VR Games and the Dissemination of Cultural Heritage

Lie Zhang[1]([✉]), Weiying Qi[2], Kun Zhao[3], Liang Wang[3],
Xingdong Tan[4], and Lin Jiao[5]

[1] Department of Information Art & Design, Tsinghua University, Beijing 100084, China
zhlie@tsinghua.edu.cn
[2] Henan Police College, Zhengzhou 450046, China
qiwy266@qq.com
[3] Emperor Qinshihuang's Mausoleum Site Museum, Xi'an 710600, China
513419331@qq.com
[4] EZ360 Infotech Co., Ltd., Beijing 100041, China
tanxingdong@ez360.cn
[5] Luxun Academy of Fine Arts, Shenyang 110004, China
jljlgo@163.com

Abstract. Known as the Eighth Wonder of the World, the Emperor Qingshihuang's Mausoleum and Terracotta Warriors contain rich information and unique value in the field of history, culture, military, science and technology and so on, highlight the core values of Chinese civilization, and have become an epitome of Chinese history and culture. In recent years, with the rapid development of technologies such as augmented reality (AR), virtual reality (VR), video analysis based on indoor high-precision positioning, big data, mobile Internet and wearable interactive terminal etc., there are great opportunities and development space for the innovation and dissemination of cultural heritage. In this context, the Emperor Qingshihuang's Mausoleum in China, in collaboration with relevant scientific research units, developed the VR Terracotta Warriors Serious Games which is part of research series on Key Technologies of the Smart Museum for the Audience. The VR games combines the live experience of the audience, using 360° panorama shooting, 3D modeling, virtual reality, intelligent question-answering technology to design this games. From the real scene to the virtual scene, the audience can experience a wonderful journey through time and space, and learn the history and culture of Qinshihuang's Mausoleum. This game allows the audience have a deep experience. Through the combination of cultural heritage and VR games, this paper tries to explore new technologies to promote the interactive dissemination of cultural heritage, as well as the effective ways to promote the further prosperity of cultural tourism market.

Keywords: Cultural heritage · VR game · Virtual reality
The Emperor Qingshihuang's Mausoleum · Terracotta warriors

1   Introduction

Emperor Qinshihuang's Mausoleum is the tomb of the first Chinese emperor Yingzheng (259–210 B.C.), a world famous cultural heritage and tourist destination. It is one of the largest, most peculiar and rich imperial tombs in the world. It fully displays the technical and artistic ability of the ancient Chinese working people more than 2000 years ago. It is the pride and treasure of the Chinese nation. The mausoleum of the First Emperor of Qin Dynasty contains rich information and unique value of history, culture, military, science and technology, but at the same time it has many unsolved riddles, and it is also a rich source of historical literature and anecdote.

The Terracotta Warriors Pits was discovered in 1974 and are known as "the Eighth Wonder of the World" and "one of the great discoveries in the archaeological history of the 20th century" [1]. The three terracotta warrior pits are arranged in a zigzag pattern with a total area of over 20,000 m². There are more than 7000 terracotta figures and real size terracotta horse statues which are have high artistic value.

The terracotta warriors and horses have an important position in the history of Chinese culture heritage, which reflect the political, military and social development and change from the Warring Sates period to the Qin dynasty. The terracotta warriors have huge model, neat organization, its shape and arrangement imitated the choreography of the army at that time, which showed the history of "The king of Qin conquered other six countries, and became the only king of the whole China". Therefore terracotta warriors and horses are symbols of the power and martial arts of the Qin dynasty. The shape of the terracotta warriors and horses used the extraordinary artistic techniques, vivid model, accurate proportion, rich and colorful clay to depict different identity, personalities and spirits. The terracotta warriors and horses have unique value of learning in the history of architecture, costumes especially the history of emperor tomb system which reflect realistic social life and the cultural traits of the Qing dynasty [2]. In addition, the unearthed cultural relics of the Qin Terracotta Warriors Pits are greatly changed the people awareness of science and technology level of the Qin dynasty.

