Virtual Museum Scene Design Based on VRAR Realistic Interaction under PMC Artificial Intelligence Model

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Abstract

At present, there are problems of insufficient conservation and heritage and single display channels in the field of museums. In the background of digital era, innovative new museum display mode and interaction mode can bring new exhibition experience for visitors. In this paper, we study the key technologies such as 3D scene visualization, facility and equipment simulation, and human-computer interaction simulation. Based on virtual reality and augmented reality, somatosensory interactive digital technologies, an interaction engine under multiple classifiers is proposed, an online virtual museum design strategy is built, and an all-round, multi-angle, three-dimensional interactive museum display platform is constructed. A quantitative analysis method based on the policy consistency index model is proposed to conduct user measurement and post-use evaluation of the conceived virtual museum. The application results show that the design platform can intuitively display the complex environment of an intelligent digital museum, support the development of immersive virtual roaming and virtual touch, and provide a new way to visit a new type of interactive museum.

Keywords: virtual reality; augmented reality; somatic interaction; virtual museum; policy coherence index

AMS 2020 codes: 68T01

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ISSN 2444-8656

https://doi.org/10.2478/amns.2023.1.00200

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1 Introduction

As an important carrier of social and cultural heritage, museums help to understand the political, economic, scientific and cultural forms of a country or region, and they are also a microcosm of a country or region [1]. However, due to their rich cultural outreach and profound aesthetic connotations, as well as objective issues such as patronage restrictions, traffic pressure, and openness, visitors have difficulty achieving in-depth knowledge of heritage culture [2]. In order to enable more people to visit museums conveniently, comprehensively, and with independent selectivity, the introduction of digital technologies such as virtual reality and augmented reality in museum displays is a requirement of the times to stimulate the interest of visitors and promote the dissemination and transmission of traditional culture [3]. Virtual Reality (VR) is a high-tech technology that has emerged in recent years, mainly using computer simulation to generate a three-dimensional space virtual world, which enables users to obtain an immersive experience and observe things in three-dimensional space in a timely and unrestricted manner [4]. Augmented Reality (AR) is a new human-computer interaction technology that enables participants to interact with virtual objects in real time, resulting in an amazing visual experience [5]. Augmented reality can superimpose the virtual world and the real world in the observer’s display screen through holographic projection, and can also be interactive.

In recent years, there have been significant developments in China in the area of digitization of cultural relics, including the establishment of the “University Digital Museum Construction Project” by the Chinese Ministry of Education, the “Collaborative Research on Digitized Dunhuang Murals” by the Dunhuang Academy and Northwestern University, and the development of the virtual Forbidden City by the Palace Museum and Toppan Printing Japan [6]. Networked PC-driven construction methods are becoming the trend for multi-projection surface virtual environment systems with larger display size, wider field of view, and more impactful and immersive visual effects than ordinary standard projection systems [7-9].

Xie et al [10] proposed to apply 5G+ Open VR cross-platform experience technology to the science of deep-sea virtual museums, allowing museums to truly access the meta-universe. Ren et al [11] proposed to combine 3D information various exhibition information, digital simulation exhibition not only to give users a quick way, geographical, time constraints, 3D virtual museum interaction, but also a new VR experience, a new mode of cultural communication. Yu et al [12] applied the “Internet+” model to unite and deeply integrate the Internet with traditional museums, presenting them in a multi-level, multi-sensory, multi-angle, three-dimensional, and all-round way to bring people an immersive experience. Mobile augmented reality technology, proposed automatic recognition of surfaces, capturing feature point clouds, anchor points, 2D planar collections and tracking state drawing planes for each frame.

