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Retraction

Retracted: Key Technologies of Digital Protection of Historical and Cultural Heritage Based on Virtual Reality Technology

Mobile Information Systems

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] W. Zhang, "Key Technologies of Digital Protection of Historical and Cultural Heritage Based on Virtual Reality Technology," *Mobile Information Systems*, vol. 2022, Article ID 1598160, 8 pages, 2022.

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Research Article

Key Technologies of Digital Protection of Historical and Cultural Heritage Based on Virtual Reality Technology

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Due to the increasing progress of digital technology in recent years, the protection, inheritance, development, and utilization of historical and cultural resources have become more and more integrated into it, and it has become an ideal way. At present, many countries and regions have carried out relevant research projects. With the change of the living conditions of cultural heritage and the rapid development of sci & tech, many traditional protection methods are no longer suitable and need to be replaced by new protection methods. Digital protection technology is one of the fastest developing and most concerned. With the help of virtual reality (VR) technology, it presents the essence of Chinese culture for thousands of years and comprehensively combines the characteristics of all viewpoint with traditional Chinese culture. Select the representative Chinese traditional culture as the research direction, and analyze the cultural characteristics contained in the Chinese traditional culture. In this paper, Harris operator is used to extract the feature points of the images, and two registered images are calculated according to the affine transformation coefficient. The images after affine transformation are bilinear interpolated and weighted smoothed according to the adjacent position of the overlapping area to realize the seamless mosaic design of the images and the forward and backward projection algorithm of cylindrical panoramic images. And study the artistic expression of 3D panoramic image acquisition. Based on the analysis and experiment, it can be obtained that after calculation, the average spatial data acquisition efficiency can reach 61.8%. In practice, the average display effect can reach 60.4%.

1. Introduction

Due to the increasing progress of sci & tech, communicators can build a surreal world based on real scenes and cultural background with the help of VR technology and depict the stories that have happened in an artistic and virtual narrative way, and the audience can experience the value and connotation of traditional ancient architectural culture with the help of VR equipment. This communication mode is very different from the cultural communication under the traditional ordinary video communication mode [1, 2]. Due to the increasing progress of VR technology and the rationality of its application content, in practical work, high-resolution images beyond the visual angle of human eyes are used, while the visual angle of ordinary cameras cannot meet the needs [3]. For example, due to the limitation of distance, some super-large objects cannot be photographed in one photo, which is particularly prominent in the field of aerospace photography, and the demand for real-time rendering technology of realistic graphics has increased dramatically.

In order to realize the correct expression of cultural symbols, the combinations of model structure, related structure, and internal information are widely used [4, 5]. The model includes not only the external content, but also the internal environment, texture, and structure of materials, thus realizing the true presentation of culture [6, 7]. When the related buildings need directional restoration work, virtual models can be used for dynamic display, which can effectively reduce the possible uncertainties caused by the restoration work, reduce the risks and crises, and realize the effective protection and scientific management of ancient buildings [8, 9]. It can be seen that VR has the characteristics of multi-perception, immersion, interaction, and conception. It will be of great help to apply these characteristics to the protection of cultural heritage. In the current development of cultural undertakings and cultural industries, cultural resources have received unprecedented attention.

As the precious wealth of human civilization, historical and cultural resources are the essence of our country and nation, and their protection and development have attracted the common attention of all countries in the world in recent decades [10, 11]. The protection and utilization of foreign historical and cultural resources have been deeply practiced and studied. "Cultural industry and information industry are two super-industries in modern society and an important symbol of a country's soft power [12, 13]. Digital technology has given birth to the comprehensive convergence and integration of information industry and cultural industry, making the connection between the two industries completely beyond the traditional meaning [14]. With the development of information industry, the cultural industry has obtained a new interpretation and development opportunity; the development of cultural industry provides rich digital cultural content for the information industry" [15]. However, the above research does not solve the current problem of digitization of historical and cultural heritage. Therefore, this paper proposes the following innovations:

① Put forward the research of artistic expression of 3D panorama: on the basis of objective representation of 3D panorama, study the artistic expression of 3D panorama image and the application of HDR high dynamic density image in 3D panorama. In the technology, the commonly used panorama technology will be studied. The key technologies of image mosaic mainly include image matching and image synthesis.

② Research the collection method of panorama, and focus on analyzing the construction process of 360-degree cylindrical panorama space. The feature points of the image are extracted by the Harris operator, and the two registered images are calculated according to the affine transformation coefficient. The affine transformed image is subjected to bilinear interpolation and weighted smoothing according to the adjacent position of the overlapping area to realize the seamless stitching design of the image and realize the columnar design. Front and back projection algorithm for surface panorama images.

