Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

Information Design of Heritage Site Display Based on Alternate Reality in 5G Background

Xiao Zhang, Deling Yang*, Xijun Huang
Transmedia School, Guangzhou Academy of Fine Arts, Guangzhou, Guangdong, China
*Corresponding Author.

Abstract:

5G high-speed mobile communication will develop the application of VR and AR in the field display of cultural relics. This paper analyzes the design scheme of site display information based on the alternation of VR, AR and real environment in 5G mobile communication environment with the concept of alternating reality. Through the analysis and extension of the scientific research project design of the French Ministry of culture, this paper contributes new design ideas to simulate the effect of mixed reality on-site display experience, and solve the problem of VR and AR on-site display due to technical limitations at the present stage, which can serve the needs of China to promote the tourism value of heritage resources with emerging media in 5G environment.

Keywords*: Alternate Reality, Virtual Reality, Augmented Reality, Heritage Site Display, 5G.*

I. INTRODUCTION

Heritage site display content includes the previous architectural structure, landscape, environment and life. To construct cultural value of the heritage based on their intertextual connection, it is necessary to explain to the audience the diverse value as well as historical and cultural connotation of the heritage through the display. Augmented reality (hereinafter referred to as AR) or virtual reality (hereinafter referred to as VR) has been widely used in virtual display of heritage site, but the space and texture of the site as a physical environment should also take into account AR or VR experience design factors. The main content of this paper is how to combine VR, whether real environment and AR can intertextually explain and interweave the audience experience on the spot, and method to explain cultural sites through intertextual association of virtual and material cultural heritage, surrounding environment and historical stories.

The on-site AR display of heritage sites is to dynamically superimpose virtual content on

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

the screen in real-time and in the real environment. The virtual content can be combined with the site environment in a partial or semi-transparent overlay mode to interpret objects. The on-site digital reconstruction project of Old Summer Palace in China (2006) adopts three AR modes for display: providing users with AR effects of the site in a fixed geographic location by fixed-point observation, and presenting AR effects within a certain range of movement by handheld and helmet devices [1]. For Sheffield Manor, Kong Liming and Kang Jian (2017) partially superimposed 2D restored images on the real scene of the site, and specially showed the connection between site change and time evolution [2]. In Greek Arche-guide project (2001)[3], 3D restored images were partially superimposed on the temples and Olympic sports venues on site. In Italian LIFEPLUS project (2005), AR is used to embed 3D scenes and characters into the Pompeii site to showcase the life of the Romans before the destruction [4]. M. Canciani et al. (2016) used 3D data collected from the Aurelian Wall Ruins in virtual restoration model and superimposed it with part of the wall ruins image [5]. However, at this stage, AR on-site scanning and identification of large-area or large-scale buildings is still technically difficult; in addition, mainly visual content of the site is displayed to the audience, with little kinesthesis and tactile sense.

VR display of heritages site is to completely cover the real environment with virtual content on the screen. The screen of VR image covering device constitutes a closed virtual environment for the audience, and the audience coordinates vision and kinesthesis to interactively experience various knowledge of the site. The “Forbidden City· Emperor’s Palace” project (2003) of the Institute of Digital Application of Cultural Assets of the Palace Museum takes VR to represent the Hall of Supreme Harmony, and the “Lingzhao Pavilion” project (2017) used VR to restore the architectural site and compare it with the current condition. The VAM visual asset management platform (2019) for ancient village big data allows audience to move to different locations in the ancient VR building through the website to experience the virtual environment. The LEDEN Laboratory of the French Academy of Social Sciences (1999) used 3D in virtual Lascaux cave environment and murals, and Giovanni et al. (2018) used 3D to restore and reproduce the pagan church of Santa Maria in L’Aquila, Italy through VR [6]. However, at this stage, limited by data communication and VR equipment, VR seldom showcases site knowledge in the outdoors.

