology has the characteristics of immersion, interaction, and conception. Immersion aims to establish a sense of user presence, is a measure of the performance of VR systems, and emphasizes the authenticity of the environment. Conceptuality is the rationalization of the existence of different things (real or imagined) in a virtual environment. Interactivity refers to the active participation of users and the real-time and natural interaction between users and the environment, emphasizing the naturalness in the process of human-computer interaction. The method of achieving interactivity is shown in Fig. 1.

As shown in Fig. 1, the interaction in the current VR system is mainly dominated by nine components, including myoelectric simulation, tactile feedback, gesture capture, orientation monitoring, voice interaction, sensors, real scenes, eye capture, and motion monitoring.

2.2 *Technical Route of VR Technology in Digital Design of Museum Cultural Heritage*

2.2.1 *Dynamic environment modeling technology*

Virtual environment modeling is an important design step in VR technology. It needs to acquire 3D data corresponding to the real environment and create corresponding 3D models according to the needs of the application. The museum environment can be obtained using the AutoCAD production technology and organically combined with the 3D MAX or MAYA software modeling technology to effectively improve the efficiency of data collection and complete the virtual dynamic environment modeling.[19,20] Once modeling is complete, the 3D model is transferred to Java II software to add motion to animate the digital scene.

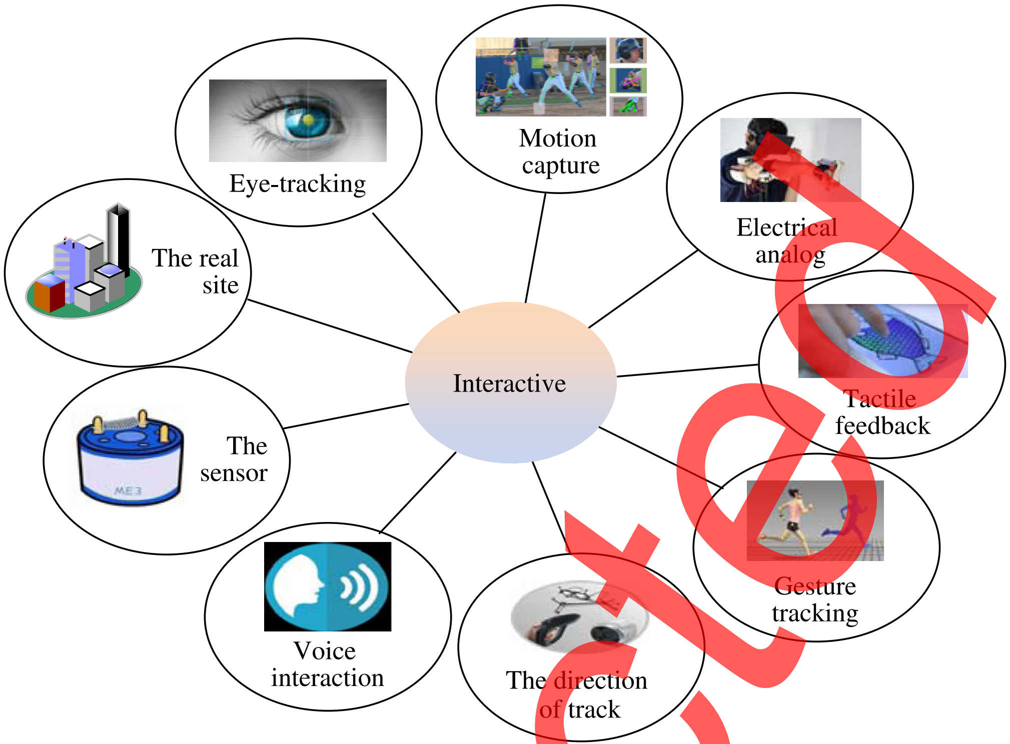

Fig. 1 Method of achieving interactivity.

2.2.2 *Real-time 3D graphics generation technology*

The key step in 3D graphics production technology is to solve the "real-time" production problem. To achieve the real-time purpose, when creating a 3D virtual museum, the graphics update rate must be high, and then images of the same scene are extracted from different angles to create 3D graphics. An important requirement of VR is to achieve "presence," which is the creation of 3D graphics in real time through changes in the user's position and orientation. Continuous and smooth images can be created by changing the viewing angle.[21] The 3D graphics generation technology is shown in Fig. 2.