The chapters of this paper are arranged as follows: the first chapter is the introduction, which discusses the background and significance of the topic, and expounds the innovation of this paper. The second chapter mainly combines the research results of key technologies of digital protection of historical and cultural heritage based on virtual reality technology at home and abroad, and puts forward the innovative results and research ideas of this paper. The third chapter is the method part, which deeply discusses the application and principle of relevant algorithms. On the basis of previous research results, combined with the innovation of this paper, this paper puts forward the development and research model of new digital protection key technologies. The fourth chapter mainly discusses the experimental part of algorithm application. Through the experimental results, the technical model is established on the basis of sorting out the data. The fifth chapter is the conclusion, which summarizes the research results of this paper.

2. Related Work

Liu *G* proposed that with the help of VR technology, cultural forms such as ancient buildings, which are difficult to spread across time and space in daily life, can not only make the audience feel immersive, but also break the boundary between time and space, so that the audience can feel the cultural connotation of ancient buildings through ancient and modern times. This plays a very important role in strengthening patriotic education and improving national pride and cohesion [16]. Hong *l* believes that in practical application, GBR technology has many deficiencies both from the current computer processing capacity and from the perspective of developers. On the one hand, the cost of modeling and rendering is very large. When the actual scene is quite complex or needs to provide quite a lot of details, this method is inadequate. On the other hand, the real-time rendering speed is not satisfactory, and the rendering speed is inversely proportional to the scene complexity and rendering quality [17]. Phoon, Yap et al., and others believe that model construction is the first important link of digital protection. Effectively input the content into the software system and synchronously build cultural heritage with different software. In order to ensure the rationality and accuracy of the system, contacting each module is the focus of the model, and the expression content is clear, efficient, and accurate [18]. The research of Ren, Du, Feng, etc., shows the characteristics of virtual scene modeling and the main technical indexes for evaluating this modeling process, introduces and compares several modeling methods at present, and puts forward the hybrid modeling method applied in this paper. At the same time, by comparing the characteristics of the popular VR modeling software, the modeling software and real-time roaming driver software are selected [19]. Li and Hou believe that the image of the real scene is directly used as the representation of the virtual scene to truly reproduce the visual information of the real scene. The quality of the generated scene view has nothing to do with the complexity of the scene, but only with the resolution of the image to be displayed and the corresponding generation algorithm. The calculation amount of the view generation algorithm is small and can be completed in real time on the workstation and PC [20]. Zhang proposed that it should be emphasized that historical and cultural resources are a spiritual element. The key to historical and cultural resources lies in "historical culture." "Historical culture" contains at least three meanings: culture in history; culture with history as the core; and history and culture. Historical and cultural resources refer to the things that happened in the past of human beings and have an influence to become the spiritual elements that meet people's spiritual needs and the spiritual elements that are attached to the material [21]. Pletz C believes that the existing situation of intangible cultural heritage is even worse. Industrialization and modernization have had a subversive impact on traditional culture, and the urbanization process has made the folk culture produced under the traditional farming civilization desperate. The modern education system has changed the environment and thinking mode of children's childhood growth, while the current social environment has also changed the traditional way of life and entertainment of the masses, which has greatly shaken the survival foundation of intangible cultural heritage [22]. Zhao C believes that the effective combination of augmented reality technology and the digital development and utilization of intangible cultural heritage can fully highlight and give full play to the complementary relationship between the two, promote the effective full interpretation, display dissemination of intangible cultural heritage, and finally realize the rational development, utilization, and protection of intangible cultural heritage [23]. Zhanjun proposed that the "image-based" VR technology gradually came to the fore. Image-based rendering (IBR) technology proposed in the 1990s has become a research hotspot in recent years. 3D panorama has attracted more and more attention due to its strong realism and strong interactivity [24]. Zhong put forward the research and construction of the theoretical framework of the development mode (3) of cultural digital implantation based on augmented reality technology. Based on the principle of augmented reality technology, with the basic idea of cultural digital implantation in the existing material media, and the comprehensive application of digital technology and information technology and other related fields, the theoretical framework of cultural digital implantation development model is constructed [25].

Based on the research of the abovementioned related work, this paper determines the positive role of the research field of digital protection key technologies of historical and cultural heritage based on VR technology, constructs the algorithm model of digital protection key technologies optimized by algorithm, and makes in-depth analysis and research on the acquired and collected data by using VR technology, so as to make more effective use of the data and excavate the valuable hidden behind the data.

3. Methodology

3.1. Overview and Analysis of Related Theories

3.1.1. The Concept and Connotation of Historical Heritage. Cultural digital implantation refers to the process of using digital technology to process cultural content, transforming cultural content into digital form, adhered to, and integrated into a certain carrier.

