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Research on Interactively Digital Display for Cultural Heritage-Discovering the Hall of Mental Cultivation: A Digital Experience Exhibition

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Abstract

The digital heritage display breaks through the limitations of exhibition space, cultural relic vulnerability, and supported by the integration of techniques such as computer animation, AR, VR and others. In order to better achieve the effective dissemination of knowledge and culture, digital construction of cultural heritage museum focus on the interactive design of the exhibition items. The Discovering the Hall of Mental Cultivation: A Digital Experience at the Beijing Duanmen Digital Museum is a famous digital exhibition of cultural heritage in China, using touch-controlled interaction, augmented reality, virtual reality, simulation, and motion capture, which maximize technical and artistic levels. Based on the research and scholars' experience in the field of digital cultural heritage and interactive design, the digital presentation and interaction of touchscreens, AR and VR in this digital exhibition is reviewed. Digital presentation and human-computer interaction such as technical concepts, interactive forms, operational details, characteristics, and advantages are discussed. In addition, the paper explores how the interaction of cultural heritage narrates the distance between the audience and historical relics. Finally, considering the challenging factors and future trends in the field of digital cultural heritage.

Keywords: Digital Cultural Heritage Display, Touch-Controlled Interaction, AR, VR, Human-Computer Interaction, Discovery the Hall of Mental Cultivation, Duanmen Digital Museum

1. Introduction

Human civilization has formed a large number of precious cultural heritages. However, under the influence of natural changes and human activities, cultural heritage has inevitably suffered destruction. How to better preserve, inherit and disseminate cultural heritage is an important historical mission.

In recent years, museums are significant assets of preserving urban history, inheriting, and spreading urban culture. Nowadays, museums have become a comprehensive system of cultural relics, and have experienced a display evolution from Jane to complex, from static to dynamic,

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from inside to outside. Moreover, artificial intelligence technology, such as touch-controlled virtual reality and augmented reality, has greatly changed and injected impetus into the way museums display their exhibits. The digital display of traditional culture has become the consensus of all countries in the world, and developed countries in Europe and America were the first to carry out the digital exhibition project of cultural heritage[1]. An increasing number of museums in China began to present their collections in a three-dimensional, dynamic, high precision, and interactive manner, aiming to transform digital museums from material-centered to human-computer interaction.

From the perspective of digital presentation of cultural heritage, this paper discusses the current situation and related key technologies of digital cultural heritage in China. Introducing the Duanmen Digital Museum and the digital display of Discovering the Hall of Mental Cultivation. Meanwhile, the five digital displays of Digital Painting, Digital Calligraphy and Digital Cabinet of Curiosities, AR Imperial Attire and Digital Hall of the Three Rarities in this exhibition are illustrated. Based on the research and scholars' experience in the field of intangible digital heritage and interactive design, interaction modes such as touch-controlled interaction, augmented reality, virtual reality in the exhibition are discussed. Analyzing the construction concepts, interactive modes, operational details of five digital displays. Characteristics and advantages for digital presentation of cultural heritage in touch-controlled and AR/VR fields are also be stated. Finally, highlighting the challenge and prospect for digital presentation of cultural heritage.

2. Consciousness Status of Digitization of Cultural Heritage in China

In China, with the support of technology programs of various departments of the state, a number of units have carried out digital protection and inheritance of cultural heritage. Digital display methods are be adapted and differentiated according to the characteristics of the different pieces of cultural heritage. As shown in [Fig. 1] (Huang Yonglin & Tan Xinguo, 2012)[2], the digital display types of cultural heritage have been subverted and innovated at present. Museums have begun to add touch-screens and sensor-based interactions, as well as virtual reality-based experiential presentations to the cultural relics display. Therefore, since the museums are aimed at the general public, the concept of applied interaction design should be considered, including the adoption of different interaction means a project characteristics.