With the rapid development of technologies such as augmented reality (AR), virtual reality (VR), indoor high-precision positioning video analysis, big data, mobile Internet and wearable interactive terminal, it has brought huge change in the way people get their public cultural resources. At the same time, it also has brought great opportunities and development for the spread of the cultural heritage of innovation and the development of cultural tourism. Based on this background, the Chinese museum of Emperor Qingshihuang's Mausoleum has joint relevant scientific research units to develop a serious VR terracotta warriors game which toward to audience's a series of wisdom museum in the cooperation of the key technology research. This VR games use the world famous "the Eighth Wonder of the World" of the Terra Cotta Warriors pit as the background, Combined with the audience's experience in the spot using technology such as the 360-degree panoramic camera, three-dimension modeling, virtual reality, intelligent questions etc. This game led the audience to learn the history and culture knowledge. With the emerging science and technology and creative development, this game will promote the further prosperity of cultural tourism market.

2   Related Work

With the rapid development of VR technology, in recent years, many museums at home and abroad have launched virtual tours of online museum based on the online virtual museum, enabling users from all over the world to visit the museum online and watch the important cultural relics in the museum through the Internet and the mobile Internet. For example, the British Museum and Google Street View have cooperated to make users use Google Street View online to visit the museum of the scene, and have a closer look at the museum exhibits [3] (see Fig. 1).
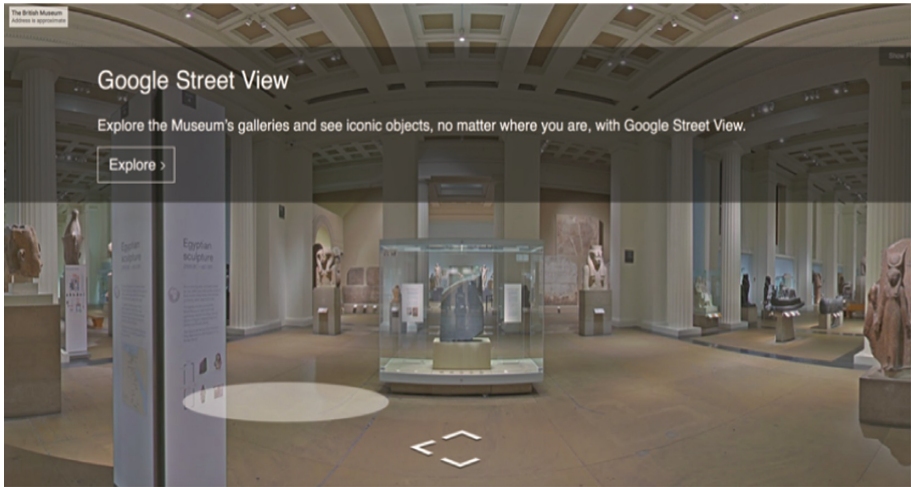

Fig. 1. British museum online virtual tour

Although the experience of wearing VR glasses has appear in many games, the application in the museum is not very common. In April 2016, the Capital Museum in Beijing introduced a virtual tour of VR during the exhibition of Fu Hao tomb [4], according to the use of the guide supplied by the museum, attendance can view the tomb of Fu Hao in 360° and experience different excavation layer after wearing VR glasses (see Fig. 2). Virtual reality brings a strong sense of immersion to the audiences, enabling the audiences to experience the historical environment. This bring a brand-new cultural experience to the audience.

Fig. 2. Capital museum VR visiting scene

On June 30, 2017, the EZ360 Company developed a "Van Gogh Virtual Reality Art Exhibition" for Changsha museum [5]. The Exhibition set up a "windmill town" VR cycling program, with the help of virtual wearable devices, the audience can enter Van Gogh's town, roaming in the Van Gogh's tulip country – Holland. This Virtual Reality Art Exhibition allow the audiences trace the footsteps of the artistic and explore Van Gogh' artistic inspiration (see Fig. 3).