To explain the concept of cultural digital implantation, this paper divides the ways of cultural implantation into physical ways and digital ways. For example, China has a large number of intangible cultural heritages that have lost their inheritance before they have time to protect. If all inheritors can consciously use digital means, at least some can be retained. Although many inheritors are out of touch with the times, there are some simple ways to do it. Even a few photos and simple videos taken by mobile phones can be used as the basis for the existence of this culture. Compared with traditional methods, this form of protection has many advantages because the traditional data storage cost is high and the capacity is low. Digital archiving is just the opposite, with low cost and explosive growth of stored information. Information must rely on digital technology. As the cultural heritage itself is facing an endangered situation, it is an important strategy for the protection of cultural heritage to adopt advanced computer technology to combine its information sorting, monitoring, management, and decision-making, to make a true, systematic, and comprehensive record of precious, endangered, and historic cultural heritage, and to make virtual representation and establish permanent archives and databases. In foreign countries, it has become a fashion to use three-dimensional panorama to display the beautiful environment of the scenic spot, giving the audience an experience of being in the scenic spot. Combined with the guide map of the scenic spot, the audience can shuttle freely between the scenic spots and let the tourists feel the charm of the scenic spot in an all-round way.

Historical and cultural resources in the general sense belong to cultural resources in the final analysis and have all the characteristics of general cultural resources. However, apart from the characteristics of general cultural resources, historical and cultural resources have some characteristics of their own. Like objectivity, different from the subjective creation of realistic cultural resources, historical and cultural resources belong to the cultural resources formed and accumulated in the past. Like "historical past events," they have objective existence, and once they are formed, they will not be transferred by people's subjective ideas. Second is publicity. Historical and cultural resources "are not only the wealth of a region and a nation, but also the common wealth of human society." Then there is mystery. Because historical and cultural resources are usually formed in history, there is often a period or a long time interval from reality, which forms the mystery of "historical past." Cultural heritage is generally divided into two types: tangible cultural heritage and intangible cultural heritage. However, as historical and cultural resources, ancient books and cultural heritage have certain particularities, which are in essence between material and intangible, and are extremely rich and self-contained in a country like my country. Therefore, historical and cultural resources can be divided into three types: first, cultural relics and their derivatives; second, ancient books and their derivatives; and third, intangible cultural heritage and its derivatives.

3.1.2. Application of VR Technology in Digitalization of Cultural Heritage. Economy is the foundation of all development, and culture belongs to the category of superstructure. The change of economic foundation will inevitably lead to the change of cultural development. With economic globalization, the development of cultural globalization has become an inevitable trend. In order to create an environment for the user to feel immersive and immersed in it, one of the necessary conditions is to realistically display the objects in the objective world in the VR roaming system as required. For example, it can display the characteristics of each ancient building and the three-dimensional images of the surrounding supporting environment. Figure 1 shows the basic process of virtual scene establishment.

To analyze the historical and cultural heritage based on VR technology, we must first analyze the VR. VR is a comprehensive technology that integrates information collection technology, image stitching technology, computer technology, and other technologies. According to the abovementioned related technologies, VR technology can realize a virtual world that is similar to or beyond the real world. Under the virtual world, the audience can not only feel the shocking visual experience, but also feel it from many aspects, such as hearing and even touch, so as to have the feeling of being there and achieve the real VR. VR technology can bring people very real experiences and feelings, which is determined by its own characteristics. The main features of VR include perception, immersion, interactivity, imagination, and autonomy.

Simply put, the image transformation model is intrinsically linked to the camera imaging geometry. They are different outward manifestations of the same type of concept. The transformation model between the captured images can be obtained from the imaging geometry of the camera; similarly, the information of the transformation model between the images can generally reversibly deduce the geometric posture of the camera during imaging. They are the mathematical basis of image registration and image stitching technology. As shown in Figure 2, it is the schematic diagram of world coordinate system and camera coordinate system.

Among them, the above coordinate system is represented based on $H_W M_W Z_W$, and its origin is generally located at a certain place in the shooting location; the H-axis is consistent with the horizontal direction of the heading, the M-axis is perpendicular to the H-axis, the Z-axis is up in the vertical direction, the H-axis is vertical, M-axis and Z-axis form a right-hand rectangular coordinate system. The camera coordinate system is represented by $H_C M_C Z_C$, with the optical center of the camera as the origin and the optical axis as the Z_C-axis. The plane determined by the H_C-axis and M_C-axis is parallel to the imaging plane. The camera is placed in the objective three-dimensional world with a certain attitude. Generally, the world coordinate system will not completely coincide with the camera coordinate system, and there are rotation and translation relations. Under the secondary coordinates, these relations can be expressed by a matrix. The relationship between camera coordinate system and world coordinate system is as follows:

$$\begin{pmatrix} H_C \\ M_C \\ Z_C \\ 1 \end{pmatrix} = \begin{pmatrix} R & T \\ 0 & 1 \end{pmatrix} \begin{pmatrix} H_C \\ M_C \\ Z_C \\ 1 \end{pmatrix} = M \begin{pmatrix} H_C \\ M_C \\ Z_C \\ 1 \end{pmatrix}. \tag{1}$$