Presentation modes	Presentation means	Characteristics
Traditional information presentation	Graphic design and printing of pictures and texts, and on-screen display of videos and models.	Low presentation cost and technology requirements.
Mechanically controlled presentation	Visualization of the "formless" contents of intangible cultural heritage via mechanical devices and displays.	Strong user experience, and high maintenance cost for software and hardware.
Interactive touchscreen presentation	Integration of information, software, users and a screen, where users interact with the screen.	Strong immersive feeling, and relatively low development cost.
Sensor-based interactive presentation	Interaction between users and sensors, and processing and feedback of interactive information by computers.	Relatively mature technologies, and a wide range of applications.
Virtual-reality-based experiential presentation	Computer-generated highly realistic sensory world of three-dimensional vision, hearing, touch and smell.	Strong sense of reality, high requirements for hardware and sites, and high maintenance cost.

[Fig. 1] Types of Digital Display of Cultural Heritage, Huang Yonglin

For example, the Dunhuang Academy began working on the digital Dunhuang project in the late 20th century[3]. Since 2002, Zhejiang University CAD&CG State Key Laboratory has been the first to use VR technology to realize the demonstration of multiple digital cultural heritage systems. Especially typical is the dynamic display of riverside map of Qingming Festival[4]. In 2005, took the lead to undertake the digital Olympic Museum project. Microsoft Research Asia and Tsinghua University have been engaged in color restoration of murals, marking and roaming of ancient paintings and interactive display system of ancient buildings for many years[5]. Moreover, many domestic institutions(such as Tsinghua University, Tianjin University, etc) have also carried out fruitful work and been demonstrated in a number of projects or museums, specifically involving calligraphy, paintings, poetry, etc. Of course, the most classic is the construction process of the Palace Museum's digital exhibition.

2.1 The Palace Museum in Beijing

The Palace Museum in Beijing is located in the Forbidden City, which is the world's largest and well-preserved ancient palace complex. Cultural relics of more than 1.86 million pieces have become an important carrier and great reminder of Chinese civilization history. It is China's first batch of UNESCO's World Heritage List of cultural treasures, and it has been assigned with one of the highest levels of protection[6]. However, due to the restoration of cultural relics and exhibition hall size, some precious cultural relics cannot be displayed to the audience. In order to make up for this regret, the Palace Museum began the construction of a digital version of itself, within the digitization project of cultural heritage. In order to allow more audience members to share and enjoy the achievements of the Digital Palace Museum, a digital display hall was built in the Duanmen Tower - the Duanmen Digital Museum.

2.2 The Duanmen Digital Museum

The Duanmen Digital Museum was designed in 2015 by a joint team composed of the College of Fine Arts of Tsinghua University and the Research Institute of Beijing Qingshang Architectural Design ([Fig. 1] & [Fig. 2]). The space in the exhibition hall is integrated with ancient solid vertical columns, which can create a sense of time travel between the past and the present. It also forms the background for the cultural heritage by combining the real and the imaginary. The Duanmen Digital Museum was successfully inaugurated on the 90th anniversary of the establishment of the Palace Museum, holding its first digital exhibition, The Palace Museum Is a Museum. Fei Jun, who is in charge of the program designing of the digital Palace Museum, stated that the digital exhibition aims to make the ontology and gene of the cultural heritage come alive, presenting the cultural heritage in a perfect way (DesignBoom, 2016)[7]. The object of the exhibition was selected to be the Hall of Mental Cultivation, which was built in the JiaJing period in the Ming Dynasty as the emperor's bedroom, becoming an office for administrative affairs and a resting place starting with the Yong Zheng Dynasty. However, in 2016, the most comprehensive conservation and restoration work of the Hall of Mental Cultivation left people unable to visit, which became a cause for regret for many.