Based on the above analysis, this paper uses virtual reality technology to build a museum simulation scene, based on the dual-channel ring screen VR environment can meet the needs of visitors to the museum and other complex scenes virtual roaming, so that the observer produces a strong sense of immersion; based on gesture recognition, motion tracking and a number of VR/AR technologies combined with the interactive display process of the museum, in the premise of ensuring the quality of the scene picture, try to The classifier model optimization algorithm is used to reduce the number of facets of the scene; a format with a higher image compression rate is used to reduce the physical memory and video memory requirements of the scene for Personal Computer, further enhancing the realism of the scene.
2 ARVR technology and its features

2.1 Virtual reality technology

Virtual reality (VR) is an interactive information simulation technology generated by a high-performance computer that acts on the user through visual, auditory, haptic and other means of information dissemination to produce immersive improvements [14]. It mimics the external stimuli perceived by the human body and belongs to a type of computer simulation technology. Virtual reality allows the creation and experience of virtual worlds, which are multidimensional information spaces that contain a variety of information and are the goal that humans have been pursuing. In this virtual space, both the perceptual and rational cognitive abilities of humans can be fully exploited [15]. As shown in Figure 1, it shows the way of interaction between virtual and real technologies and human senses.

![Figure 1. 3I virtual and real features and interaction methods](image)

2.2 VR technology application scope

The application of VR technology in digital museums is more reflected in human-computer interaction, by combining virtual and realistic technologies, promoting the completion of interaction through the display of three-dimensional technology, superimposing reality and virtual, and providing a better museum browsing experience for the audience [16]. VR system in the implementation process, the need for coordinate positioning in different collections of the virtual museum, according to different virtual coordinates to correspond to the virtual model. The location and image of the virtual collections, etc. are identified and positioned in the process and trimmed against the real 3D pictures and camera positions [17]. As shown in Figure 2, by controlling the VR system, the images of the collection in the virtual are processed, while the virtual spatial coordinates are embedded and fused with the real world coordinates, so that the virtual scenes are smoothly superimposed in the real world, and the images of the real world combined with the virtual scenes are transmitted back to the real device to realize the reality enhancement effect, in which case the interaction between the user and the scenes is supported to improve the audience’s sense of participation and sense of experience.
In the process of reality augmentation implementation, the following technologies are mainly applied.

1) Display technology. The main application of this technology is the enhancement of virtual reality effect, through display technology to make the exhibits in the museum more realistic display in front of the audience, to improve the perceptual experience effect.

2) 3D technology. This technology should strengthen the management and identification effect of three-dimensional coordinates in the application process [18]. Strengthening the overlap effect between the 3D coordinates and the coordinates in the real environment is beneficial to improve the combination effect between the virtual and real environment.

3) System development technology. In the process of VR design for digital museums, in order to improve the reality-enhancing effect, different system development tools need to be flexibly used to identify and control the virtual collections and optimize their display in the real environment, so as to improve the overall system development and display role.

2.3 Overview of the key technologies of AR

Augmented reality (AR) refers to the superimposition of computer-generated virtual objects or information onto the real environment, where the experiencer can both see the real world and interact with the virtual world through the device. This allows the experiencer to achieve a sensory experience beyond reality. The system is capable of creating 3D graphics that appear to be overlaid on the real world [19]. As shown in Table 1.
Table 1. Comparison of virtual reality system interaction

<table>
<thead>
<tr>
<th>Classification</th>
<th>Working Principle</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Main Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-immersive systems (desktop systems)</td>
<td>Use low-level workstations to generate 3D interactive scenes</td>
<td>Low cost, High penetration</td>
<td>Two-dimensional display, can not get a strong sense of immersion</td>
<td>Panoramic virtual roaming system</td>
</tr>
<tr>
<td>Immersive systems</td>
<td>Use of helmet display devices</td>
<td>Highly real-time Interactivity, Good system integration, Integrativeness, Openness</td>
<td>High technical requirements, High cost, Late start</td>
<td>CAVE system</td>
</tr>
<tr>
<td>Distributed system</td>
<td>Users in different physical locations are able to enter a virtual reality environment at the same time.</td>
<td>Multi-person interaction, Real-time interaction, Information sharing</td>
<td>Large investment, Not suitable for mass popularity</td>
<td>Teleconferencing, tele-education, telemedicine, etc.</td>
</tr>
<tr>
<td>Augmented Reality Systems</td>
<td>Virtual images superimposed on real physical objects, users can observe both the virtual world and the real</td>
<td>High security, Combination of reality and reality, Real-time interaction</td>
<td>Three-dimensional registration, High cost</td>
<td>Late start</td>
</tr>
</tbody>
</table>