The alternation of VR and reality is to study the establishment of perceptual associations by alternately switching the screen between the virtual scene and the real environment to enhance the audience's physical experience of the VR environment, and at the same time enhance the audience's experience and understanding of the real environment. Hoang (2018) defines alternating reality (hereinafter referred to as AltR) as the user's experience of two-way conversion between the real world and the virtual environment to emphasize the correlation and

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

difference between the two. ("Alternating Reality is an experience which transitions the user from the real world into the virtual environment and vice versa to highlight connections and differences across both realities." - Translated by the author [7].) They build undistorted model to simulate Villa Filiota (English: Pholiota house) in the indoors, make a VR villa with the same structure as the model, and then set up VR alternate experience points in the model. The audience can browse the model on site while viewing the corresponding virtual villa environment in these locations, and also touch the corresponding physical part of the model to experience the physical space and texture.[7] Suzuki (2012) proposed a substitutional reality system (hereinafter referred to as SR) to experience AltR.[8] It uses VR recording video and live broadcast to alternately switch on the VR head display screen to control the audience's perception of reality and virtual time. Simeone (2015) designs the VR environment and objects corresponding to the real environment, and establishes tactile and kinaesthetic associations to replace and enhance the physical experience of VR [9]. Liestøl (2014) develops Appia Road AR application in Rome, which already has AltR features. 4 viewing experience points are set up on the 1km route, but the audience's mobile phone screens are covered by VR to showcase the environment and events in different historical periods, rather than AR display of virtual part superimposed with the real environment. The audience alternately switches between VR and real environment of the road at the scene, thereby enhancing kinaesthetic and tactile experience of the VR historical environment, and also developing the understanding of the historical and cultural connotation of the real environment [10]. Therefore, the alternation of VR and reality can form an interwoven experience and intertextual interpretation of kinesthesis, touch and vision. This paper investigates the alternation between VR, real environment and AR to interpret knowledge and enhance the audience's understanding towards the connotation of the site.

However, at the current stage, there is still a lack of mature solutions for using VR technology in continuous tracking, precise location and interaction in an outdoor space of more than hundreds of square meters to accommodate more than a hundred people. It is still difficult to use AR technology to scan large-area building environments or large-scale building structures. It is difficult to matching complex building structure features and gather positioning data. Thus, exploration into easier-to-implement information design is needed. Next, this paper analyses the French Ministry of Culture's cultural heritage enhanced design project "Terra Numerica" which the author personally participated in, analyses, reflects on, and extends this information design method and process from the author's point of view, and contributes new ideas for developing VR and AR application design in heritage site display in 5G high-speed wireless communication environment.

II. DESIGN METHOD AND PROCESS ANALYSIS

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

"Terra Numerica" is a scientific research project completed by LEDEN Laboratory of the French Academy of Social Sciences and the French Institute of Geography in 2014 and applied in value-added cultural tourism services. The project aims to study the propagation methods of value-added French cultural heritage tourism. In particular, it studies how foreign self-help tourists use mobile phones to assist the tour and enhance their understanding of heritage values. The subject of the project is the site of the ancient Roman-era Les Arènes de Lutèce in the 5th district of Paris. This enhanced visit project allows the audience to cover the mobile phone screen using VR images and watch the original appearance of the site and the environment, rather than using AR to perform partial restoration. In this way, the audience can put down their mobile phones at any time to experience the real environment. The author believes that this project has the characteristics of AltR, which provides interweaving experience and intertextual interpretation of site under VR and real alternate switching.

The project designs a visiting route for the audience, and sets up on-site viewing points on the route to achieve the alternation between VR and reality. The design method is to use VR modelling to restore the original appearance of the building, and set the spatial location and structure of the model in VR to accurately match the site, so that the VR restoration model can be fully nested with the real site model in the computer. Then, the site visit route is designed according to the dissemination theme, and 4 on-site viewing experience points are set on the route. The viewing point location is consistent with the spatial location of the VR model. The audience can watch and experience the virtual original appearance of the site from the same place on the site. The specific design process is as follows:

2.1 Set the Communication Theme and Core Content

The communication theme of "Terra Numerica" project is to experience the original appearance and use of the arena during the ancient Roman period. The core content is to display the complete structure and scene of the building. (The project materials include historical documents of Paris in the Gaul-Roman period, the architectural archives of Les Arènes de Lutèce, images, data and other materials, which are taken from the French Ministry of Culture, the French National Library, the French National Archives, the National Heritage Center, etc. The selected materials are edited to constitute different contents, and form the core contents by intertextuality and complementary links. For example, the large stone block archive with inscribed records found on the Cite Island of Paris provides archaeological evidence for the virtual restoration of the auditorium structure of the arena as well as historical materials for the display of the performance scene.) This determines the expression content and purpose of interweaving experience and intertextual interpretation-allowing the audience to understand the

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

cultural life and landscape of the site during the Gaul-Rome (Gallo-Romain) period on the spot. The specific location of the viewing point is set under expression of this theme.