Fig. 3. Scene of the Van Gogh virtual reality art exhibition at the Changsha museum

3   VR Terracotta Army Culture-Oriented Travel Game Design

3.1   The Raise of the Question

With technologies of virtual visual and interactive such as VR, AR, MR began to enter people vision, there is a growing demand for the sense of reality, immersion, and interaction of the visual experience. Through the analyze of surveys from audiences of the museum of Emperor Qingshihuang's Mausoleum, and backstage data analysis of APPs such as Yi You Terracotta Warriors and Horses which was launched by the museum over the past two years, and by video identification, mobile phone technology and equipment such as high precision indoor positioning, QR code the statistical analysis of the data and information collected at the museum, we found that the audiences has a great desires to know further about the story behind the cultural relics, and hope to have a closer contact with the Terracotta Warriors. Audiences hope to be able to enter to the Number One Terracotta Warriors Pit, and they even hope the Terra Cotta Warriors could "be alive" and interact with the audiences. Due to the realistic conditions and the safety of cultural relics, these hopes are impossible to be realized during the normal tour, and the audience can only stand outside the fences of the Terracotta Warriors pits. At the same time, through the devices such as the website, APP, VR devices, they could achieve a certain effect in the depth of the content and immersive, but as to lack of experience of "Being Present", it is difficult for viewers to achieve the ideal effect about the continuous attention of this kind of information and user viscosity.

The perception of the body and the surrounding space are the most basic cognitive activity of human beings, unlike the pure digital study, we emphasize the organic combination of numbers and space. As Norberg Schulz said, "The reason why man is interested in space is the root of existence" [6]. In space, we get the perception of the surrounding world through the body, and connect ourselves to the surrounding world, together constitute the perception of the world, and acquire the initial understanding of the world, namely, "beauty is physical and in deep space" by Melo Ponti [7].

In order to achieve a more comprehensive and in-depth tour experience effect, this project build a virtual world of the Terracotta Warriors. The design make full use of the site of cultural heritage, in combination with VR, integrated the "virtual" with "reality". We hope the audiences could get more intense sensory experience by and more profound understanding and cognition by interactive devices when they visit at the scene, and learn the history with modern technology to experience the Terracotta Warriors with zero distance of the story which happened more than 2000 years ago.

3.2   Function of Framework

The Emperor Qingshihuang's Mausoleum and Terracotta Warriors have abundant cultural heritage resources and profound historical and cultural knowledge, in order to meet the audiences' needs of understanding the Terracotta Warriors, and to spread the cultural content of the Emperor Qingshihuang's Mausoleum and Terracotta Warriors profoundly, this paper selects some representative of cultural heritage and cultural knowledge, and use the technologists such as the acquisition of three-dimension data,

information on the field data fitting, three-dimension modeling technology, and make use of virtual reality, artificial intelligence technology to develop a set of field real virtual scene roaming and the series of little game in fictitious space with the combination of VR interaction system (see Fig. 4). The system based on the using of the real site of the three dimensional space and the Terracotta Warriors three-dimension data of cultural relics, and related knowledge and history which uncovered by the institute of archaeology. Such as the color of the Terra Cotta Warriors, the ancient military system, the ancient chariots and horses system, knowledge of ancient weapons etc. Using people's preference of the story of "crossing" and "treasure hunt" situation, let the audience wear VR glasses at the scene of the ruins, to feel the Terracotta Warriors Pit grand momentum and to see the full clear image of cultural relics. At the same time, they can also cross the time and space at the scene, and go back to thousands of years ago to find more interesting knowledge and detail. This system can bring the audience a full range of profound experience.
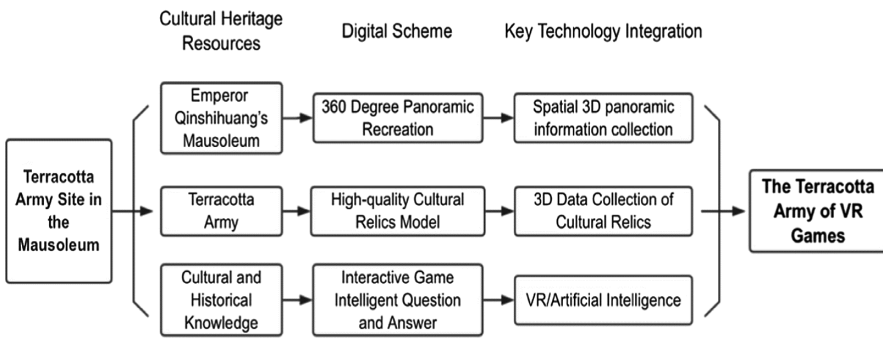