2.2.3 *Display technology*

The digital design of museum VR technology is to allow the public to obtain rich visual information and insight through the interaction and integration of VR information and real-world

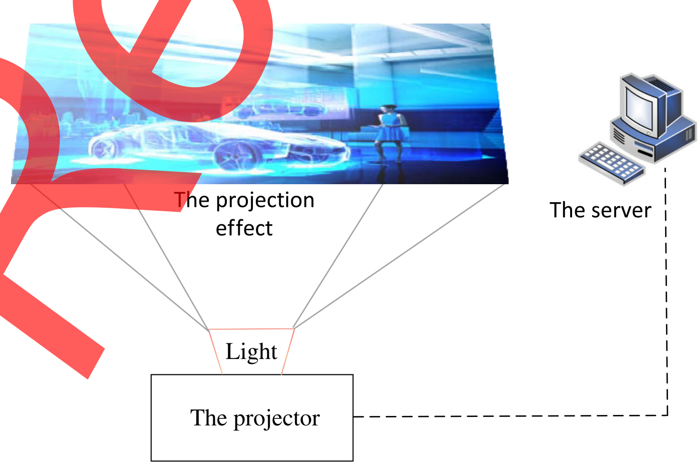

Fig. 2 3D graphics generation technology.

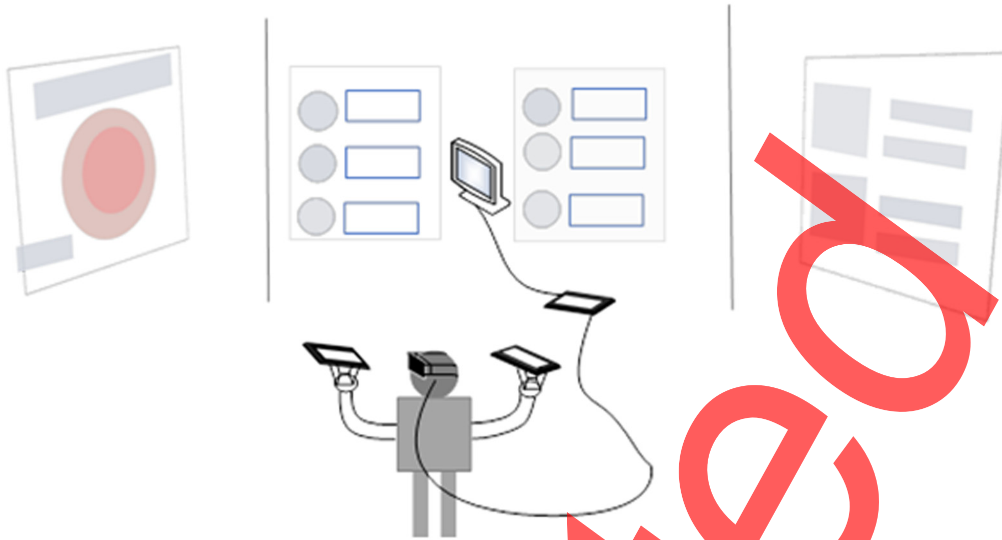

Fig. 3 VR display technology.

perspectives. To realize the reality of the virtual fusion part of the virtual museum, it must have projection technology and powerful projection equipment. At present, augmented reality imaging technology is mainly divided into three categories: head screen, handheld screen, and projection screen.[22] The VR display technology is shown in Fig. 3.

2.3 *Application Design of VR Technology in Digital Design of Museum Cultural Heritage*

2.3.1 *System framework of mobile VR design*

The realization of mobile augmented reality system in digital museum should be composed of hardware and software. The hardware mainly includes the screen carrier, human-computer interaction application, and application computing platform.

The architecture of the digital museum display system can adopt the client-server combination function, as shown in Fig. 4.

Clients are handheld devices primarily used to store 3D models. First, it records the video in the actual area of the museum through the camera of the mobile terminal, and then it transmits the recorded video information to the server for transmission through the wireless network. Finally, according to the calculated performance parameters, the portable terminal puts the virtual model (exhibition or building) into the real scene for virtual-real fusion, and then the advanced image information is displayed on the mobile terminal in a visual form.