2.2 Surveying and Mapping of the Site and Building of 3D Models

The surveying and mapping of the project is completed by the French Institute of Geography team using technologies like GPS global positioning, digital mapping, aerial photography, digital photogrammetry, three-dimensional laser scanning. The Les Arènes de Lutèce was built in the first century AD. The part above the first floor of the building has been destroyed or disappeared, leaving only the foundation and the first-floor structure, and some of the building remains have been occupied by other modern buildings or greenery. To collect the site data as complete as possible, the first step is to set up E-level GPS control points at the Les Arènes de Lutèce for survey control; the second step is to use RTK, total station, digital tablet for digital mapping of the arena and import CAD to form a topographic map; the third step is to obtain orthophotos of the arena by aerial photography; the fourth step is to use 3D laser scanning technology to acquire point cloud data of the arena building, and use geomegic model reconstruction technology to create fine architectural models. The arena building and environment models made by surveying and mapping will provide accurate reference for the next VR and AR processing.

2.3 Nest the Site VR with the Real Scene

The project uses AutoCAD and 3DMax modeling on the basis of surveying and mapping models and historical files to display the complete modeling structure of the arena. According to the archives, the arena used to be 130 meters long and 100 meters wide, but it has been partially destroyed; the stage at the site is now 41.20 meters long. In the middle of the arena is an oval gladiatorial show area with a major axis of 52.5 meters and a minor axis of 46.8 meters. The team compares the surveying and mapping models based on archives, first restores the architectural layout of the arena using AutoCAD, and then uses 3DMax modeling to accurately represent the complete form and structure of the Roman arena. All model dimensions are consistent with the actual site size. Then, the model is input into the Unity system, and spatial positioning and coordinates of the model in the system are accurately aligned with the real site scene, so that the model and the real scene can be nested.

2.4 Set up Site Visit Routes and Viewing Points

The route to visit Les Arènes de Lutèce is to enter the gladiatorial show area in the middle from the entrance of the south gate, then enter the stage through the audience seating area, and

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

then exit the arena from the north gate. This route allows audience to visit the main arena attractions in one hour. The audience first watches the VR model of the arena on the touch screen outside the south gate to get an overall understanding of the complete form and structure of the original virtual appearance of the site. It is possible to download the Unity application on Wi-fi and install it on their smartphones, and then enter the south gate to start visiting. The 4 viewing points are respectively located at the gate entrance, gladiatorial show area, auditorium, and stage. There is a scanning point next to each viewing point. The audience logs onto the Unity application in the mobile phone to scan this point with the standing posture while watching. The application matches the virtual camera to the physical space position contained in the scanning point, and the audience can start the experience by aligning the scanning point and the virtual red point with the mobile phone at the viewing point. The audience height is calculated based on the inclination angle scanned by mobile phone by aligning the position and height of the audience in the real environment and VR environment. The calculation algorithm is "scanning point height + the horizontal distance between the audience and the scanning point/tan (mobile phone scanning inclination)". At each viewing point, the corresponding restoration scene is rendered with Unity so that the audience can view it.

The audience enters the arena from the south gate along the preset visit route, scans the first circle at the south gate entrance with mobile phone application, and dynamically observes the original VR arena at the viewing point from the entrance position with a mobile phone. Then, the audience walks to the viewing point of the gladiatorial show area, scans and calls for VR scene to look around the virtual completely repaired auditorium and stage. Next, the audience follows the tour route and ascends step by step, takes an audience seat and uses VR to watch the gladiatorial show area and stage, and experiences the feeling of ancient audience when watching in the seats. Finally, the audience enters the stage viewing point and looks around the auditorium from the perspective of the actor. In the gladiatorial show area, audience seats and stage of the arena VR model, 3D simplified model is added to show the activities content of the people at the time. The audience watches at the viewing point with mobile phones to enhance the experience of arena usage scenario.