2.3 Discovering the Hall of Mental Cultivation: A Digital Experience Exhibition

Therefore, in October 2017, at its the 92nd anniversary, the Palace Museum developed a second digital experience exhibition with the theme of Discovering the Hall of Mental Cultivation, which used to attract tens of millions of visitors and already had a reputation. As the first digital exhibition hall integrating ancient architecture, traditional culture, and modern technology in China, it not only breaks with the existing vulnerability and nonrenewable nature of cultural heritage, but also increases the possibility of preservation and display, and tries to meet the audience's strong demand for close interaction with cultural treasures. By seizing the opportunity for the development of new technology, and through its deep appreciation, the audience and the collection create a positive synergy. In order to let more people feel the unique charm of the Palace Museum culture in their own city, Discovery the Hall of Mental Cultivation "walked out" of the Duanmen Digital Museum to hold its first exhibition tour in Shanghai on April 30, 2019, with plans to settle in a number of cities within three years. In addition to its popularity in China, it has also attracted attention and high praise worldwide,

standing out and being granted the Golden Award at the 2018 Festival of Audiovisual International Multimedia, which was sponsored by the Committee of International Council of Museums (ICOM) and Audiovisual International Multimedia (AVICOM). This is not only an affirmation of the digital museum, but also a confident demonstration of intertwining Chinese traditional culture and modern science and technology on the world stage.

[Fig. 2] Duanmen Digital Museum, the Palace Museum

[Fig. 3] Design Plan of Duanmen Digital Museum, the Palace Museum

3. Construction Concepts, Interactive Modes and Operational Details of Discovering the Hall of Mental Cultivation: A Digital Experience Exhibition

The concept of interaction design represents the development direction of cultural relic conservation and exhibition. Interactive touchscreen displays are basically composed of information,

software, user, and screen, functioning through the interaction between the latter two. In the type of virtual reality or augmented reality display, computer technology generates 3D vision, hearing, and other multi-sensory information to achieve a high degree of object restoration[8]. Through equipment such as large projection screens, touchscreens, virtual reality helmets, and somatic capture, the elegant interior space and fragile texture can be set into multi-function displays. Hence, the American interaction design master, Jon Kolko, believes that interaction design is a dialogue among people, products, and systems (Jon Kolko, 2012)[9]. Reimann, president of the World Design Association, also defined interaction design as the behavior between design objects, environments, and systems. Similarly, Walter Benjamin (2008) pointed out that "modern techniques of display have had such a profound effect on human consciousness[10]."

Shan Jixiang, a director of the Palace Museum, explained that the concept of the Discovering the Hall of Mental Cultivation exhibition is to make the cultural relics come alive, letting people walk into the hall and feel the essence and charm of traditional culture (The Palace Museum, 2017)[11]. Discovering the Hall of Mental Cultivation is mainly about interactive touchscreens, augmented reality (AR), and virtual reality (VR) displays. Hence, these exhibition items include five interactive items, which are Digital Painting, Digital Calligraphy and Digital Cabinet of Curiosities, AR Imperial Attire and Digital Hall of the Three Rarities.

Therefore, Discovering the Hall of Mental Cultivation provides the audience with a more vivid and highly immersive experience through interesting and convenient multi-dimensional interaction, which is the intersection of digital art and media technology. The following section will analyze the technical concepts, interactive modes and operational details for selected displays in exhibition.

3.1 Brief Description of Touch-Controlled Interactive Display

Touch-controlled interactive displays achieve information interaction in interactive media by touching a screen. The earliest touchscreen is the AccuTouch, designed by American Samuel Hurst, which is composed of information, software, screen, and users (Lyv Yanru & Zhang Li, 2016)[8]. Until now, the touchscreen technology has promoted the development of digital displays, such as ultra-sensitive touch screens that fuse sensors and displays. Each advance in touch screen technology has greatly advanced the field of digital display, especially has also been used as the main digital display in the Duanmen Digital Museum.