The subscript C represents the coordinates in the camera coordinate system, and the subscript W represents the coordinates in the world coordinate system, where T, R, 0 represents the rotation vector of $3 \times 1, 3 \times 3, 1 \times 3$, respectively. Figures 3 and 4 show the images of the camera coordinate system, the image plane coordinate system, and the image plane coordinate system.

In the above formula, the spatial coordinates need to be processed and transformed into European coordinates. The relationship between the above two coordinate systems in homogeneous coordinate system can be expressed by the following formula:

$$Z_C \begin{pmatrix} h_C \\ m_C \\ 1 \end{pmatrix} = \begin{pmatrix} f & 0 & 0 & 0 \\ 0 & f & 0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix} \begin{pmatrix} H_C \\ M_C \\ Z_C \\ 1 \end{pmatrix}. \tag{2}$$

In order to facilitate subsequent processing, this paper converts its representation, where (u_0, v_0) is the coordinate of O point in the coordinate system $O - uv$, and d_x, d_y represents the width and height of each pixel. The specific expression is as follows:

$$\begin{pmatrix} u \\ v \\ 1 \end{pmatrix} = \begin{pmatrix} \frac{1}{d_x} & 0 & u_0 \\ 0 & \frac{1}{d_y} & v_0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x_C \\ y_C \\ 1 \end{pmatrix}. \tag{3}$$

Through the above formula, the coordinate system relationship between the image plane and the world can be obtained through calculation. The expression is as follows:

$$Z_C \begin{pmatrix} u \\ v \\ 1 \end{pmatrix} = \begin{pmatrix} \frac{f}{d_x} & 0 & u_0 & 0 \\ 0 & \frac{f}{d_y} & v_0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix} \begin{pmatrix} R & T \\ 0 & 1 \end{pmatrix} \begin{pmatrix} H_W \\ M_W \\ Z_W \\ 1 \end{pmatrix} = K \begin{pmatrix} R & T \\ 0 & 1 \end{pmatrix} \begin{pmatrix} H_W \\ M_W \\ Z_W \\ 1 \end{pmatrix} = P \begin{pmatrix} H_W \\ M_W \\ Z_W \\ 1 \end{pmatrix}. \tag{4}$$

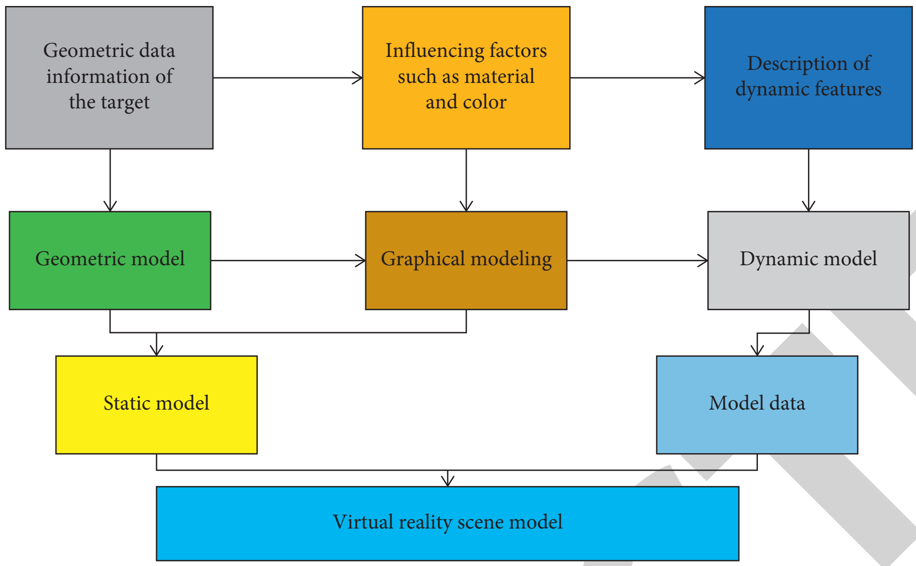

FIGURE 1: Basic flow of virtual scene establishment.