Fig. 4. VR terracotta warriors culture-oriented travel game design framework

The design has the following main points:

1. Conversion of real space and virtual scene. VR Terra Cotta Warriors were designed according to the pattern of the present experience. Using the real experience of the scene and the space experience to give the audiences more intense immersion and the presence experience by using VR technology.
2. Role interaction. The audiences participate in the interactive games with Terra cotta Warriors, resurrect Terracotta Warriors by granting weapons to them. The audiences can have video intelligent Q&A with Terracotta Warriors, virtual hand stitching and repair the damaged of cultural relics and so on. Participating in interactive games with a specific identity, let the audience have a strong sense of participation and identity. Gain knowledge and experience through interaction.
3. Serious game. Rigorous historical and cultural knowledge and archaeological discoveries are the basis of game scenes, props and plot design. The game tries to achieve a better balance between sensory experience and cultural heritage spread education. In setting up the mysterious atmosphere and situation to arouse the audience's desire to explore, with a strong sensory experience to attract the continuous

attention of the audience, and at the same time, put the rich cultural and archaeo-logical information throughout the whole process, stimulating the audience's knowl-edge exploration desire, to acquire the satisfaction of absorbing knowledge and pleasure.

3.3 Main Development Process and Content

Data Acquisition. It is the first step to transform the live scene of emperor Qinshi-huang's Emperor Mausoleum museum into online digital information. The information of the museums and cultural relics includes panoramic three-dimension and rich media information. A spherical panorama is used in the collection of scenes, and a panoramic photograph is taken every 5–10 m (see Fig. 5). After turning a cycle content can be restored in the VR glasses in the museum site 360°. For the collection of cultural relics information, it mainly adopts the 3D modeling which bases on photography technology and the modeling of 3DS Max. Because of the low cost of 3D modeling which base on photography, there is no harm to cultural relics, therefore, most of data collections use this method. Through the calculation of the real scene and the image sequence of the object, the position of each photo in the space is matched, and the special modeling tool is used to create the three-dimensional model with the texture.

Fig. 5. Panoramic view of the No. 1 site of terracotta warriors

Design of the Game Content. Design of VR Terra Cotta Warriors games regard audi-ences as the center, to the greatest extent possible to meet the audiences' need to get close and interact with the warriors, to learn more about the depth of understanding of cultural, and to the real scene and the virtual world seamless switching, roaming in the virtual world with the first calling, make and design of interesting quizzes, etc. The main structure of the game is as follows (see Fig. 6).
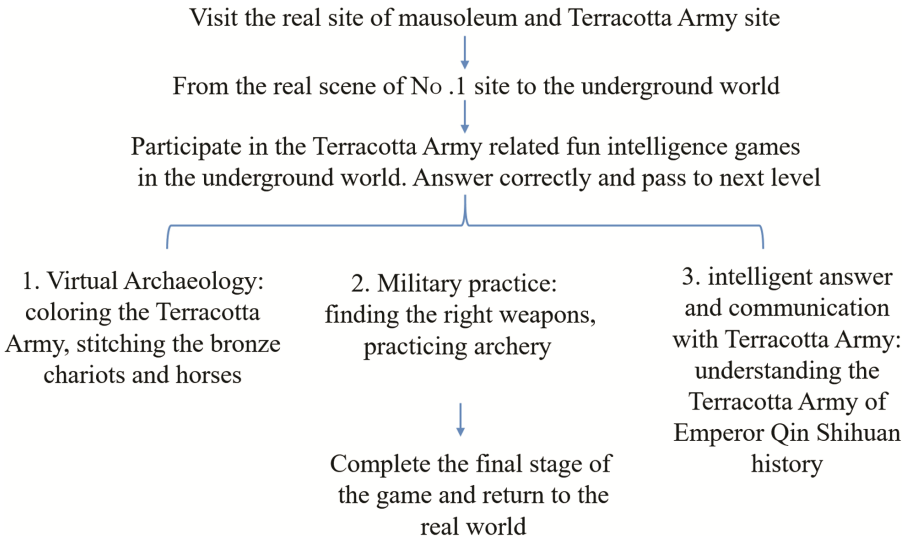
Visit the real site of mausoleum and Terracotta Army site

