

# Application of VR Technology in Cultural Heritage Dissemination: Design and Production of VR Documentary “Dunhuang”

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**Abstract:** As the on-site technical command, it is responsible for maintaining the stability and emergency response of the on-site base station signal. This paper considers and expounds the two important directions of project content architecture and VR interaction design, and explores the innovative and feasible application of virtual reality technology in the direction of cultural heritage. The content of the experience mainly focuses on the artistic creation of the mural paintings on the south wall of Cave 285 and the design considerations of Buddhist aesthetics. This project was selected for the 2017 Amsterdam Documentary Film Festival (IDFA).

## 1. Introduction

Cultural heritage is a precious material and spiritual wealth of mankind, and has important characteristics that cannot be preserved and regenerated. Compared with other digital restoration technologies, virtual reality technology has many advantages in the field of cultural heritage. It provides an immersive experience while completing 3D digital restoration. Virtual reality technology can mainly reshape the content of cultural heritage, increase the audience's multi-sensory experience dimension, and enhance the artistic value of cultural heritage itself. With virtual reality technology as the core and reasonable design, this paper integrates the historical, humanistic, philosophical and religious contents of cultural heritage into the VR documentary Dunhuang.

## 2. Advantages of Virtual Reality Technology in the Field of Cultural Heritage Communication

### 2.1 Virtual Reality Technology Can Reshape Content

Virtual reality technology can transcend time boundaries, regional boundaries and remodel murals in different periods. For example, the process of artistic collision in ancient Central Plains, Western Regions, Central Asia and Europe is presented to modern people in the form of vision and hearing, so that the viewers can be immersed in it. Take the actual case as an example: In 2017, the conductor VR StoryStudio and the music production co-produced “VR Naihai Battle” [1] used large space positioning technology to restore the classic battle scene of the Sino-Japanese War. Let the experiencer feel the sea battle scene filled with smoke and hundreds of guns, and remember the heroes who died because of the war. The experiencer can move freely in the scene to complete the interactive content without wearing too many devices, as shown in Figure 1.



Fig.1. Scene Effect of VR Sino-Japanese Naval War

## 2.2 Virtual Reality Technology Has First Person Perspective Attribute

Usually, viewers enjoy exhibitions or films from the third person perspective, and can not participate in or influence the content of the exhibition. But virtual reality technology can allow viewers to participate in the exhibition from the perspective of the protagonist, intervene in a reasonable interactive way, and let viewers input and output actively from the subjective consciousness rather than passive reception. The first-person perspective reduces the sense of content disengagement, allowing viewers to quickly bring in the environment set by the author, which is more impressive than other modes of appreciation.

In 2018, the Taipei National Palace Museum and the HTC Vive content production team collaborated to develop the “Qingming Shanghe Map Series VR” [2] based on the “Qingyuan Ben Qingming Shanghe Map”. Focused on the development of Hongqiao Market, Wild Taiwan Opera, Jinlanju Restaurant and other scenes, through a series of interactions to let the viewers experience the prosperous life of the Qianlong period in the Qing Dynasty, as shown in Figure 2.