Next, this paper compares VR and AR at current stage to analyze the display characteristics of the "Terra Numerica" project from the perspective of VR and reality alternation.

III. DISPLAY CHARACTERISTICS ANALYSIS

"Terra Numerica" project adopts display mode in which VR model is fully nested with the real environment to achieve interwoven experience and intertextual interpretation. The arena site provides a physical spatial reference for the audience's VR experience and enhances the

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

three-dimensional spatial experience in the audience's VR experience. Unlike the VR experience that completely covers the screen in a way separated from the real environment, the project is to experience the real and virtual environment alternation at the site. Visitors along the visiting route will not only experience environmental changes of the site's horizontal location, but also can walk up and down in the real environment along with the route. The kinesthetic experience of elevation changes in different locations will be related to the audience's virtual elevation experience of the corresponding location in VR, resulting in height difference experience of real interweaving VR that enhances the audience's original experience of the virtual arena, for instance, the height difference change of the architectural space after the audience ascends step by step and sits in the auditorium. On the contrary, the vision of viewing the original VR appearance is also related to the kinesthetic experience of being at the real site, forming a kinesthetic experience in which VR vision intertwines with the real environment. In addition, when the audience sits in the auditorium, the stone and VR auditorium also form an intertwined tactile and visual experience. Therefore, the project establishes a real and virtual AltR interweaving experience in terms of vision, kinesthesis, and touch through fully nested display and alternate experience.

VR covers the mobile phone screen in a panoramic switching mode, intertextually expounding and explaining historical changes in historical and today's site environment. VR panorama is completely nested with real scene, integrating the audience's two embodied experiences in immersive manner. Audience visits along the route so that "data is personified, (individual) subjectivity is computerized... the result is narration"[11]. A story is "a mental image, a cognitive construction that involves specific types of entities, and the connection between..."Narration can "evoke story in the heart"[12]. Arena is a symbol of history and culture in the vision of the audience, which transforms into a narrative space in the audience. The previous architectural structure, landscape, environment, and life elements in VR constitute a contextual space for narrating history. The viewing point is the experience fusion point of the two spaces. Audience's switching operation associates the symbols and element entities of the two spaces, constructs meaning and cognition, and inter-textualizes the image of historical stories. Panorama is a contextual framework that integrates various elements and explains the corresponding site content. Today's heritage environment is a result of accumulation of generations of history. Switching operation can enhance interpretation of time gradation of the corresponding VR display content, allowing the audience to look back at the history after the vicissitudes of life. Therefore, the fully nested display enables the arena VR and the real scene to narrate each other, explain the historical and cultural knowledge, and achieve AltR intertextual interpretation.

The VR and reality alternation mode is easier to implement in outdoor site display than the

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

current VR mode, and the real remains can enhance VR environment experience on the site. Visiting routes and viewing points can be designed to allow the audience to directly experience the site outdoors via VR. The viewing point design eliminates the need for VR to continuously track and locate the audience in the site space in real time, thus reducing technical development difficulty and equipment costs. At this stage, VR mostly simulates vision, hearing, kinesthesis or touch by completely covering and detaching from the real environment to replace the audience's feelings of the real environment, but the audience cannot watch the real environment in this mode, and it is difficult to coordinate VR and real space experience. VR and reality alternate ways switch in between, so that the visual, kinesthesis, and tactile sense of the real site environment can reversely complement or enhance the physical real experience of VR.