After the image information is stored in the mobile terminal in the form of a 3D model, the mobile terminal calculates and inputs the image signal to the VR, and the user wears the mobile terminal VR or VR all-in-one machine to watch. VR adopts a split-screen display, which brings an immersive experience to the 3D environment constructed by viewing different perspectives of the same scene through both eyes.[23] The user experience is shown in Fig. 5.

2.3.2 *Virtual display system*

The following design elements should be considered for the virtual display system.

Factors such as a smooth operation mechanism, clear operation method, perfect functional system, and practical visiting experience are particularly important for the virtual display system of the museum.

Resource portfolio design. For the virtual resources of museum collections and information, museums should integrate, design, and store them as background resources, and at the same time, classify and manage collections and information according to period, type, scale, etc., and design digital virtual works through category information.

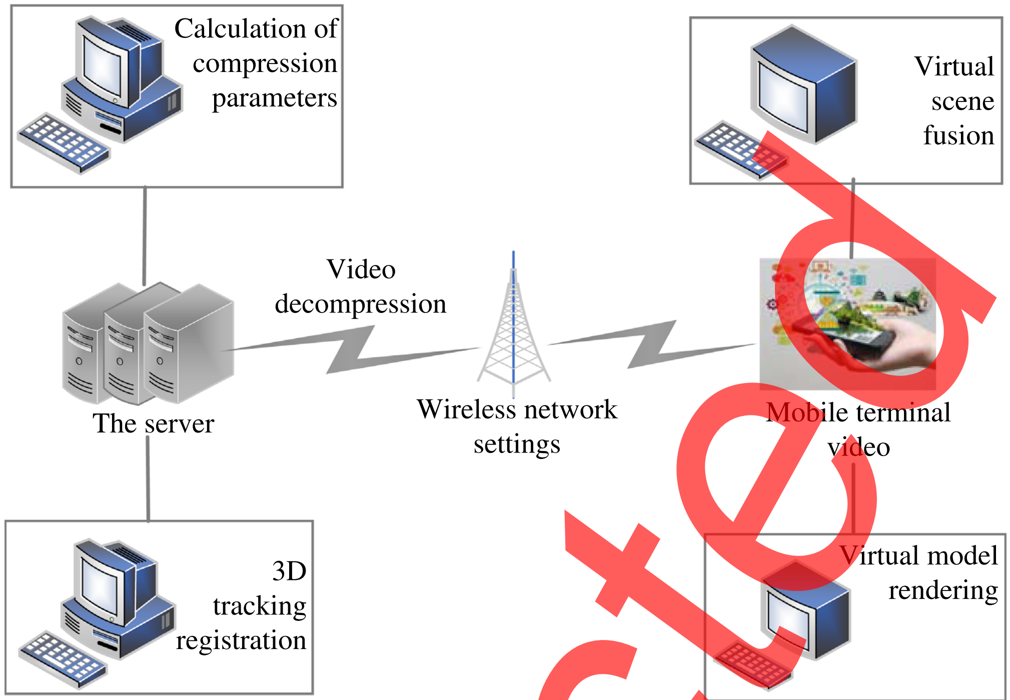

Fig. 4 Mobile augmented reality system framework.