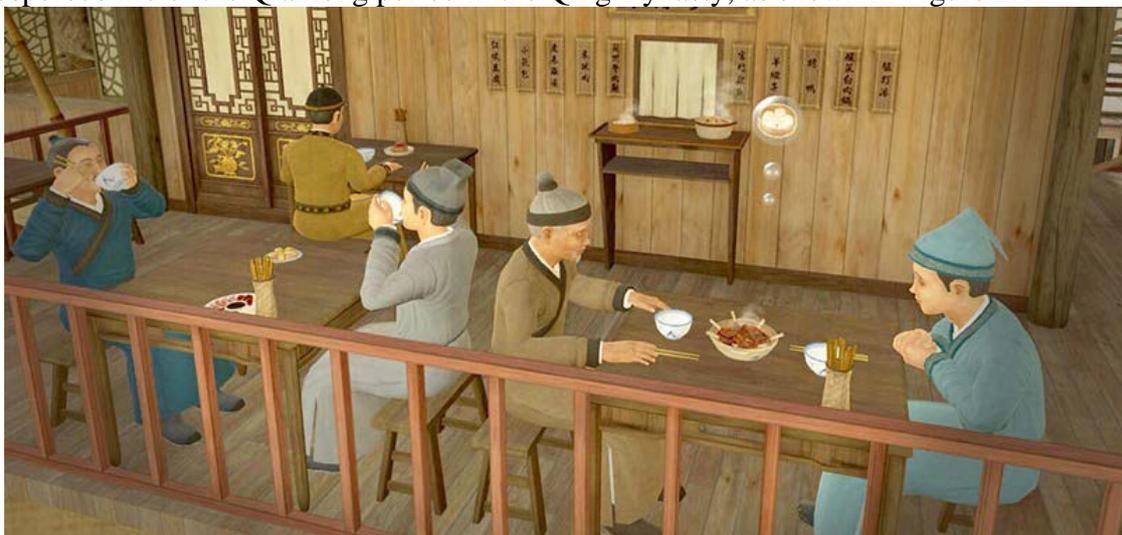


Fig.2. “Qingming Shanghe Map Series VR” scene

## 2.3 Virtual reality technology increases the artistic value of cultural heritage themes

Virtual reality technology can form a complete narrative experience through the transmission of visual, auditory, olfactory, tactile and other sensory organs combined with film techniques. In the process of experiencing, interactive design can be added through input devices, so that viewers can experience and appreciate more exploratory at the same time. The addition of creative content not only makes the theme of cultural heritage more popular, but also makes the works have artistic value. “Notes On Blindness: Into Darkness” [3] is a virtual reality experience based on the oral

diary of the blind professor John M. Hull. In the works, binaural audio and 3D animation effects are used to shape the world that a gradually blind person feels. The use of environmental sounds in the works allows the experiencer to shift the position according to the sound, allowing the experiencer to immerse himself in the sensory world of Professor Blind. This work won the Tribeca Film Festival Feature Film Award and the Sheffield International Documentary Film Festival VR Works Award, as shown in Figure 3.



Fig.3. Visual presentation of Notes On Blindness: Into Darkness

### **3. Content Design and Production of VR Documentary Dunhuang**

#### **3.1 Background of topic selection**

Located on Mingsha Mountain in Dunhuang, Gansu Province, Mogao Grottoes were discovered in 1908 by Paul Bercy, a Frenchman, and an expedition team. The grottoes were over 400 in size and contained precious scrolls of classics and paintings. The caves of Bech and Dunhuang Grottoes and Dunhuang Catalogue were photographed, classified and numbered. The creation content of this project is based on No. 285. The murals of Cave 285 are relatively intact and are not open to the public at present. It is the earliest cave with a record of years.

#### **3.2 Content design and display solutions**

The project lasted for 6 months and was closely coordinated by screenwriters, planners, creatives, and technical staff. Considering a lot of factors such as the cost of model production, the connection between element content and element orientation, and the upper limit of the number of models required by the development engine. Four main contents are determined: introducing the structure of the inner wall of the cave, Kai Le tian, story painting of 500 robbers'origin, meditation and meditation. Through the analysis of similar content projects in the previous period, we can conclude that the content design must be logical, the connection between different plates is natural and reasonable, the interaction design is simple and easy to understand, and the time cost of interaction is increased without designing complex processes.

Firstly, the content design of cave structure

##### **a) Content representation**

The top of Cave 285 presents the structure of the top of the bucket, and the four slopes are centered to form a square and protrude upward to form an algae well. There are nested square lattices inside the algae well, and each layer between the grid and the grid is rotated by 45°. A total of three layers form a stack of algae wells. It is a typical northern dynasty account [4], and the algae well in it is actually The cover of the bill is decorated with tassels and beasts. The sculptures on the west wall include the statues of Buddha and Buddhist monks, and the niches are painted with gods. The upper part of Nanbi paints the story of Happy Sky and 500 robbers, and the lower part is four Zen chambers. The upper part of the north wall is four Zen chambers in the lower part of the seven

Buddhas' Falun Tu. At the top of the entrance to the east wall is a Buddha sitting on the Buddha's side, and a large Buddha's sayings are illustrated on both sides.

b) Display mode

The inner wall of the cave is restored by three-dimensional modeling technology, and the ratio is one to one. The more common guiding methods in virtual reality include light source and sound, using the natural factors of insufficient light in the cave, illuminating the explained position in the form of spotlights, and guiding the experience rhythmically.