The alternation between VR and reality simplifies the difficulty of AR scanning technology at this stage and enhances physical space experience of virtual buildings. Presetting scanning points at the viewing location can reduce the technical difficulty of identifying complex building structures and precisely positioning in AR, thus facilitating popularization and application. The project feature is that the virtual part is not superimposed with AR display of the real environment, but the VR method of covering the screen with a panoramic view is adopted. At this stage, AR mainly displays virtual content partially superimposed on images of the real environment, allowing viewers to see the superimposed complete restoration image of the site, while the VR and reality alternation mode emphasizes the interweaving experience of virtual and real three-dimensional space. Because the real scene of the site is nested with VR, and the visiting points accurately correspond to VR space location, the audience touring the site according to the visiting route are also immersed in the corresponding VR space. They move inside/outside or up and down in a three-dimensional space, thus experiencing VR and real scenes of the site form multiple angles by moving steps, so experienced visual and kinaesthetic sense are also three-dimensional. In addition, material of the site will also complement the audience's texture experience of the space. For example, when the audience sits in the arena auditorium, the stone of the seats will enhance the VR texture experience.

Therefore, the three-dimensional interweaving experience and intertextual interpretation through virtual connection with the real environment are the main characteristics of the exhibition design. The French Ministry of Culture also applies the “Terra Numerica” project to the virtual restoration of the ancient port of Marseille. According to the survey conducted by the Ministry of Culture, the audience can have a clearer understanding of the harbor environment, complete form, structure, and size of the site through this method, developing a deeper understanding of related history and life knowledge.

However, this project is designed in the background of 4G network technology, so there is

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

limited number of observation points set on the site, which limits the audience's comprehensive and in-depth understanding of the site. The computing power of the audience's smartphone limits the terminal data processing amount in VR applications, so it is difficult to guarantee smooth experience of VR images. The alternate explanation of the VR model image covering screen and the site does not introduce the construction relationship between the internal and external structures of the site building, nor is the relationship between the remaining structure and the restored building introduced. The description of the complex structure of the site is incomplete and lacks levels, resulting in shallow intertextual interpretation. The lack of real-time interaction between the model and the on-site lighting environment makes it difficult to maintain consistency, which weakens the interweaving experience. Next, this paper focuses on the development trend of immersive experience in view of today's site demonstrations, and explores ways to extend this design in the context of accelerated construction of 5G high-speed mobile communications.

IV. PROJECT EXTENSION DESIGN PLAN

Based on the AltR concept, this paper explores and extends the design plan of "Terra Numerica" project. The purpose is to use 5G high-speed mobile communication to enhance the audience's experience and knowledge understanding of the site at a relatively low cost based on the current VR and AR hardware and technology. The author believes that the design development direction is to combine VR and real environment with AR to form a display platform that simulates the on-site experience effect of mixed reality (hereinafter referred to as MR) with higher hardware costs at present.

4.1 Platform-based Site Display Application Design Based on the Alternation of VR, AR and Real Environment

Mobile terminal applications are designed to integrate VR and AR display of the site and alternately display the site with the real environment. AR virtual restoration display is input into this application to provide the audience with site AR effect at the observation point via fixed-point AR observation mode, thus reducing AR technical difficulty in scanning and identifying the site. VR is used to present the original appearance and environment of the site in a panoramic view, and AR is used to express the relationship between the internal and external structure of the ruins as well as the relationship between the remaining structure and the restored building. Combining the alternate real environment of VR and AR, the site is fully explained in different levels, forming a platform display application to pragmatically enhance the audience understanding of the site knowledge. The specific design content is:

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

First, design three-dimensional or two-dimensional images to partially cover the incomplete parts of the site, combine the architectural structure of the site, use AR to explain the relationship between the virtual restoration and the current state of the building structure; or use animation to explain the site in steps and combine virtual structures to restore the original site appearance.

Second, use platform-based AltR to alternately display AR and VR, and use AR to demonstrate the relationship between the building structures to facilitate the audience's understanding of the internal structure knowledge of the original appearance of VR. VR provides the historical background and complete restoration experience for the AR structure.

Third, use AltR to enrich the kinesthetic experience of audience watching with AR. Design multiple viewing points around the same building structure and watch the AR restoration display from different surrounding angles to alternately associate AR with the kinesthetic experience of physical space location changes in the real environment. For example, the height difference changes at different viewing points are associated with the audience’s AR viewing perspective and kinesthetic experience.