2.3.1 Real and imaginary fusion display

AR technology enriches and supplements the real world by superimposing virtual information, and the fusion of reality and imagination is its basic characteristic. Through human perceptual channels such as vision, hearing and touch, virtual information is fused with real information, which confuses the virtual boundary to a certain extent and enhances the feelings brought by the environment [20]. The main devices for AR devices are cameras, which are used for capturing image features and motion capture, etc. The main devices for AR fusion display of virtual and real information can be divided into AR glasses, vehicle HUD and handheld AR [21]. HoloLens, Magic Leap and Meta are recognized as the top 3 AR headsets in the world. However, AR glasses are not popular in the short term due to the hardware challenges that are difficult to overcome, such as wearing comfort, mobility and interactivity.

2.3.2 Real-time interactive system

The user can interact in real time is an important feature of AR system, the user through the interactive operation of the virtual object in the scene of specific instructions, recognition, processing and then the feedback of the virtual object to the user to achieve the effect of real-time interaction, so that the audience of augmented reality applications to get a better experience. Common interaction methods include button interaction, voice interaction, gesture interaction and interaction with hardware devices. Different interaction methods are used to achieve control of the computer system in the form of different information input. Haptic-based button interaction is the most basic interaction method in mobile devices, and the mobile terminal collects information about touch points during user input through the touch screen, and button information is judged and executed to complete various touch-based interaction methods [22]. Speech-based interaction uses voice as the input signal to manipulate virtual objects by voice. At the same time, AR systems can use realistic sound effects and voice to instruct the user’s behavior, thus realizing the information interaction between human and computer systems [23]. Vision-based interaction such as gestural interaction usually consists of two components, namely tracking and understanding. Tracking is to identify the image information within the field of view by the camera, determine the presence of target features such as hand information.
and track it, and understanding is to determine the meaning of the gesture’s or action and execute the gesture command to the device by extracting the hand information features, building the hand model and then matching it with the preset hand model library. Hardware device based interaction requires the use of handles, data gloves and other physical sensing devices to obtain and convey input and output information in a simple operation manner and can add some physical feedback.

2.3.3 Three-dimensional registration alignment

3D registration alignment technology can accurately realize the overlay of virtual information and real environment, which is one of the key technologies for building AR applications and a prerequisite for realizing the fusion of virtual and real information display and real-time user interaction. Environment perception is achieved through target detection, and whether the system can accurately and stably identify objects in a complex environment directly determines the performance of the AR system, and also directly affects the user’s interactive scene experience. The 3D registration alignment is mainly divided into two steps: (1) the tracking process is to obtain the location information of the real space where the virtual information will be superimposed, to determine the change of the target location by acquiring the sensor pose in real time, and to establish the spatial coordinate system with the current viewpoint of the user; (2) the registration process is to superimpose the virtual scene into the real environment based on the tracked location information [24].

The 3D tracking and registration techniques of augmented reality are mainly divided into computer vision-based tracking and registration techniques, hardware sensor-based tracking and registration techniques, and hybrid tracking and registration techniques, as shown in Figure 3.

Figure 3. Classification of 3D registration technology in augmented reality
2.4 Virtual reality technology in museum display

Design of the application of the information age, the traditional museum display design both in space, content, scale and other aspects of the shortcomings, but also produced a more profound contradiction, therefore, people in order to be able to solve the shortcomings of the traditional museum display design, through the integration of virtual reality technology, to meet the needs of people watching, but also greatly enhance the visibility of the museum, so that people understand more of the history Culture, its main performance for the following two aspects.

i. Solve the space of massive exhibit resources and effective physical display Our country is vast and has a history of five thousand years, therefore, the goods and resources displayed in each museum are more abundant. However, some museums have limited display space and capacity. Although some museums have been expanding their space and capacity, they cannot meet the demand of the public for merchandise display to a certain extent.