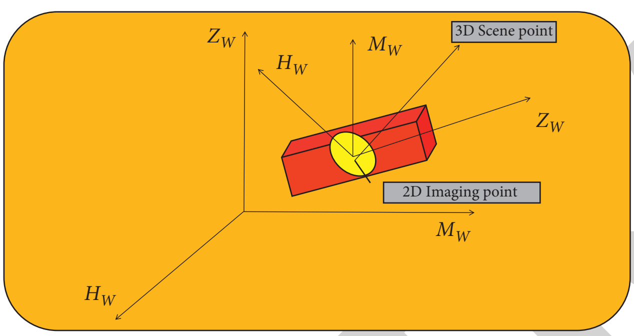

FIGURE 2: Schematic diagram of the world coordinate system and the camera coordinate system.

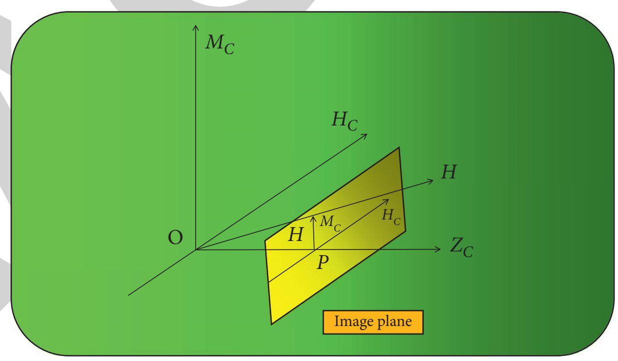

FIGURE 3: Camera coordinate system and image plane coordinate system.

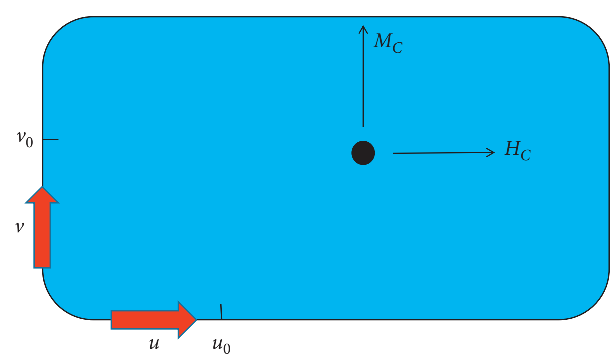

FIGURE 4: Images of two representations of the image plane coordinate system.

In the above formula, matrix P is called projection matrix, matrix K is only related to camera internal parameters, vector T, R is determined by the camera's position and direction relative to the world coordinate system, and they are called camera external parameters.

3.2. Focused Research on Digital Protection Technology. Image-based graphics rendering technology is a process in which the basic data are composed of discrete images sampled from the environment, and the continuous description of the environment is obtained by processing and organizing these image data. Generating scene pictures from different viewpoints based on some pregenerated images is an emerging research field, which changes people's traditional understanding of computer graphics. The panorama function characterizes all possible environmental mappings of a given scene; thus, it gives an accurate description of the scene in the form of images.

It can be described by parametric equation, which defines all the visible information in the scene at any time and within any wavelength range in any space. For any viewpoint $V(V, V_y, V_Z)$ in space, any line of sight from this viewpoint can be defined by spherical angle e and time t. If the recording wavelength is λ, the panoramic function at the viewpoint t at V time can be defined as $P = P(e, V_X, V_y, V_Z, t)$. To generate a view of a given viewpoint in a specific direction, it is only necessary to substitute the viewpoint $V(V, V_y, V_Z)$, the spherical angle e, and the time t into the panoramic function.

The corner points extracted based on Harris operator are used as feature points in image matching. It is simple and effective in calculation and very stable. It is a more stable point feature extraction operator compared with other operators under the conditions of image rotation, gray level, noise, and viewpoint transformation. The corner detection formula of Harris operator only involves the first-order difference of the image:

$$M = \frac{1}{2\pi\sigma^2}\exp\left(-\frac{x^2+y^2}{2\pi\sigma}\right)\otimes\begin{bmatrix} I_x^2 & I_xI_y \\ I_xI_y & I_y^2 \end{bmatrix}. \quad (5)$$

Here, I_x, I_y represents the horizontal and vertical derivatives of the point in the image, respectively; g_x is the gradient in the x direction, g_y is the gradient in the y direction, and σ is the standard deviation of the Gaussian smoothing filter function.