4.2 Simulated MR Experience Effect

In the 5G high-speed mobile communication environment, more viewing points are added to the heritage site, and VR, real environment and AR are alternately used to simulate MR experience effect for the audience. The key to the design technology implementation is to store the VR and AR display programs and data content of the site in the cloud, and use cloud computing to process the data. At the same time, use 5G network to transmit the VR or AR data processing results to the mobile terminals of the field audience to generate experience. "In the 5G era, cloud computing can be used to do a lot of processing on the edge cloud. Using high CPU/GPU in such processing will not consume too much power. Fast connection of 5G enables quick transmission to the local area, which will strongly support the improvement in user experience of VR/AR products... For example, Huawei VR OpenLab and Cyber Cloud released the latest VR solution-Cloud VR in February 2019, which means that VR operation capabilities will be transferred from the terminal to the cloud. This will promote the popularization of VR/AR applications on smartphones"[13].

First, refine the core content based on the theme of the site display, and set up more viewing points on the site visiting route to display VR and AR content related to the site.

Second, set up multiple viewing points around the site structure that needs to be highlighted,

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

so that the audience can experience more about the site from multiple perspectives. For example, use AR to display the virtual restoration of the site structure, use VR to experience the restoration environment of the site structure, use VR and AR to alternate the kinesthesis and tactile sense of the real environment, thereby enhancing experience of reality.

Third, for the front and rear obscured parts of the site structure, multiple viewing points can be progressively set up on the site according to the front and rear spatial positions of the structure, so that the site buildings are displayed in sections and hierarchies to enhance the placement and coexistence of AR virtual images in the site.

Fourth, calculate the sunshine angle, intensity and color temperature in every year, every day and every hour of the site according to the geographical location of the site, and use this to render the lighting effects of the 3D model of the site. VR and AR are transferred to the site in real time to display at the same time, and the model is displayed via simulated lighting effects. Simultaneous time simulation of light effects can enhance the fusion experience of VR, AR virtual content and on-site environment.

This paper compares the similarities and differences between MR and VR, AR, and AltR and briefly summarizes them as follows:

TABLE I. Comparison of the similarities and differences between MR and VR, AR, AltR experience

	Similarities with MR experience	**Differences from MR experience**
VR	Both use screens to display virtual and real environment images.	The holographic image of MR is mixed with the real environment, and the senses of vision, hearing, and touch are integrated with the environment, while VR virtual image covers the real environment, with sense of vision, hearing and touch completely immersed in the virtual environment.
AR	Virtual images are combined in real-time on the screen with the same viewing angle at a certain location in the real environment.	MR can perceive the depth of the real world and perform three-dimensional modeling. It uses spatial mapping technology to place holographic images into the real environment picture for coexistence with real objects. The light of the holographic image is consistent with that of the real environment, which can interact with the objects in the real environment, the audience's gaze,

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

		gestures and voice commands. AR virtual image is partially superimposed on the real environment picture, and the audience conducts interaction through the touch screen interface.
AltR	Virtual objects combine the visual, kinesthetic and tactile senses of the real environment to experience the realism.	The MR holographic image directly integrates the experience with the real environment, while AltR alternately uses virtual image and real environment to transform the experience in both directions.

Compared with VR, AR, and AltR, MR shows a deeper integration of virtual and real environments with a stronger interaction to enable a more immersive audience experience. MR has now been applied to heritage site display. Through on-site mobile communication and interaction, MR puts holographic images into the real environment to form an information environment that integrates virtual and real, and presents knowledge of the site with immersive intertextual interpretation and interwoven experience to the audience. For example, in 2019, the Museum of the Liberation of Paris in France (French: musée de la Libération de Paris) used Microsoft's HoloLens head display to show the audience the work of the headquarters of the Paris Liberation Organization in the summer of 1944 through MR at the site. However, at this stage, the cost of MR terminal hardware equipment such as Hololens2 is relatively high, which is difficult to afford for small museums. Thus, wide promotion and application is difficult.