After the fusion of multimedia technology and virtual reality technology, it has the feature of interactive. It effectively rises and expands the limited museum space into the infinite network virtual space, which in turn allows people to have a multidimensional experience in the virtual scene and feel infinite relaxation in the experience, thus relieving the pressure brought by real life [25].

ii. Strong sense of realism in the museum of goods display design, the need to use virtual reality technology to increase personal contact with the entity, and then for the exhibition area to build a relaxed scenario, so that people in the viewing experience the rich information carried by the exhibits. For example, the use of stereoscopic glasses allows people to “truly” feel the value of the goods, and deep inside, adding a different feeling to the goods. As you can see, virtual reality technology effectively solves the single nature of museum display equipment, to meet people’s viewing needs, so that people in the virtual scene and the physical connection with the goods, and then more detailed understanding and observation of the collection, to meet people’s understanding of culture and the pursuit of spirituality.

3 System solution design

The overall system architecture is based on Ethernet, switch, AR loop system composition, technology allows the system to create a richer way of interaction, AR technology can enhance the real world objects and environment [26]. The system hardware structure and interaction process is shown in Figure 4, using PC series processing module, the augmented interaction module is developed to first capture real scene video images through the camera and overlay virtual information in the real scene to enrich the exhibit information display. The captured images are pre-processed to complete the conversion from color video images to black and white binary images.
3.1 Enhanced interaction module development

The system augmented interaction module captures the environment in the museum in real time and generates real scene images for the system to call. Tracking and registration is the core of augmented reality system, which mainly has two types of technologies based on computer vision tracking and registration and sensors for hardware tracking and registration, the former is distinguished by whether the system uses artificial markers or not. The augmented reality system based on artificial markers can locate the virtual model to the real world and can quickly detect artificial markers from the complex real environment, and the tracking registration module of most augmented reality systems is implemented in the way based on artificial markers.

The tracking registration process is first based on the video capture device to capture video images, and the AR/VR system captures video images by calling the mobile device camera. Pre-processing of the captured image is done to complete the conversion from a color video image to a binary image in black and white. For example, the pixel point gray value $S(x, y) \geq t$ can be a background point, which is three hold as shown in equation (1).

$$S(x, y) = \begin{cases} \alpha_0, f(x, y) < t \\ \alpha_1, f(x, y) \geq t \end{cases}$$

(1)

$S(x, y)$ The binarized image is obtained, and the image segmentation technique is used to find out the points of interest in the image. Determine whether the marker is a legitimate marker, and determine the specific ID of the marker for identification after successful template matching.

3.2 Display technology module

With the continuous development of computer hardware and software technology, the helmet display allows users to feel the spatial three-dimensional sense, and the VR system in this paper adopts Ocular
virtual display device with a resolution of 1920×1080, DK2 display effect is ideal. The AR system presents object information should be designed with the principle of lightness, and adopts smartphone screen based on Android operating system as the display device, which can be free from exhibition environment restrictions [27].

3.3 Parameter selection for KNN classifier

In the thesis algorithm, the KNN (K-Nearest Neighbor algorithm) classifier needs to set two parameters, one is the number of reference nearest neighbors k and one is the proportion of the predicted dump in the number of video frames to be encoded \( R_{pf} \). Where \( R_{pf} \) is calculated from Equation (2).

\[
R_{pf} = \frac{N_{pf}}{N} \times 100\%
\]

In equation (2), \( N \) is the total number of video frames to be encoded and \( R_{pf} \) refers to the number of predicted frames. Since both \( R_{pf} \) and \( k \) have an impact on the accuracy of the classifier, the data will be back-tested using different \( R_{pf} \) and \( k \) to select the most desirable parameters. In the following, we will calculate the correctness of the data backtesting using different \( R_{pf} \) and \( k \).