3.1.1 Digital Painting - Birds, Insects, and Turtles Sketched from Life

The digital painting Birds, Insects, and Turtles Sketched from Life is one of the most representative digital works of touch screens in the Duanmen Digital Museum. This was created in the Later Shu of the Five Dynasties and Ten Kingdoms Period by the famous painter Huang Quan. The painting [Fig. 4] is amazingly subtle, depicting more than 20 kinds of animals, including sparrows, doves, and insects. According to the records, this painting is the only work of Huang Quan still intact. As the only one of his precious works, the Duanmen Digital Museum has made an exquisite short film to present the creation background and painting features with the expert guidance from the Painting and Calligraphy Academy of the Palace Museum. In addition, touchscreen interaction is the main feature. When the audience is near the touchscreen for about one meter, it can not only trigger the birds to move on the screen, but they can also enjoy the colors and delicate brushstrokes. On the appreciation level, the viewer can touch and observe the divine appearance, dynamism, and habitat environment of individual birds. Flapping their wings, catching insects, and feeding birds can also be realized through touch interaction. Overall, this can not only allow the audience to learn the cultural history and bird knowledge, but also stimulate their curiosity. For this reason, they can integrate the feeling of surprise into the digital painting and feel the value of the work through the interesting interaction.

[Fig. 4] Digital Painting－Birds, Insects, and Turtles Sketched from Life, the Palace Museum

3.1.2 Digital Calligraphy - Preface of Lanting

Moreover, emotional design greatly increases exhibition activity. Digital calligraphy－Preface of

Lanting—is a masterpiece of the Tang Dynasty calligrapher, Feng Chengsu. It is known as the first script, however, its whereabouts are, sadly, uncertain. Famous calligrapher Wang Xizhi's Preface of Lanting is known as Feng Chengsu's hand copy, therefore, the Palace Museum has restored the lost original work to the greatest extent, with digital calligraphy [Fig. 5]. Digital calligraphy has strong interactive and interesting features. For example, in order to strengthen the audience's understanding and satisfy their imitation desire, digital calligraphy simulates winding streams. Clicking the glowing cup on the screen can open the digital copy. The tablet computer in front of the digital calligraphy desk can also randomly open writing or a group of words of Lanting Preface, and the audience can use the touch pen to simulate and copy the written words into the original text for comparison and appreciation.

[Fig. 5] Digital Calligraphy—Preface of Lanting, the Palace Museum

3.1.3 Digital Cabinet of Curiosities

In addition to the two interactive displays described above, the Digital Cabinet of Curiosities ([Fig. 6] & [Fig. 7]) is a large-scale touch display. This is a virtual treasure pavilion composed of 18 63-inch high-definition LCD screens that present more than 90 pieces of cultural relics, including ceramics, enamel, gold and silver, jade, bronze, and lacquerware. These were collected by the Palace Museum in a high precision 3D model. The Digital Cabinet of Curiosities is divided into LCD screens with upper and lower layers, which are based on the digital model of cultural relics made by the Hall of Mental Cultivation and the Forbidden City. Therefore, digital virtual segmentation constitutes the concept of the Digital Cabinet of Curiosities. The original limitation of observing the real object is eliminated, and the hidden details can be freely and easily obtained. After 3D scanning and reconstruction of cultural relics, by clicking on one of the treasures on the screen, it displays detailed information on the appliance, such

as the age, production methods, technological features, decorative patterns, and usage mode. The finger cannot only rotate the screen around, zoom in and out, drag the cultural relics from any angle, but also slide into interesting videos, such as painting enamel jugs, setting small oil cylinders on fire, and simulating the process of boiling water. Users' finger dragging, rotation, and sliding are natural instinctive operations, which can better immerse users in the narrative experience, so as to appreciate and explore the details of the virtual collection visually.

[Fig. 6] Digital Cabinet of Curiosities, the Palace Museum

[Fig. 7] Digital Cabinet of Curiosities, the Palace Museum

3.2 Brief Description of Hybrid Design of AR and VR Display

In addition to the touch-controlled interactive display, the exhibition contains displays based on a hybrid design of augmented reality (AR) and virtual reality (VR). AR technology is often used in the digital presentation of cultural heritage, especially for the field display and experience integrating virtual and reality. There are three main forms of AR system, namely

handheld device type, head-mounted type and spatial type. The Spatial type AR has the advantage of display and excellent interactive effect[12].