After similar diagonalization of the above formula, the following is obtained:

$$M = \frac{1}{2\pi\sigma^2}\exp\left(-\frac{x^2+y^2}{2\pi\sigma}\right)\otimes\begin{bmatrix} I_x^2 & I_xI_y \\ I_xI_y & I_y^2 \end{bmatrix}\Rightarrow R^{-1}\begin{bmatrix} \lambda_1 & 0 \\ 0 & \lambda_2 \end{bmatrix}R, \quad (6)$$

where λ_1, λ_2 is the eigenvalue of the quaternion matrix M. Each pixel corresponds to one such quaternary matrix. Here, R can be regarded as a rotation factor, and only the characteristic value λ_1, λ_2 can be used to analyze the variation, without affecting the variation components in two orthogonal directions. After diagonalization, the variation components of the two orthogonal directions are "extracted" and become λ_1, λ_2. When both are small, it is defined as a flat area. When only one of the two is larger and the other is smaller, it is defined for the edge when both are larger. Table 1 shows the common camera focal length and corresponding viewing angle.

Assuming that the camera is in its normalized position, that is, the camera posture rotation matrix is identity matrix, then the optical axis Z coincides with the axis and is perpendicular to the Y-axis. The phase space coordinate of a point (X, Y) in the image is (X, Y, f).

Transform such an image to the unit cylindrical surface, and the points on the cylindrical surface are represented by angle θ and height h, that is,

$$(\sin\theta, h, \cos\theta) \propto (x, y, f). \quad (7)$$

Accordingly, the image plane point coordinates can be mapped to the cylindrical coordinate transformation formula, and its expression is

$$x' = s\theta = s\tan^{-1}\frac{x}{f},$$
$$y' = sh = s\frac{y}{\sqrt{x^2+f^2}}, \quad (8)$$

where s is the scaling factor, and for cylindrical stitching, s usually goes to the focal length of the camera. Generally, in order to prevent "holes" during transformation, it is necessary to use the inverse transformation form of cylindrical coordinate transformation. For the point (x', y') on the cylinder, when the focal length is f and the scaling factor is s, the corresponding image point coordinate (x, y) is

$$x = f\tan\theta = f\tan\frac{x'}{s},$$
$$y = h\sqrt{x^2+f^2} = f\frac{y'}{s}\sec\frac{x'}{s}. \quad (9)$$

Table 1: Common camera focal lengths and corresponding viewing angles.

Camera focal length	14	16	24
Horizontal view angle	81.20	73.70	53.24
Vertical visual angle	104.20	96.55	73.24

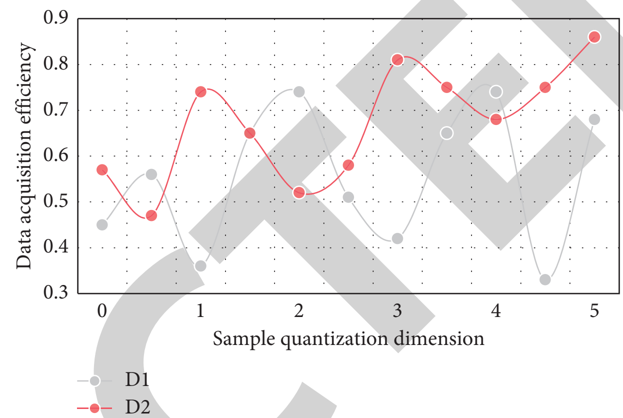

Figure 5: Analysis of spatial data acquisition efficiency.

4. Result Analysis and Discussion

Through the above research and analysis, this paper has a relatively perfect system in theory. Next, the experimental analysis will be carried out in this part to prove the spatial digital model designed by the text. In order to build a scientific, reasonable, and feasible experimental conclusion system, this paper will analyze and experiment from four important aspects: spatial data acquisition efficiency, data acquisition accuracy, actual display effect strength, and digital loss rate. Figures 5 and 6 show the experiments. The results show the differences between the data sets D1 and D2 in terms of spatial data acquisition efficiency and data acquisition accuracy, and the data sets have a quantitative relationship of D1 < D2.

Through the above experimental analysis, it can be seen that in terms of virtual technology, the acquisition efficiency of spatial data is well reflected by the optimized processing in this paper, and the acquisition efficiency can be kept above 30% in different sample sets, which will also ensure that data interruption can be well avoided in the process of digitalization. After calculation, the average spatial data acquisition efficiency can reach 61.8%. When analyzing the

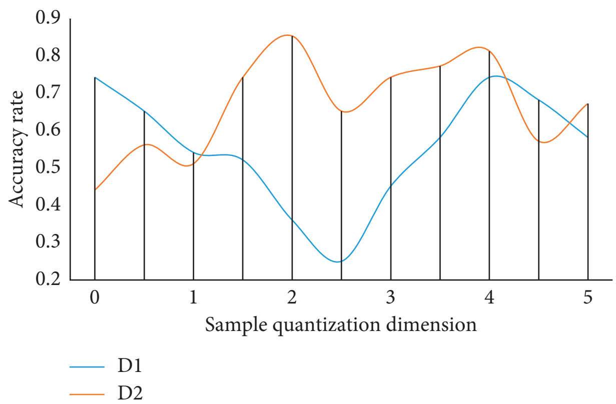

Figure 6: Data acquisition accuracy analysis.