↓

From the real scene of No .1 site to the underground world

↓

Participate in the Terracotta Army related fun intelligence games
in the underground world. Answer correctly and pass to next level

1. Virtual Archaeology: coloring the Terracotta Army, stitching the bronze chariots and horses

2. Military practice: finding the right weapons, practicing archery

↓

Complete the final stage of the game and return to the real world

3. intelligent answer and communication with Terracotta Army: understanding the Terracotta Army of Emperor Qin Shihuan history

Fig. 6. VR terracotta warriors culture-oriented travel game structure

Virtual Tour of the Site. To satisfy the audience needs of having an interactive experience with the Terracotta warriors, VR-terracotta tour interactive equipment was deployed in the museum scene. The VR game can be experienced after visit the Terracotta Warriors pits. After wearing the VR glasses, the audience will firstly watch a scene constructed by the real photos of Emperor Qin Shihuang's mausoleum, the VR scene and the scene have the matching spatial scale, direction and shape matching, giving the audience a strong sense of reality (see Fig. 7).

Fig. 7. Terracotta warriors site VR tour

In this scene, the audience can feel the real museum space when they head down or look around by wearing glasses. As the audience moves forward, the objects on both

sides of the scene move back while the contents in front of the eyes are constantly approaching. Through scene switching, VR glasses display the whole scene of the Emperor Mausoleum Museum, including the Terracotta Warriors No. 1 pit, the No. 2 pit, the No. 3 pit, and the Emperor of Qin Shihuang mausoleum.

Visitors can stand outside the fence to see the pit of the terracotta warriors. However, when the audience chooses the corresponding icon according to the on-screen instructions, the audience can enter the pit bottom of the terracotta army and interact with the terracotta warriors in close proximity (see Figs. 8 and 9). This is a completely impossible in the real world tour, which is easily realized in VR.

Fig. 8. Terracotta warriors No. 1 site VR tour

Fig. 9. Close look at terracotta warriors No. 1 site VR tour

From Reality to Virtual Time Travel. When the audience reaches the designated terra-cotta warriors in No. 1 pit, there will be ripples in the screen, which prompts the audience to enter the virtual scene into the ground (see Fig. 10). The VR Terracotta Warriors are designed according to the pattern of the presence experience, and the virtual space-time is seamlessly accessed through VR which give the audiences real scene feeling and the space experience, giving the audience more intense immersion feeling and the presence experience

Fig. 10. VR tour of the ripple effect

.

Fig. 11. VR tour into the underground world

With the swaying of the ripple, the audience go into the Virtual World of Terracotta Warriors. There is a series of interactive games waiting for the audience to pass (see Fig. 11). The audience can return to the world after completing all the tasks. However, the audience can stop the game at any time and return to the real world.

Knowledge of VR Game Creation. According to the historical data of the Mausoleum of the Qin Emperor, this paper has constructed a virtual underground world which is in line with the historical facts of Terracotta Warriors. In the underground world, the audience can understand the color of terracotta warriors, weapons, as well as bronze chariots and horses of the terracotta warriors. This part of the game experience content mainly "virtual archaeology", "the sword of the sword" and "Terracotta Warriors".