Let the input of the KNN classifier be \( \tilde{x} \), the true class of \( \tilde{x} \) is \( y \), and the class of samples predicted by the KNN classifier \( \tilde{y} = f(\tilde{x}) \) is \( \hat{y} \). The correctness of the prediction is determined by the calculation of \( R(y, f(\tilde{x})) \), where \( R(y, f(\tilde{x})) \) is shown in equation (3).

\[
R(y, f(\tilde{x})) = \begin{cases} 
1, & \tilde{y} = f(\tilde{x}) \\
0, & \tilde{y} \neq f(\tilde{x}) 
\end{cases}
\]

The total LCU of the predicted frames of the video to be encoded is \( N \). The correct rate of classification \( p \) is shown in equation (4).

\[
p = \frac{\sum R(y, f(\tilde{x}))}{N} \times 100\%
\]

\[
F = \{ \min(M(U_i)) \}
\]

In Eqs. (4) and (5), \( p \) only indicates the correct rate of KNN classification results, and misclassifying LCU2 as LCU3 does not affect the quality of the encoded video.

\[
p(w) = \frac{f(w)}{\sum_{w' \in U} f(w')}
\]

The algorithm determines the range of CUs in the encoding process by classifying LCUs. If LCU2 is misclassified as LCU3, it will only calculate 32×32 and 16×16 CUs if the classification is correct, and an additional 8×8 CUs if the classification is incorrect. The additional 8×8 CU calculated after LCU2 was misclassified as LCU3 does not affect the final classification.
In order to improve the efficiency of the classification system and to maximize it, it is necessary to construct the objective assignment matrix $X_{ij}$ that allows the best task assignment balance, so it is necessary to construct the overall optimal objective function for task assignment.

The calculation method of the correct rate is optimized according to the actual situation, and let the total correct rate after optimization be $P_t$, and the calculation method of $P_t$ is shown in equation (8).

$$P_t = \frac{\sum R(y, f(\bar{x})) + L_{23}}{N} \times 100\%$$ (8)

$$N_i(t) = \{ j : x_j(t) - x_i(t) < r_d'(t) ; l_i(t) < l_j(t) \}$$ (9)

$L_{23}$ The in Eq. (8) and Eq. (9) indicates the number of LCU2 misclassified by the classifier as LCU3. The values of $x$ are chosen as 2, 3, 4, and 5, respectively (predicted as the class with the greatest depth when multiple maximum nearest neighbor sample classes occur simultaneously), and the values of $R_{pf}$ are 20%, 30%, 40%, and 50%; the correct LCU classification rate is calculated at $P_t$, and the results are shown in Table 2.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Accuracy</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>$P_1$</td>
</tr>
<tr>
<td>$M_0$</td>
<td>83.0%</td>
</tr>
<tr>
<td></td>
<td>79.5%</td>
</tr>
<tr>
<td></td>
<td>80.3%</td>
</tr>
<tr>
<td>$M_1$</td>
<td>81.5%</td>
</tr>
<tr>
<td></td>
<td>80.6%</td>
</tr>
<tr>
<td></td>
<td>78.3%</td>
</tr>
</tbody>
</table>

After the experiment, the best classification was achieved when $P_3=83.6\%$ for the $M_1$ classification case, followed by $P_2=83.5\%$ for the $M_0$ classification case and $P_1=83.0\%$ for the third $M_0$ classification case.

$$P_y(t) = \frac{l_j(t) - l_i(t)}{\sum_{k \neq i} l_k(t) - l_i(t)}$$ (10)

Since the KNN classifier is used to classify the LCU, the predicted frame share is too small classifier will set a large number of frames to be encoded as training frames and encode them using the traditional way, resulting in the speed improvement of this algorithm is affected. However, too high a discrete rate share of training frames will affect the encoding speed of the video.
3.4 Construction of PMC index model

The Policy Modeling Consistency (PMC) model states that discrete data are constantly changing and no single policy-relevant variable should be ignored, so the coverage should be as broad as possible when selecting variables [28-29]. Therefore, the model does not limit the number of secondary indicators and requires that each secondary indicator has the same importance to the input-output table. Compared with previous studies, the PMC index model has two significant advantages: (1) the coherence of the policy can be assessed; and (2) the strengths and weaknesses of the policy can be identified with the help of PMC surface plots.