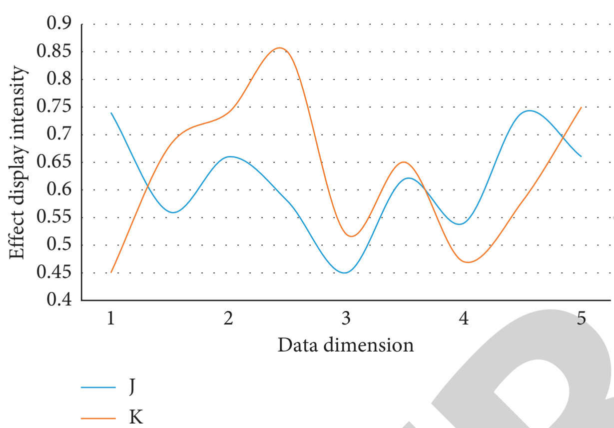

Figure 7: Analysis of the actual display effect strength.

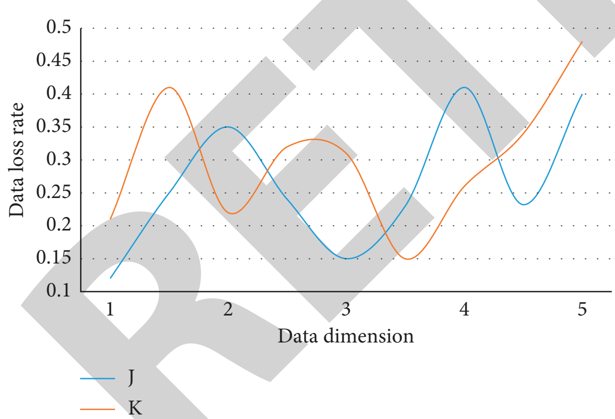

Figure 8: Digitization loss rate analysis.

accuracy of data acquisition, it is obvious that there are large fluctuations in the range of 1–3. This is due to the larger capacity of D2 in the data set, which inevitably leads to the increase of interference items. With the rapid expansion of data, this also causes the interference items to be unable to be reduced in time. But as the overall capacity increases, the interference term is diluted, so the accuracy returns to normal levels.

On the basis of the above experimental conclusion, the actual display effect intensity and digital loss rate are analyzed, and *J* and K are experimental data sets, as shown in Figures 7 and 8.

Through the analysis, we can know that in the actual display situation, the effect is still very obvious, and it is in good strength on the whole horizontal axis. In particular, the display strength of sample set K in the interval of 2–3 is up to 85%. Therefore, the spatial coordinate system algorithm designed in this paper is very effective. In actual operation, the average display effect can reach 60.4%. In the process of digitization, this paper also analyzes the loss rate of digitization. It can be seen from the data that the loss rate is generally low, but it is worth noting that if the data set is too large, the loss rate will increase. Therefore, the capacity of the data should be reasonably controlled.

5. Conclusions

In the field of cultural heritage protection, the future application of VR technology will be more and more extensive, and the experiencers will have higher requirements for 3D fidelity. Therefore, the related technology research will become more and more urgent. In the process of heritage information collection, statistics, processing, storage, and display, a large number of equipment and a large number of computer software and hardware are needed to assist. It has become an inevitable trend to make rational use of modern scientific and technological means such as digital technology and information technology for development protection. This paper analyzes the advantages of image-based rendering technology in virtual scene construction, as well as the problems that need to be solved based on image-based rendering technology. Construction and manipulation are given in detail. On the basis of analysis and experiment, after calculation, the average spatial data acquisition efficiency can reach 61.8%. In practice, the average display effect can reach 60.4%.

Data Availability

Data are available on request from the corresponding author.

Conflicts of Interest

The authors declare that they have no competing interests.

References

[1] P. Zheng and L. Huang, "Research on the application of 3D VR technology in the protection and development of ancient villages," *Revista de la Facultad de Ingenieria*, vol. 32, no. 5, pp. 766–774, 2017.

[2] D. Cao, G. Li, W. Zhu et al., "VR technology applied in digitalization of cultural heritage," *Cluster Computing*, vol. 22, no. 4, pp. 1–12, 2017.

[3] Z. Liang and R. Shuang, "Research on the value identification and protection of traditional village based on VR technology," *Boletin Tecnico/Technical Bulletin*, vol. 55, no. 4, pp. 592–600, 2017.