In the underground world, the viewer can pick up the torches on the ground and light the small torches on both sides of the tunnel. The audiences in the underground world can rotate back and forth and can also get the corresponding content of feedback. Although this is the three-dimensional modeling of virtual content, but one can still have a strong sense of immersion. The audience can walk in the tunnel, watch the tips given on the tunnel walls, according to the prompts, if the audience answers to questions about the Terracotta Warriors, then the gate of the figurines will open, and the audience would see the terracotta warriors and horses scattered in the underground world.

In the experience of virtual archaeology, the audience can color the Terracotta Warriors. The Terracotta warriors were originally colored, but exposure in the air made their bright colors fade away. Audiences need to accurately paint the terracotta warriors with corresponding colors, such as black hair, pink faces, black or brown eyes, and different colors on the armors.

The audience can also perform the task of splicing copper chariots. Emperor Qinshihuang mausoleum has the largest and most complete bronze chariots and horses which are great for the study of Chinese ancient chariots and horses system, sculpture art and refining technology, etc. They have the extremely important historical value. During the underground virtual tour, the audience can assemble the main components of the bronze

Fig. 12. VR tour into the underground world

wheel and canopy according to the order in which the bronze chariot was assembled by the Qin dynasty (see Fig. 12). When the audience successfully completed the task of the bronze chariot and horses, they can stand on the bronze chariot and ride on the battlefield of ancient times.

In the "sword dance" section, the audience needs to find the correct weapon for the terracotta warriors. Thousands of terracotta warriors belong to different categories and grades including spears and halberds, tomahawk, Shu, beryllium, bows, crossbows [8]. The audience needs to find their corresponding weapons for the terracotta warriors. When the audience finds the weapon correctly, the terracotta warriors will be activated and wield their weapons (see Fig. 13).

Fig. 13. Find weapons for the terracotta warriors in the underground world

In the process of underground road in the world, the audience can also talk with the Terracotta Warriors by using voice quiz Q&A, the Terracotta warriors use the background of large data, real-time answer audience questions by voice. The speech intelligent question answering system helps the audience to understand the ancient history knowledge, but also can give the audience through the authentic hint, helps the audience to pass quickly back to the ground.

4   Conclusion

The Mausoleum of the Qin Emperor and Terracotta Army is an outstanding representative of Chinese culture heritage. But under the restrictions of reality and safety reasons of cultural relics, the audience cannot be allowed to contact with Terracotta Army, therefore it is difficult to disseminate the brilliant history and culture of Qin Dynasty effectively.

This article takes the audience's need which is to deeply understand the culture of terracotta Army. The VR serious game based on the Terracotta Warriors culture tourism

was developed for this purpose. The rigorous historical and cultural knowledge and archaeological evidences are the basis of the game designs including scenes, props and plot. The game tries to achieve a better balance between the sensory experience and the cultural heritage dissemination and education. While setting up mysterious atmosphere and situations along with a strong sense experience stimulating the audience's desire to explore and attracting the audience's attention, the game will enrich the cultural and archaeological information. The game will stimulate the audience's desire for knowledge and allow them explore the Mausoleum of the Qin Emperor and Terracotta Army pits with pleasure.

References

1. http://www.bmy.com.cn/2015new/contents/463/18357.html
2. Zhao, Z.: Terracotta Army: Chinese civilization spirit identification. Sanqin Metropolis Daily, 05 March 2015
3. http://www.britishmuseum.org/with_google.aspx
4. http://www.sootoo.com/content/662346.shtml
5. http://hunan.ifeng.com/a/20170630/5785364_0.shtml
6. (Norway) Norberg Schulz: Existence. Space. Architecture. Yin Peitong. Translation. China Architecture Industry Press, Beijing, June 1990
7. Morris Melo Ponti's phenomenology of perception. Jiang Zhihui transl. The Commercial Press, Beijing (2001)
8. Qin Shihuang Terracotta Army Museum: World Heritage Series: Mausoleum of the First Qin Emperor and Terracotta Army. World Book Inc., Beijing (2008)