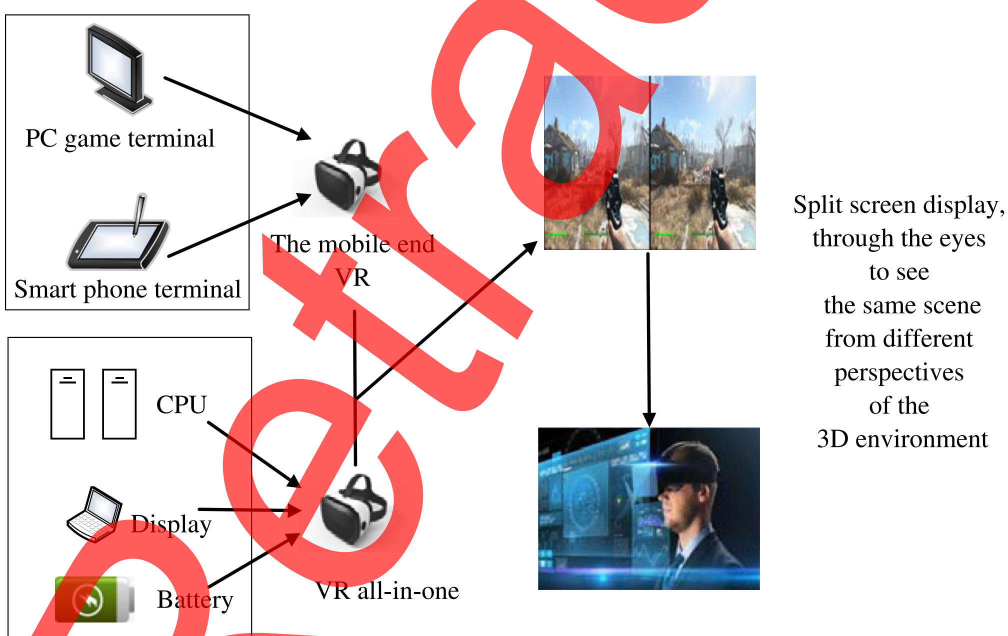

Fig. 5 User's VR experience.

Service project design. At the beginning of designing a virtual museum project, it is necessary to define different types of VR imaging and augmented reality service projects. Key elements such as displaying exhibits, entering and interpreting information, and related interactions should be included.

Visiting route and perspective design. When designing the visiting route of the VR experience, the basic spatial structure of the museum should be used as the basis, the personal habits of the visitors during the visit should be considered at the same time, and multiple routes should be planned for the visitors to choose. In terms of the setting of the perspective, it should not be limited to the first perspective of the characters, and various tour forms such as God's perspective and free perspective can be added according to the existing technology.

The overall content of VR and augmented reality-based museum virtual displays is complex and comprehensive, rather than a simple process of creating, editing, and overlaying information. As a technical means of displaying information, it is inseparable from the connection between the displayed information and the collection of cultural relics. Therefore, the design of the museum's virtual exhibition should follow the following principles: the most basic purpose is to accurately transmit the information of the cultural relics in the collection to the visitors, and interaction and convenience should be considered. It should also take into account the individual needs of visitors for the display of exhibits and provide visitors with a practical and reasonable information experience.

2.4 *Digital Design Algorithm of Museum Cultural Heritage Based on VR Technology*

2.4.1 *IK algorithm*

The IK inverse kinematics algorithm is used to determine the information of extreme bones.[24] According to the position information of the end bone, the position information of the N-level parent bone in the inheritance chain of the bone is reversely deduced; in this way, the "pose" of the figure is determined, i.e., the angle originally attributed to the skeletal joint structure. The so-called pose is represented by the angle, including the vector and the direction and position of the vector node. For the IK algorithm, the basic formula is

$$\theta = f^{-1}(X). \tag{1}$$

Among them is usually the position information of the most end bone, and the algorithm is used to calculate the conditions that meet the requirements.

For an N-level bone chain, the N-level parent bone information T is related to the N-1-level infant bone information, which is simply represented by the terminal bone information as

$$ {}^0_nT = {}^0_1T\,{}^1_2T\,{}^2_3T \ldots {}^{n-1}_{n}T. \tag{2}$$

Taking an arm with two chains as an example, we use the skeleton chain property to quickly find θ_1 and θ_2 using a closed-form solution

$$\theta_1 = \tan^{-1}\left(\frac{x + (l_1 + l_2 \cos \theta_2)y}{y + (l_1 + l_2 \cos \theta_2)x}\right), \tag{3}$$

$$\theta_2 = \cos^{-1}\left(\frac{x^2 + y^2 - l_1^2 - l_2^2}{2l_1 l_2}\right). \tag{4}$$

Among these, l is the length of the bone.

Often the first thoughts that comes to mind when studying a path-solving problem is to use a system of matrix equations to find one or more optimal solutions. The Jacobian matrix is introduced here to form a function on θ. First, it uses the Jacobian matrix to solve the narrow width linear variation problem, moves the N-level parent bone to the target position, and calculates the inverse Jacobian matrix

$$\Delta\theta = J^{-1}(\Delta X), \tag{5}$$

$$X = f(\theta + \Delta X). \tag{6}$$

It keeps moving ΔX until X reaches the target position X_g.