VR is a high-tech human-computer interaction mode created through the integration of various technologies with the help of computing and sensing technology. VR technology can reconstruct multi-dimensional cultural space and provide the possibility of immersion in the digital world. Thus, it is increasingly becoming an important tool for the research, protection, and dissemination of cultural heritage. At present, the VR system mainly includes desktop VR, head-mounted VR, and projection VR. Head-mounted VR presents virtual scenes with the help of VR headset display. As the head-mounted display content completely replaces the user's vision, the user has a strong sense of immersion. Projection VR can have a wide field of vision to achieve virtual display with the help of projection system. In addition, it is widely used in the virtual display of large ruins. It can also achieve interpersonal communication and interaction. Typical products include CAVE, VR Workbench, etc[13].

The sense of immersion in AR and VR can comprehensively and vividly trigger the experiencer to visit and think, having the opportunity to achieve a deeper level of interactive experience, which is also the fusion of virtual digital information superimposed in the real environment. The following AR Imperial Attire and Digital Hall of the Three Rarities are digital exhibits based on such technologies.

3.2.1 AR Imperial Attire

Costume culture is an important part of national culture. The AR Imperial Attire ([Fig. 8] & [Fig. 9]) selects the most representative costumes of the Qing dynasty, including four types－Rong suit, Ji suit, Dress suit, and Casual suit. The exhibition is divided into two parts－virtual fitting and costume appreciation. Virtual fitting is the application of AR technologies. According to the audience's curious psychology, designers use the recognition technology of body gestures and the 3D body sense camera. The contents of the screen can be interactively controlled through body posture and gesture recognition methods. Hence, motion capture is bound to become a key technology for digital collection and display of intangible cultural heritage. In the virtual fitting session, the audience can wear a complete set of palace costumes and can try on different types of clothing with a variety of backgrounds of the Palace Museum. By waving their left and right hands, they can experience the interactive effect between themselves and the palace costumes. Moreover, the audience can also appreciate the clothes they are interested in, and they can understand the system of palace dressing as well as the scenes of dressing through the appreciation process. The project also sets the height of children, therefore, adults

and children can participate in the trial simultaneously.

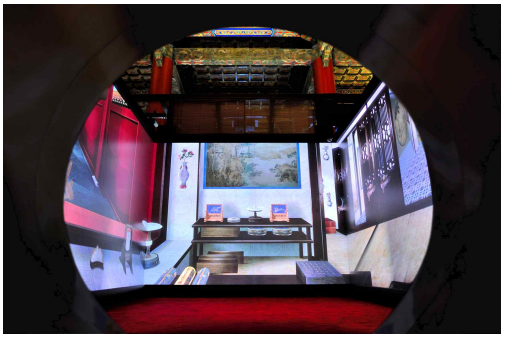
[Fig. 8] AR Imperial Attire, the Palace Museum

[Fig. 9] AR Imperial Attire, the Palace Museum

3.2.2 VR Digital Hall of the Three Rarities

The Palace Museum also provides a VR display－Digital Hall of the Three Rarities－in a digital Cave Automated Virtual Environment (CAVE) experience. The Three Rarities hall is a world-famous interior space holding three rare old treasures, which were appreciated and collected by Emperor Qianlong. Due to its small area of 8 square meters, the interior space and furnishings are not open to the public. For this reason, the ultra-short distance projection system is used to build the 3D virtual display of high immersion, which is wrapped on the left, middle, and right ([Fig. 10] and [Fig. 11]). The virtual reality system of CAVE allows a realistic reproduction through screens and projections to surround visitors. Virtual simulation has a better stereoscopic effect, which is mainly used in high-end simulations. This is a mature and highly immersive virtual reality system and has the advantage of realistic three-dimensional imaging technology to restore the precious architectural space. With the glasses and image-recognition software, visitors can use the iPad supplied by the Museum to scan the cultural relics from the Digital Cabinet of Curiosities. Furthermore, they can take the

scanned treasure, turn it into the Three Rarities, and decorate the hall to their liking. Therefore, users can intuitively appreciate the original interior environment of traditional architecture in this realistic recreation.