[4] C. Kai-YiL. Ko-Fong et al., "Effects of a ubiquitous guide-learning system on cultural heritage course students'

performance and motivation," *IEEE Transactions on Learning Technologies*, vol. 13, no. 1, pp. 52–62, 2019.

[5] F. Wang, "Computer distance virtual experiment teaching application based on VR technology," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 13, no. 4, p. 83, 2018.

[6] Y. Wang and E. Liu, "VR Virtual reality technology of multi UAVEarthquake disaster path optimization," *Mathematical Problems in Engineering*, vol. 2021, Article ID 5525560, 9 pages, 2021.

[7] R. Xie, "Intangible cultural heritage high-definition digital mobile display technology based on VR virtual visualization," *Mobile Information Systems*, vol. 2021, Article ID 4034729, 11 pages, 2021.

[8] Z. Mai, "Application pattern innovation and value analysis of VR assisted technology in urban landscape design," *Boletin Tecnico/Technical Bulletin*, vol. 55, no. 17, pp. 788–794, 2017.

[9] D. Yu, "Analysis of rural culture construction and innovation based on integration of digital media technology and paper material," *Paper Asia*, vol. 1, no. 9, pp. 122–125, 2018.

[10] Y. Fu, T. Guo, and X. Zhao, "Intelligent splicing method of virtual reality lingnan cultural heritage panorama based on automatic machine learning," *Mobile Information Systems*, vol. 2021, Article ID 8693436, 10 pages, 2021.

[11] F. Škola, S. Rizvić, M. Cozza et al., "Virtual reality with 360-video storytelling in cultural heritage: study of presence, engagement, and immersion," *Sensors*, vol. 20, no. 20, p. 5851, 2020.

[12] G. Palma, S. Perry, and P. Cignoni, "Augmented virtuality using touch-sensitive 3D-printed objects," *Remote Sensing*, vol. 13, no. 11, p. 2186, 2021.

[13] F. Poux, Q. Valembois, C. Mattes, L. Kobbelt, and R. Billen, "Initial user-centered design of a virtual reality heritage system: applications for digital tourism," *Remote Sensing*, vol. 12, no. 16, p. 2583, 2020.

[14] T. Caciora, G. V. Herman, A. Ilieş et al., "The use of virtual reality to promote sustainable tourism: a case study of wooden churches historical monuments from Romania," *Remote Sensing*, vol. 13, no. 9, p. 1758, 2021.

[15] M. Sanna, D. Manuri, and fnm De Pace, "Special issue "wearable augmented and mixed reality applications"," *Information*, vol. 10, no. 10, p. 289, 2019.

[16] G. Liu, "Research on the integration of animation design and Huizhou culture based on VR technology," *Revista de la Facultad de Ingenieria*, vol. 32, no. 3, pp. 201–209, 2017.

[17] L. Hong, "Design of multimedia teaching platform for Chinese folk art performance based on VR technology," *International Journal of Emerging Technologies in Learning*, vol. 12, no. 9, p. 28, 2017.

[18] S. Y. Phoon, H. J. Yap, Z. Taha et al., "Interactive solution approach for loop layout problem using VR technology," *International Journal of Advanced Manufacturing Technology*, vol. 89, no. 5, pp. 2375–2385, 2017.

[19] H. Ren, Y. Du, X. Feng, J. Pu, and X. Xiang, "Mitigating psychological trauma on adult burn patients based on virtual reality technology of smart medical treatment," *Journal of Healthcare Engineering*, vol. 2021, Article ID 5531176, 11 pages, 2021.

[20] J. Li and T. Hou, "Application of virtual reality technology in analysis of the three-dimensional evaluation system of rural landscape planning," *Mathematical Problems in Engineering*, vol. 2021, Article ID 6693143, 16 pages, 2021.

[21] C. . Zhang, "Research on interface visual communication design based on VR technology in paper manufacturing," *Paper Asia*, vol. 2, no. 1, pp. 146–150, 2019.

[22] C. Pletz, "Which factors promote and inhibit the technology acceptance of immersive virtual reality technology in teaching-learning contexts? Results of an expert survey," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 16, no. 13, p. 248, 2021.

[23] C. Zhao, "Application of virtual reality and artificial intelligence technology in fitness clubs," *Mathematical Problems in Engineering*, vol. 2021, Article ID 2446413, 11 pages, 2021.

[24] W. Zhanjun, "Application research of VR technology in environmental art design," *Acta Technica CSAV (Ceskoslovensk Akademie Ved)*, vol. 62, no. 1, pp. 215–224, 2017.

[25] J. Zhong and J. Xu, "Taekwondo action design combining CAD and VR technology," *Computer-Aided Design and Applications*, vol. 19, no. 5, pp. 132–142, 2021.