A more flexible mathematical simulation expressions is

$$\Delta\theta = J^{+}\Delta X + (I - J^{+}J)\Delta H, \tag{7}$$

where J^{+} represents the inverse of the square matrix, matrix I represents the identity matrix of the other field-space joints, and ΔH represents the additional anomaly of the parent bone relative to the target position.

Introducing the restriction that the rows of the matrix are greater than the columns and the columns are equal to the rank of the matrix results in

$$J^{+} = (J^{T}J)^{-1}J^{T}. \tag{8}$$

Conversely, ranks are equal to rows and are less than columns

$$J^{+} = J^{T}(JJ^{+})^{-1}. \tag{9}$$

The degrees of freedom of the bone being manipulated are much greater than the degrees of freedom to reach its position, resulting in X not equaling θ, and introducing a scattered matrix ensures that the system makes sense.

To change the pose of the skeleton

$$\Delta\theta = J^{+}\Delta X, \tag{10}$$

$$\theta_t = \theta_{t-1} + \Delta\theta, \tag{11}$$

$$\Delta\theta = J^{+}X + (I - J^{+}J)\Delta H, \tag{12}$$

$$\Delta H = \sum_{i=1}^{n} \alpha_i(\theta_i - \theta_i^{m}). \tag{13}$$

Among them, θ_i represents the current angle and θ_i^{m} represents the median angle

$$\theta_i^{m} = (1 - \alpha)\theta_i + \theta_i. \tag{14}$$

2.4.2 *POSIT algorithm*

The POSIT algorithm is an iterative algorithm that repeatedly approximates the perspective projection model as a composite of two projections, namely the orthogonal projection and the size scaling model.[25]

After determining the object coordinate system, camera coordinate system, and image coordinate system, the mathematical model of pinhole imaging is as follows:

$$\lambda_i \begin{bmatrix} x_i \\ y_i \\ 1 \end{bmatrix} = K[R \quad t] \begin{bmatrix} X_i \\ Y_i \\ Z_i \\ 1 \end{bmatrix}, \tag{15}$$

$$K = \begin{bmatrix} f_u & s & u_0 \\ 0 & f_v & v_0 \\ 0 & 0 & 1 \end{bmatrix}. \tag{16}$$

Assuming K is the identity matrix, the equation under the first component is expanded as

$$\lambda_i x_i = i^{T} \begin{bmatrix} X_i \\ Y_i \\ Z_i \end{bmatrix} + T_Z. \tag{17}$$

Assuming a fixed point (X_0, Y_0, Z_0), then

$$\lambda_0 x_0 = i^T \begin{bmatrix} X_0 \\ Y_0 \\ Z_0 \end{bmatrix} + T_z. \tag{18}$$

Equation (17) is subtracted from Eq. (18) and then divided by λ_0 to get

$$\frac{\lambda_i}{\lambda_0} x_i - x_0 = \frac{i^T}{\lambda_0} \begin{bmatrix} X_i - X_0 \\ Y_i - Y_0 \\ Z_i - Z_0 \end{bmatrix}. \tag{19}$$

Denoting the depth change between object points as ε_i, then

$$\frac{\lambda_i}{\lambda_0} = 1 + \varepsilon_i. \tag{20}$$

Assuming that ε_i is 0, Eq. (19) becomes

$$x_i(1 + \varepsilon_i) - x_0 = I^T \begin{bmatrix} X_i \\ Y_i \\ Z_i \end{bmatrix}. \tag{21}$$

The same is obtained for y

$$y_i(1 + \varepsilon_i) - y_0 = J^T \begin{bmatrix} X_i \\ Y_i \\ Z_i \end{bmatrix}. \tag{22}$$

Among them $I = \lambda i$, $J = \lambda j$, $\lambda = (1/t_z)$.

This is the scaling silver in POSIT, and ε_i can be thought of as the error factor between the POSIT prediction point and the perspective prediction point.

3 Experiment of Digital Design of Museum Cultural Heritage Based on VR Technology

3.1 *Experimental Method*

The museum collection models were constructed using VR, CAD models, traditional models, and animation methods, and 10 subjects were selected to score the methods on four aspects: 3D stereoscopic imaging effect, dynamic imaging, real-time rendering, and immersive effect. The score range was 1 to 10 points, with six points being passing. The larger the score is, the better the effect is. The data were summarized and analyzed.