[Fig. 10] Digital Hall of the Three Rarities, the Palace Museum

[Fig. 11] Digital Hall of the Three Rarities, the Palace Museum

4. Characteristics and Advantages for Digital Presentation of Cultural Heritage in Touch-Controlled and AR/VR Field

Through the above examples, it can be concluded that the application of a technology-based cultural heritage digital museum should meet the needs of three aspects. Firstly, appropriate technical forms should be adopted for different cultural heritage contents to display the information accurately, truthfully, and comprehensively. Secondly, it should reflect the value and spiritual connotation contained in the cultural heritage. Lastly, it should link the audience in the form of an appropriate, interesting, and immersive experience. For this reason, Touchscreen interaction, virtual reality, augmented reality, and other technologies are the trend. Digital technology plays a crucial role in the inheritance and display of cultural heritage.

Through the above examples, several characteristics and advantages of touch-screen, AR and VR interactive display for cultural heritage presentation can be summarized.

4.1 Simple Gestures with the Least Input, Two-way Interplay and Participation

Interactivity is the foundation of the digital world, and the coordination between story and interactive operation is crucial in digital design. The designer of the digital painting project, Fei Jun, said that in order to avoid the loss of the audience's attention, the design team abandoned the button-type interactive logic. This is because traditional buttons on the exhibit cannot show the treasured implication of realism art, thus choosing simple gestures to render the interaction. Hence, touch-screen method can immersive user experience, and obtain the most abundant output with the least input. Moreover, the interaction sets the content for the visitors with the characteristics of two-way interplay and participation, giving way to the advantages of interaction and satisfying the psychological and physical experience needs.

4.2 Interesting, Immersive, Vivid Interaction

As the American designer Poulos said, people always think that design has three dimensions－aesthetics, technology, and economy. However, even more important is the fourth dimension－humanity (Zhang Yi, 2002)[14]. The touch-controlled equipment guides the visit contents, showing the advantages of interesting and immersive interaction designs, vividly activating the original form of cultural relics, and breaking the distance between the audience and cultural heritage. Interactive master Chris Crawford (2013) mentioned that humanization is the real concept of interactivity, and the virtual art space could lead users to actively participate and become one of the creative sources of the story itself[15]. In addition, Reading (2003), an American scholar, also showed that in the history museum, the immersive experience brought by touch-screen interaction, AR, and VR could better help participants acquire memories about history and society[16].

4.3 Human-Centered Role and Scene Experience

Expert Chris Crawford (2013) demonstrated that reaction is a kind of action, and action is an interaction only when it happens interactively between two or more subjects[16]. Therefore, interaction cannot be separated from any participating party. The virtual space and the real space can be synchronized, allowing the users to realize the coexistence of the real world and the virtual objects, and to feel the charm of passing through history. The elements also reflect two aspects of virtual reality integration, namely the

human-centered role experience and scene experience. For example, AR Imperial Attire encourages the audience to play a role in the fitting through role experience and to integrate into the corresponding scene. The combination of human-centered role and scene experience can provides knowledge in an optimized way and it enables users to participate in the virtual world actively. For this reason, one of the technology trends in cultural heritage digital displays is the virtual roles in virtual environments[17]. Therefore, it has broad application prospects in the virtual display of cultural heritage digital museums, historical, or cultural sites.

4.4 Sensory, Behavior, Reflective Layer Interaction

Simulation as the digital representation and information transmission mode, can produce different levels. Firstly, VR technology can simulate the motion form of objects and make experiencers more truly perceive objects in the simulation environment. Secondly, the virtual environment can create the effect of being in the real world. Thirdly, in the virtual environment, the experiencer can carry on the omnidirectional control for the object. In general, the interactivity of virtual experience can be summarized as a sensory layer interaction, behavior layer interaction, and reflective layer interaction. The brain reaction is also divided into an instinct layer, behavior layer, and reflection layer. Users can receive sensory and somatic stimulation to meet their emotional needs. In the context of virtual reality and simulation environment, the designer's reproduction gradually turns into interactivity, and the museum infuses relics information into the on-site virtual space. Thus, the audience can gain the experience of manipulation, navigation, and immersion in the continuous interaction between real and virtual spaces.