The PMC index model is used to analyze and evaluate the policy through four main steps: (1) establishing a multidimensional input-output table; (2) determining the primary and secondary indicators and determining the measurement criteria of the secondary indicators; (3) obtaining the values of each secondary indicator through textual analysis and calculating the PMC index; and (4) generating a PMC surface plot to analyze and evaluate the policy.

3.4.1 Selection of indicators

The number of secondary indicators is not limited because the role of each influencing factor is to be considered comprehensively in the PMC index model. The PMC index system for quantitative evaluation of virtual museum management policies has nine first-level indicators, denoted by X1 to X8, respectively [30].

X1 indicates the nature of the system, which is used to examine whether the interactive system has the role of guiding, supervising, advising, describing, and identifying the construction of the virtual museum, and set each secondary indicator accordingly; X2 indicates the system timeliness, which examines the timeliness of the policy, and includes four secondary indicators in the long term, medium term, short term, and within one year; X3 indicates the system receptor, which reflects whose behavior is regulated by the policy, including X4 indicates government departments, museum managers, virtual visitor services, visitor feedback and other five secondary indicators; X4 indicates government departments, which is used to examine what aspects of the model to make the museum work; X5 indicates museum managers, which examines the means to ensure the normal operation of the virtual museum in each policy; X6 indicates virtual visitor services, which is used to simulate the management of visitors throughout the X7 indicates the feedback evaluation of visitors, which is based on the quantitative scoring of visitors’ feelings about the museum; X8 reflects whether the service data are open, with a value of 1 for openness and 0 otherwise. The indicators and specific scoring criteria for each level are shown in Table 3.


<table>
<thead>
<tr>
<th>Table 3. Indicators and scoring criteria for each level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1 indicators and numbers</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td>System nature</td>
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<td></td>
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<td></td>
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<tr>
<td>System timeliness</td>
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<tr>
<td>Systemic receptors</td>
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<tr>
<td>Government departments</td>
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<tr>
<td>Museum management</td>
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<tr>
<td>Virtual visitor services</td>
</tr>
<tr>
<td>Visitor feedback evaluation</td>
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<tr>
<td>Service data disclosure</td>
</tr>
</tbody>
</table>

3.4.2 Scoring criteria

When constructing a multidimensional input-output table, each second-level indicator should have the same weight, so the second-level indicator scores are binary. Combined with the text mining method, if the policy is related to the meaning represented by a secondary indicator, or has the content represented by the secondary indicator, then the secondary indicator is scored as 1, otherwise it is scored as 0. Each secondary indicator score obeys the [0,1] distribution, which can ensure that the secondary indicators have the same importance to the input-output table.

\[
P_{MC_i} = \begin{cases} 
0.5 & 1 & 1 \\
1.5 & 0.75 & 2 \\
1 & 0.5 & 1.5 
\end{cases} \quad (11)
\]

3.4.3 Comprehensive evaluation index calculation and rating basis

To evaluate the virtual museum, the calculation of the comprehensive evaluation index requires the following four steps: first, the evaluation subject obtains the scores of the second-level indicators by text analysis of the policy according to the second-level indicator rating criteria; second, the scores of each first-level indicator are calculated, and this process requires that the second-level indicators have the same importance to each first-level indicator; third, the PMC comprehensive evaluation index is calculated, and the policy is evaluated according to the rating criteria; finally, the PMC surface is constructed, and the policy is analyzed by combining the PMC surface diagram. As shown in equations (12) and (13).