3.2 *Data Analysis*

3.2.1 *Evaluation of 3D stereoscopic imaging effect*

Figure 6 and Table 1 show the evaluation of the 3D image rendering effect of the four expression methods.

Analyzing the data in Table 1 and Fig. 6, on the whole, for the 3D imaging effect, VR > animation > traditional model > CAD. The imaging effect of VR is the best, and the overall

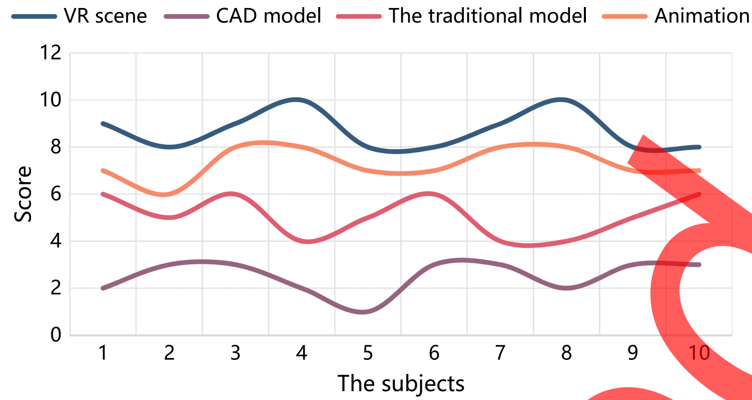

Fig. 6 3D image rendering effect data diagram.

Table 1 3D image rendering effect data table.

	Category	
Presentation	Average	Pass (%)
VR scene	8.7	100
CAD model	2.5	0
Traditional model	5.1	40
Animation	7.3	100

evaluation is above eight points, with an average score of 8.7 points. VR technology performs not only visual scene modeling but also multisensory modeling such as hearing and touch and displays graphics in an all-round, 3D, realistic manner. Immersive scenes can bring people into a "real" space to feel it. Although the animation form also has the function of 3D stereoimaging, it only includes visual and auditory imaging, and the overall evaluation is 7.3 points. The imaging effect is not as good as that of VR technology. The traditional model only has the visual imaging effect, and the imaging effect is lower than that of VR and animation, with an average score of 5.1 points. CAD does not have the effect of 3D stereoimaging. It can be seen that VR technology has a more realistic 3D imaging effect, which can bring an immersive experience to the audience.

3.2.2 *Evaluation of dynamic imaging effect*

Figure 7 and Table 2 show the evaluation of the dynamic imaging effect of the four expression methods.

For dynamic imaging effects, it can be seen from the data that VR technology and animation can perform dynamic imaging, whereas CAD and traditional models do not have dynamic imaging capabilities. Among them, animation can only be dynamically displayed in a fixed route, only has dynamic scenes, and cannot interact according to the changes of people, so the average score for its dynamic imaging effect is 6.3 points. The dynamic imaging effect of VR technology is the best, and 70% of the evaluations are above eight points. The system used to create immersive VR scenes is real-time, monitored, and interactive, creating scenes and recognizing human actions directly based on where people are in the room. It can generate interaction, so its dynamic display effect is better. And using the immersive VR scene for space design, the design elements in the space can be modified in the scene, and the control processing system of the immersive VR system quickly calculates and displays the changes.

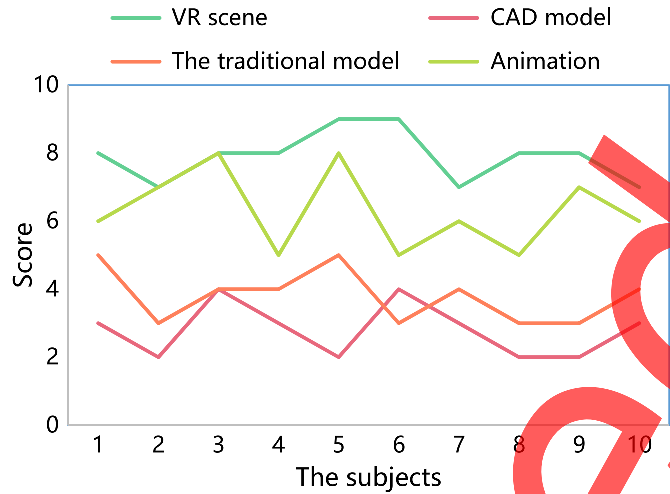

Fig. 7 Dynamic imaging effect data graph.