5. Challenge and Prospect for Digital Presentation of Cultural Heritage

Heritage digitalization work ten years, form the basic object of digital ontology analysis, basic digital processing to high technology application. From the cultural heritage, information, history, design and another multi-disciplinary comprehensive perspective of intangible digital research, has formed a multifaceted research achievement. In addition to the interactive features and advantages described above, it should also be considered that the interactive display poses certain challenges and prospects for the display of cultural heritage. The following aspects need to be further deepened in the future research on the digital display of cultural heritage.

5.1 Original Ecological Protection in the Digitization Process of Cultural Heritage

Firstly, the cultural display with innovative content and form should be both authentic and attractive. It is necessary to consider whether the detailed data generated by the presentation will reduce the interest and vividness of the heritage information, thus reducing its appeal to the audience. On the contrary, it also needs to be considered whether the attractive, immersive digital display will cause damage to the heritage information authenticity. The digital display of cultural heritage cannot destroy the integrity and authenticity of objects[18].

5.2 Digital Innovation Transformation of Cultural Heritage

Secondly, how to get the latest technology combined with the connotation of cultural heritage, how better to tell stories, inheriting civilization, cultural heritage and personalized display is another big challenge for the further. As an outlook on digital cultural heritage in the future, the creative transformation of cultural heritage digitization would be systematically studied. The achievements are made into projects through the combination of digital technology and design concepts to promote the digital inheritance and innovation of intangible cultural heritage. At the same time of ensuring professionalism, it is also able to combine education with entertainment, so that participants can get immersive experience feeling through interaction with virtual environment or other operations, so as to achieve the purpose of learning, experience and entertainment.

It is obvious that cultural heritage should be displayed and experienced digitally through novel methods and means to reconstruct its unique scientific and humanistic connotation. It is necessary to provide a more simple and convenient channel for the general public to learn about traditional culture and cultural heritage, so that our precious historical remains and wisdom crystals can provide us with a steady supply of knowledge.

6. Conclusion

Touch-screen, AR and VR technologies create more possibilities for the display of the living state, and can comprehensively present the expression form and intrinsic charm of the cultural heritage. The immersive experience also effectively promotes the accessibility and vividness of cultural heritage displays and communication.

Firstly, analysing the current situation of digitization of cultural heritage. Secondly, states the Discovering the Hall of Mental Cultivation digital exhibition breaks restrictions such as exhibition space, vulnerability of cultural relics, and technology. Full digital exhibition marks the Palace Museum of history, culture, and traditional art with a new interpretation and representation. Thirdly, focus on Touch-screen, AR and VR technologies application and practice of research results, through the analysis and elaboration of five interactive exhibition items, construction concepts, technical concepts, interactive display forms and operation details. Illustrating the cultural connotations are conveyed in the interaction process, and the emotion and feedback in the interaction are also the recreations of the exhibition. Moreover, summed up the characteristics of gestures operation, immersive participation, human-centered mode and sensory, behavior, reflective layer.

In addition, it points out the challenge and prospect, such as original ecological protection in the digitization process and digital innovation transformation of Cultural Heritage. It also demonstrated that digital means should focus on the active aspect and the process presentation of technological features, cultural background, and other invisible factors, putting forward challenges and potential applications, which have a broad exploration of space.

Overall, the trend of digital museums at the present time, the legacy of the creative digital construction has important significance for display and communication. In order to make technology better service museums and their interaction with the audience, researching the digital relics work is required to be done through the combination of digital technology and design concepts, promoting digital inheritance and innovation. Finally, constantly exploring the direction of future digital development has effectively promoted the accessibility and vividness of cultural heritage display and dissemination, which will be the focus of attention in the future.