Second: Feitian music content design

c) Content performance

Feitian Yule is the content painted on the upper part of the south wall. During the production, according to the mural painting content, ten models of flying instruments with various instruments are played. The whole model is translucent, showing the graceful and ethereal sacredness of the flying sky. Feitian originated from the "Gandapo" and "Jinnao" in India. After the Central Plains, we added ribbon decoration to Chinese culture, reflecting the artistic conception of flying out into Buddhism. Cave 285 of Dunhuang Mogao Grottoes in the Western Wei Dynasty can be regarded as the representative of "flying sky" art. Feitian is the combination of Chinese traditional aesthetics and Indian Buddhist culture. The high frequency appearance of Feitian image in Dunhuang murals is the symbol of Dunhuang culture. The Eleven Instruments Feitian holds are waist drum, clapper, clarinet, flute, row pipe, Lusheng, straight pipa, tune pipa, Ruan string and pipe from the left side of the picture.

d) Demonstration scheme

The team produced a large number of literature references to restore the shape of the instrument at the time, and the interactive content experience can be more interactive through simple interaction. The music played by Feitian Yile also has the characteristics of distinct regional culture. The addition of Fanyin and Hu musical instruments makes Dunhuang's music and dance culture unique. In the area of restoring music, the team sought a professional sound production team to simulate the sound of various instruments, and compiled a smooth and sweet soundtrack, as shown in Figure 5.



Fig.5. Flying sky from the wall

Third: the content design of the five hundred robbers into the Buddha's relationship story

a) Content performance

The five hundred robbers became the content of the central part of the south wall. In the form of comic strips, from the left to the right, five hundred robbers were depicted from the suppression and execution to the rescue of the Buddha.

Picture 1. At that time, there were 500 robbers in the country of India, and the robbers robbed and robbed the people. The king heard the troops and sent troops to suppress. The official army is well equipped and the robber equipment is relatively simple.

Picture 2: Due to the disparity in the strength of the warring parties, the robbers were quickly suppressed. They were tied up in five rows and escorted to the government for trial.

Picture 3: The judge sat in the main hall and ordered the executioner to dig the eyes of the robbers who were semi-nude and draped. The robbers after the sentence mourned on the ground.

Picture 4. The robbers who have been dug out of their eyes are abandoned in the desolate and uninhabited old mountain forest. They run and howl in the forest.

Fifth, the Buddha heard their lamentation and raised his heart of pity. The Buddha blew a fragrant fragrance with perfume. The robbers' eyes were healed and the Buddha who stepped on the lotus flower was seen.

Picture 6. The robbers, inspired by the Buddha, kneel down in front of the Buddha and listen to his teachings. Buddha's foot stepped on lotus flowers for them to say.

Picture 7. After that, these robbers practiced in the mountains and eventually became 500 Arhats to serve the Buddha.

#### b) Display Scheme

This part of the content display is designed to set up a body folding book, triggered by the rise of the lotus stone platform from the ground. The picture album is placed in the middle of the stone platform. After the experiencer opens the pages, the picture opens directly to the audience. The elements in the picture are equipped with animated dubbing. There are seven pictures in total. They tell the story together with the background sound effect explanation. After reading the picture album, I went back to the Lotus Stone Platform and went back to the underground with the stone platform. See Figure 6.



Fig.6. effect after opening the stereo book

#### Fourth: meditation meditation content design

##### a) Content performance

The 285 Cave is a multi-chan temple structure. There are four meditation rooms on the north and south walls of the cave for the believers to meditate. Meditation is a means of practice for practitioners to enlighten, to purify the soul, to exercise wisdom, and to finally gain enlightenment and relief. In the meditation experience, since the caves are restored one by one, the experiencer can actually sit in the Zen cave to sit meditation. A seed of a bodhi tree grows gradually in front of the experiencer, who touches the branches lightly, and after the cave fades away, the cosmic stars appear. As a light-grained Bodhi tree grows up, the experiencer can go to the Bodhi tree to meditate. This part is the last part of the experience. From the aesthetic concept of Dunhuang, it is a kind of design of "realm of heaven and earth"[6], which makes the experiencer feel from amazement to excitement. Raise your spiritual realm to a free and broad realm, as shown in Figure 7.