\[
X_{i,j} = \{XR : [0,1] \} \quad (12)
\]
Similarly, to ensure that the factors represented by each secondary indicator have the same importance in the comprehensive evaluation index, each primary indicator should be given the same weight when calculating the comprehensive evaluation index, as shown in equation (14), and then the distribution interval of the comprehensive index score is: $[0, 9]$.

\[
X_i = \frac{1}{T(X_{i,j})} \sum_{j=1}^{n} X_{i,j}
\]  

(13)

\[
PMC = \begin{cases} 
  X_1 \left( \sum_{j=1}^{5} X_{1,j} \right) + X_2 \left( \sum_{j=1}^{4} X_{2,j} \right) + X_3 \left( \sum_{j=1}^{3} X_{3,j} \right) + X_4 \left( \sum_{j=1}^{2} X_{4,j} \right) \\
  X_0 \left( \sum_{j=5}^{7} X_{5,j} \right) 
\end{cases}
\]

(14)

The PMC index score is the quantitative evaluation result of the virtual museum management policy, and the policy should also be rated according to certain criteria. When the PMC index is $[8,9]$, the rating is optimal; when the PMC index is $[6,7]$, the rating is excellent; when the PMC index is $[4.5,5.5]$, the rating is good; when the PMC index is $[2,4]$, the rating is poor.

4 System testing and user evaluation

Eight users were selected to test the application system, and all participants used the system for the first time. The test process was divided into two parts, using questionnaire research to evaluate the perceived effect and interactive experience of the AR application in terms of ease of learning, usefulness and satisfaction, to achieve the effect of validating the perception and behavior layers of the application design. The validation of the design reflection level mainly adopts the interview reflection method to make users reflect on and evaluate the interaction process and learning effect, and put forward rationalization suggestions for the interactive experience process. Among them, the learning effect is mainly verified through user self-evaluation.

Enter to view the physical scene, listen to the detailed explanation of cultural relics and interact with it; e. Return to the AR exhibition hall page, enter the featured exhibition hall scene and view the past exhibition hall videos; f. Return to the home page, enter the map module and view the floor plan of the exhibition hall; g. Enter the AR navigation scene, scan the picture and start to locate and navigate to the target location.

![Figure 5. Interactive system user evaluation](image-url)
As shown in Figure 5, based on the results of the interactive system questionnaire test scores, it can be seen that 80% of the scores were in category A, 50% in category B, and 30% in category C. The overall SUS usability score rating is in the middle to high level, which is an acceptable system for users.

![Figure 6. System function score feedback](image)

As shown in Figure 6, the feedback scoring mechanism was conducted after users experienced the system, where P1 is the experience dimension about ease of learning, P2 is the experience dimension about usefulness, P3 is the experience dimension about satisfaction, and P4 is the fluency of the whole tour process. The scores of each dimension can be seen that the eight users gave high recognition to these three dimensions, and 90% of them scored above 0.4. One of them scored a perfect score of 1 on interactivity experience; the overall scores were concentrated in the range of 0.6-0.9, which basically met the expected requirements according to the standard of PMC index model. The overall situation on authenticity experience scored relatively low, with a minimum score of 0.35, indicating that the application still has room for improvement in functional integration.

5 Conclusion

This paper addresses the problems of scattered information, single interaction mode and lack of immersion in the traditional physical museum display process. Based on VR/AR technology to support the display and dissemination of cultural relics, combined with the current museum display display situation, we propose a number of VR/AR technologies based on image recognition, based on gesture recognition, based on motion tracking and other interactive museum display process combined with the physical space, virtual space, information space display integration, the cultural relics resources into a visual, interactive, touchable digital form. create a new immersive virtual-real interactive display environment. Finally, based on the PMC index model, we get feedback on the user experience after participation. In addition to gaining knowledge and strengthening the emotional connection and deep interaction with the cultural relics, it also stimulates the learning initiative of users for visiting museums and gives full play to the educational public service attributes of museums.
References