References

[1] X. N. Ma, L. Tu, Y. Q. Xu, Development Status of the Digitization of Intangible Cultural Heritages (in chinese), China: Science China Press, **(2019)**

[2] Y. L. Huang, X. G. Tan, Digital Preservation and Development of China's Intangible Cultural Heritage, Journal of Huazhong Normal University (Humanities and Social Sciences), **(2012),** No.2, pp.49-55, http://caod.oriprobe.com/articles/29339321/zhong_guo_fei_wu_zhi_wen_hua_yi_chan_shu_zi_hua_bao_hu_yu_kai_fa_yan_j.htm

[3] G. Liu, D. M. Lu, Digitalization of Dunhuang Wall Drawing, China: Dunhuang Research, **(2003)**

[4] S. N. Chen, Z. G. Pan, M. M. Zhang, A Virtual Informal Learning System for Cultural Heritage, Lecture Notes in Computer Science, **(2012),** Vol.7145, pp.180-187.

[5] S. H. Xu, Y. Q. Xu, S. B. Kang, Animating Chinese Painting Through Stroke-Based Decomposition, ACM Transactions on Graphics, **(2006)**, Vol.25, No.2, pp.239-267, DOI: https://doi.org/10.1145/1138450.1138454

[6] UNESCO, World Heritage List, https://whc.unesco.org/en/list/?search=chinese&order=country. July 24 **(2020)**

[7] Design Boom, Designer Fei Jun and Project of the Palace Museum 'Duanmen Digital Museum', China: Industrial Design, **(2016)**

[8] Y. R. Lv, L. Zhang, Innovative Applications of Multimedia Technologies in Digital Display for Intangible Cultural Heritage, Packaging Engineering, (2016), Vol.37,No.10 pp.26-30, DOI：10.19554/j.cnki.1001-3563.2016.10.008

[9] J. Kolko, Thoughts on Interaction Design, 2nd ed, Netherlands: Elsevier, **(2011)**

[10] W. Benjamin, The Work of Art in the Age of Its Technological Reproducibility, and Other Writings on Media, (Jephcott. E. et.al, Trans), USA: Harvard University Press, **(2008)**

[11] The Palace Museum, Duanmen Digital Museum of the Palace Museum Celebrated Its 92nd Anniversary With 'Discovery · Hall of Mental Cultivation-Themed Digital Experience Exhibitor', https://www.dpm.org.cn/show/246075.html, Dec 31 **(2017)**

[12] Ronald T. Azuma, A Survey of Augmented Reality. Presence: Teleoperators and Virtual Environment, **(1997)**, Vol.6, No.4, pp.355-385, DOI: https://doi.org/10.1162/pres.1997.6.4.355

[13] B. W. Lin, Z. G. Pan, J. Yang, J. Y. Shi, PC Based High Performance CAVE System, JOURNAL OF COMPUTER-AIDED DESIGN & COMPUTER GRAPHICS, **(2003)**, Vol.15, No.6, pp.724-729, DOI: 10.3321/j.issn:1003-9775.2003.06.017

[14] Y. Zhang, The Fourth Dimension of Design-the Thinking of Humanized Design in the New Century, Hundred Schools in Arts, (2002), No.4, pp.108-109

[15] C. Crawford, Chris Crawford on Interactive Storytelling, 2nd ed, USA: NewRiders, **(2013),** ISBN-13: 9780133119633

[16] A. Reading, Digital interactivity in public memory institutions: the uses of new technologies in Holocaust museums, Media, Culture & Society, **(2003)**, Vol.25, No.1, pp.67-85.

[17] S. Vosinakis, N. Avradinis, P. Koutsabasis, Dissemination of Intangible Cultural Heritage Using a Multi-agent Virtual World, Advances in Digital Cultural Heritage, (2018), pp.197-207, DOI:10.1007/978-3-319-75789-6_14

[18] F. Cominelli, X. Greffe, Intangible Cultural Heritage: Safeguarding for Creativity, City, Culture and Society, **(2012)**, Vol.3, No.4, pp.245-250.