Table 2 Dynamic imaging effect data sheet.

	Category	
Presentation	Average	Pass (%)
VR scene	7.6	100
CAD model	2.8	0
Traditional model	3.8	0
Animation	6.3	70

3.2.3 *Real-time rendering effect evaluation*

The evaluation of the real-time rendering effect of the four expression methods is shown in Fig. 8 and Table 3.

According to the analysis data, the real-time rendering effect of VR technology is the best, with an overall score of 8.1 points. The other three performance methods do not have real-time rendering functions. Real-time VR rendering can reach speeds of up to 60 frames per second,

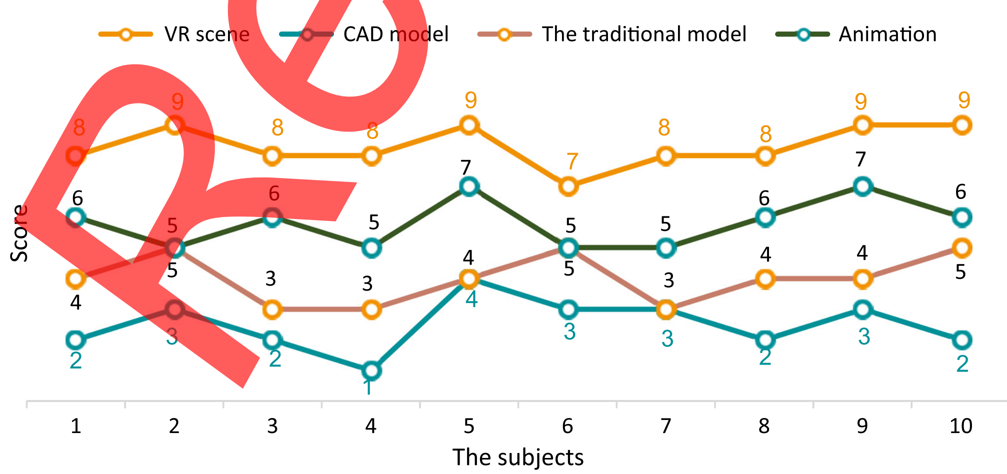

Fig. 8 Render effect data graphs in real time.

Table 3 Render effect data table in real time.

	Category	
Presentation	Average	Pass (%)
VR scene	8.1	100
CAD model	2.5	0
Traditional model	4	0
Animation	5.9	60

which the human eye sees as continuous real-time motion, and traditional rendering can range from a few minutes per frame to >30 hours per frame. And the process of change requires making changes using one type of software and then transferring those changes into another software to re-render the updated design. Depending on the complexity of the rendering, this process can take several hours to complete. But real-time 3D rendering makes the process instantaneous, meaning editing complex, heavy 3D designs can be as quick and easy as editing files.

3.2.4 *Evaluation of immersion effect*

The evaluation of the immersion effect of the four expression methods is shown in Fig. 9 and Table 4.

For the immersion effect, it can be seen from the data that the immersion effect of VR is the best, followed by the immersion effect of animation. The overall immersion effect is sorted as

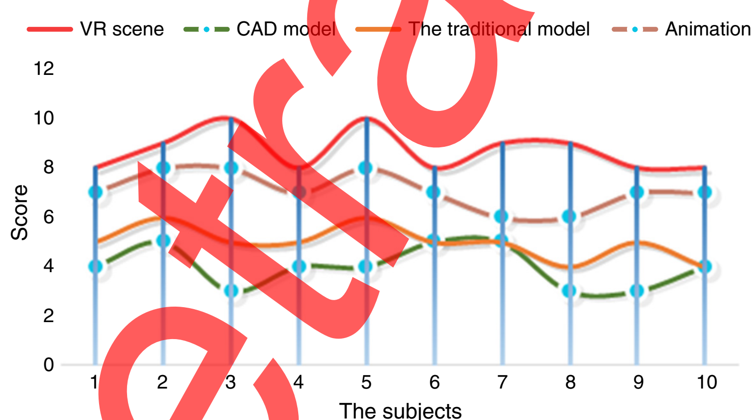

Fig. 9 Data graph of the immersion effect.