Fig.7. The effect of the growth of linden tree

#### b) Display plan

The experiencer transports himself to the Zen Cave by means of instantaneous transmission. After sitting inside, the bud appears in front of the experiencer. The bud seedling is caressed with a handle to trigger the growth animation of the bud tree. See Figure 8.



Fig.8. Zen Grottoes and Bodhi Buds

### 3.3 Interactive Design

The pre-use background of the product is set in a small open space in a museum or family, and the size of the site is uncertain. Therefore, it is determined that the method of instantaneous displacement is the smallest solution of vertigo in all VR displacement modes, which can greatly reduce vertigo. The solution determines two main ways of interaction, one is to use the handle button of the handle to complete the grab action. The other is the touchpad button of the handle to complete the transfer action. From the past development, the experiencer can calculate his palm position through natural cognition even if he can't see his own hand, so the hand model is removed from the project. The role is to reduce the interference immersion as much as possible, as shown in Figure 9.



Fig.9. Schematic diagram of handle operation

### 3.4 Experience process

In the cave scene, the scene is darker, and the basic historical information of the cave is explained by voice. Through voice guidance, the experimenter needs to learn to press the touch key to move to the corresponding position and find the only light source, the bean lamp, as shown in Fig. 10 and Fig. 11.



Fig.10. Displacement Teaching Process



Fig.11. Picking up the Teaching Process

The experimenter strolls through the cave with a bean lamp 2\*1.5 meters in front of the north wall of the cave to trigger Jile Tian. The location of Jile Tian is bright and flies out from the upper wall of the South wall. Each musician begins to play ancient music with the same instrument. The Lotte will surround the center of the cave, and the shape of the handle will become a wooden stick. If you touch any of the Lotte, the details of the instrument played by Lotte will be displayed. With the virtual environment sound field, the experimenter is close to any one of the music days, and the sound of the instrument he plays will become larger. After playing, the flying sky gradually disappeared into the top of the cave. The top of the cave began to shine and the experience was looked up, as shown in Figure 12 and Figure 13.



Fig.12.: The wall is flying after the trigger



Fig.13. Content interaction after the flying drop animation is completed

Introduce the structure of the inner wall of Cave 285: Introduce the contents of the wall in turn from the top. The way of guide is light guide and voice explanation.

The light source disappears and the cave darkens. The experiencer can find the lotus stamp on the ground with a bean lamp according to the voice prompt. See Figure 14. According to the prompt, it is transmitted to the middle of the lotus flower, the ground cracks after arrival, and the lotus stone platform grows from the inside. The stereoscopic book is presented on the stone platform. The prompt is to open the stereoscopic book with the handle key, as shown in Figure 15. The voice began to introduce the five hundred robbers into the Buddha's karma story. Whenever a page of a book is opened, the corresponding picture on the back wall will be illuminated, as shown in Figure 16.



Fig.14. prompts the lotus position



Fig.15. Book page open teaching



Fig.16. Screen content echoes back and forth

After the three-dimensional book is closed, the lotus stone platform slowly returns to its original position. The interior of the cave is restored to a dark state and the voice prompts the interior of the cave to light up. The voice and light also prompt the experiencer to move to meditate in the Zen Cave. The bud of the Bodhi tree begins to grow in front of the experiencer's left. The voice prompt touches the bud of the Bodhi tree lightly. See Figure 17. After triggering, the Bodhisattva tree grows by aggregation of particles, and the growing experience is completed, as shown in Figure 18.