Table 4 Table of immersion effect data.

	Category	
Presentation	Average	Pass (%)
VR scene	8.7	100
CAD model	4	0
Traditional model	5	20
Animation	7.1	100

VR > animation > traditional model > CAD. Compared with traditional models, immersive VR scenes present a 3D space in front of people's eyes. However, traditional models are usually designed and scaled in equal parts according to the actual construction of the room, and people can only see the whole layout of the room from one angle, not from the point of view of an ordinary user. Moreover, traditional model making is generally the last process in the entire design process, and it is basically impossible to modify and fine-tune the model after making it. Immersive VR technology, on the other hand, restores the original scale of the space and has a follow-up nature. It can achieve synchronized audio-visualization with the user and can obtain the same feeling as the normal physical world.

3.2.5 *Comprehensive evaluation*

The scores of the four performance methods in four aspects are summarized, and the comprehensive evaluation results are shown in Fig. 10 and Table 5.

It can be seen from the data that the comprehensive score from high to low is VR, animation, traditional model, CAD. VR has the highest comprehensive score of 8.28 points, indicating that VR has a good presentation effect in four aspects: 3D stereoscopic imaging effect, dynamic imaging, real-time rendering, and immersive effect. It is followed by animation, with an overall score of 6.65 points. Traditional models and CAD have slightly worse scores. VR has immersive and real-time functions, and VR technologies can include immersive virtual imaging functions, such as virtual browsing, interaction, roaming, etc. VR brings a better experience to tourists, with a score that is 9.23% higher than other traditional expressions, making it more popular with tourists. It can be seen that it is necessary to use VR technology for the digital design of museum cultural heritage.

Fig. 10 Comprehensive evaluation data graph.

Table 5 Comprehensive evaluation data sheet.

	Category				
Presentation	3D representation	Dynamic imaging	Real-time rendering	Immersion effect	Comprehensive
VR scene	8.7	7.6	8.1	8.7	8.28
CAD model	2.5	2.8	2.5	4	2.95
Traditional model	5.1	3.8	4	5	4.48
Animation	7.3	6.3	5.9	7.1	6.65

4 Discussion on Digital Design of Museum Cultural Heritage Based on VR Technology

Taking the museum display as the research object and VR technology as the research method, this paper proposes a method for the digital design of museum cultural heritage using VR technology and compares the data according to the experiment. The main contents of this paper are as follows.

1. By reading and analyzing relevant important journal papers and professional works, a comprehensive and systematic understanding of the meaning of "museum cultural heritage display design" and "VR technology" and the current research status lay a theoretical foundation for clearly expounding the concepts of the related terms and discussing the design thinking and design methods of the digital design of museum cultural heritage.
2. The digital design of museum cultural heritage is carried out using VR technology, and its design method and design process are described in detail. Four methods of VR, CAD model, traditional model, and animation were used to construct the museum collection model, and each was scored from the four aspects of 3D stereoscopic imaging effect, dynamic imaging, real-time rendering and immersive effect, and their comprehensive scores were calculated. It can be seen from the experimental data that the presentation effect of VR in the four aspects is the best. Compared with traditional performance methods, VR design can bring an immersive virtual display. The use of 3D imaging enhances the audience's sense of reality and interaction, making intuitive heritage buildings more interesting and vivid and providing visitors with an immersive and spiritual experience in which virtual and reality meet. Therefore, more people are attracted to understand and pay attention to the cultural heritage of museums.

5 Conclusion

Using VR technology to digitally design the cultural heritage of museums, 3D dynamic modeling of cultural relics can be carried out, and visitors can feel an immersive interactive experience with the characteristics of VR and augmented reality. It establishes new relationships and connections between visitors and art, makes the museum's exhibits more visual, and presents visitors with 3D and modern memorial technology with innovative audio-visual effects. Using VR, CAD model, traditional model, animation to build museum collection models, 10 subjects scored the models on four aspects: 3D stereoscopic imaging effect, dynamic imaging, real-time rendering, and immersive effect. Compared with traditional forms of expression, the overall score of VR was 9.23% higher than that of the other models, which shows that it better meets the needs of visitors and shows a diversified development path of cultural communication.

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