Fig.17. Interactive Bodhi Buds



Fig.18. Bodhi tree growth

## 4. Interactive and Innovative Exploration of VR Documentary Dunhuang

### 4.1 Adding Entity UI during Interaction

There are great differences between interactive design in virtual reality and screen-based interactive design. Screen-based human-computer interaction means that users input directly through devices indirectly or through screen interface, and then feedback directly with screen content. However, the input mode in virtual reality environment needs to avoid the traditional screen interaction mode as much as possible, because the traditional UI mode will destroy the immersion feeling, and the form of text matching buttons will reduce the recognition degree in the existing hardware solutions of virtual reality. The interaction in virtual reality will retain the input device auxiliary interaction. After the feedback interface is changed from two-dimensional space to three-dimensional space, the response mode and response degree of the program should be discussed in depth. So we added a lot of “physical” props to assist in the process of project design,

such as the bean light used for lighting, the wooden stick used to view the instrument, and so on. Transforming the interactive response buttons in traditional cognition into ‘entities’ is also an effective means of virtual reality interaction. However, this instantiation is also premised. The instantiated ‘entity’ is reasonable in most people's cognitive structure, and the interactive entity can be applied.

#### **4.2 Embedded teaching guidance in the experience process**

A very important concept in interactive design is called design visibility. If the design method does not reach the level that users can infer the interaction logic through life experience, then correct instructional guidance becomes very critical. Firstly, in the virtual three-dimensional environment, most of the inexperienced Experiencers maintain a state of distrust when they enter the virtual environment, and the Experiencers with weak acceptance of new things will also have a sense of fear or resistance. So they need a trusted guidance model to build trust. Secondly, even those who have some experience in the virtual reality experience need to properly cultivate a sense of trust, and clearly guide the experience to quickly immerse themselves in the set virtual environment. Again, when exploring in a virtual environment, it is necessary to improve the fault tolerance of the interaction design. After multiple attempts to trigger the failure, it will dampen the enthusiasm of the user to continue to explore, so that the experiencer will give up quickly. Therefore, after a lot of testing, in the interactive nodes of this project, a large number of invisible teaching contents are added to the key interaction points, and the teaching can be smoothly carried out through teachings such as visual guides and voice prompts. If the experiencer still can't let the interaction continue through the teaching, the program will automatically load according to the waiting time. Of course, this instruction will reserve enough exploration time for the experience before the trigger.

#### **4.3 Rational integration of VR narrative content and interaction design**

The matching of content script and interaction design is a key issue to be solved in VR content creation. The pre-script design discussion joined the NPC leader and introduced the cave mural content and historical origin to the audience as a guide. The NPC leader is a painter and works on restoration in the cave. Entering the cave begins the painter's hand is filling the portrait of the supporter, and the experiencer needs to follow the guide and use the handle in the hand to interact and complete the specified drawing action. The advantage of joining the leader is that the experience can be clearly guided and the experience can be completed in a linear process, but in the feedback of the actual test, most of the experiencers hope to be free to explore. In addition, NPC guides are more prone to the “horror valley” phenomenon [7], which may cause the experience to panic. Therefore, the guide's settings are deleted in the later discussion, and it is determined to make the best use of visual and auditory methods to let the experiencer enjoy freely. Although painting is the most direct way to understand the content of murals, because the input device is a handle rather than a brush, the difference in feel will also make the viewer out of experience. The combination of VR experience mode and documentary narrative mode is a highlight of this project, as well as the artistic innovation of VR technology in the field of cultural heritage protection.

### **5. Conclusion**

Through the analysis of the content and creation process of the VR documentary Dunhuang, this paper expounds the new ideas brought by the introduction of new technologies such as virtual reality to the field of traditional cultural heritage dissemination. In the direction of scientific research and application, digital storage mode is more durable and systematic. In the general direction of teaching, the new sensory experience can enhance the sense of participation and cognitive dimension, so that the dissemination and popularization of cultural heritage content is more extensive and profound. In the direction of artistic creation, new technological means have provided new creative inspiration for the artistic aesthetics of the dissemination of cultural heritage. The high-tech recording methods in modern cultural relics should be compatible with traditional

archaeological and cultural relics protection, and can also increase artistic creation while recording. Let the historical culture and aesthetics carried by the cultural heritage itself be enriched and comprehensively displayed in front of future generations.

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