From 2020, China accelerates the development of 5G network construction and promotes 5G+VR/AR applications.[14] It will provide network speed and calculation processing guarantee for experience effects of alternate simulation of MR by VR, real environment and AR. The transmission rate of 5G mobile communication is as high as 10Gps, which is 100 times faster than 4G. A mobile edge computing system is adopted, which means that user requests are sent to the base station closer to the user for data processing and faster feedback is possible for the user, which greatly shortens the short delay of VR/AR application in mobile terminal. This paper compares 5G and 4G data transmission speed and briefly summarizes them as follows:

TABLE II. Comparison of the similarities and differences between MR and VR, AR, AltR experience

Name	**4G**	**5G**
LOGIN TIME	2011	2020
CORE TECHNOLOGY	TDD-LTE, FDD-LTE, OFDMAT	NR
SPECTRUM	20MHz	>200MHz

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

BANDWIDTH		
PEAK DATA RATE	300Mbps	c.20Gps
MAIN APPLICATION SCENARIOS	Internet surfing, online games, social media, video broadcasting.	VR/AR, autonomous driving, industrial automation, smart city, Internet of Things.

Therefore, VR, real environment and AR can be alternated through 5G communication to simulate the experience effect of MR virtual and real integration. Relying on 5G high-speed communication environment, it is possible to increase the number of viewing points at the site, simulate the audience wearing an MR headset in site tour, use AR to display the virtual building at multiple angles and levels to simulate the effect of placing MR holographic images into the real environment. In this way, pre-calculated light effects can be used to simulate the lighting effect of the holographic image in the scene, and kinesthesis and tactile sense of the real environment can be used alternately to simulate the real on-site fusion experience of MR vision, hearing, touch and the environment. The low latency and low power consumption characteristics of 5G technology can promote the popularization of VR/AR applications in smart phone terminals, so that platform design that alternates between VR, AR and reality can be widely used on audience's mobile phones to simulate MR experience effects. There is no need to use high-priced MR hardware equipment at present, so it is a design scheme that can be promoted in cultural institutions to simulate the MR experience in a relatively low-cost manner at this stage.

V. CONCLUSION

The site display information design based on the alternation of VR, AR and the real environment is to explore the extension of the "Terra Numerica" project based on the AltR concept, and present the development trend of immersive experience in view of today's sites. It proposes the use of VR, AR and real alternation in the 5G high-speed mobile communication environment for platform display of the application design scheme. Its core feature is to completely nest the VR model and the real environment in design of on-site viewing point to form an intertextual interpretation and interweaving experience based on VR, AR and the real environment. Under the background of accelerating the development of 5G network environment in China, the solution can reduce the technical development difficulty of VR and AR on site display, lower the cost of MR and other technical hardware, which means extensive promotion and application value for today's heritage site display in China.

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

(1)The design solution is to explain the value of the heritage site to the audience, which takes new media to spread the cultural value of the site and enhance its tourism economic value. Adapted to the development of domestic "innovative cultural relics value dissemination and promotion system"[15], it can give play to the "important role of cultural relics resources in promoting regional economic and social development and boosting the tourism industry"[16].

(2)The solution adopts AltR concept to simulate the MR experience effect on the scene of cultural sites by designing a platform display application that alternates between VR, AR and reality, which can be widely used in small museums in China. It can solve the problem that MR is difficult to promote and apply in small museums due to the high cost of terminal hardware equipment at this stage.

(3)The solution relies on 5G wireless mobile communication, optimizes the "Terra Numerica" project design by adding a large number of viewing points at the site and presetting real-time simulation of light effects of the model, so as to achieve more comprehensive interpretation of the site's intertextuality and enable deeper interweaving experience. The relationship between architectural site and virtual restoration is more completely illustrated so that it is possible to simulate the way by which MR uses holographic images to mix the real environment and create an information environment for site explanation.

(4) The solution stores site data, VR and AR display programs and content in the cloud, so that domestic experts and scholars studying heritage sites can directly invoke cloud data to conduct research, and directly upload the latest research results to update cloud data, VR and AR display contents. The updated content can be displayed through 5G transmission to the audience's mobile terminal, so that cultural institutions can update the display content to the audience at a lower cost.

(5)The solution specifies the scope of the audience's visit by designing the site visit route, and sets the viewing point to specify the audience's viewing position, so as to solve the current technical problem that VR is difficult to continuously track, accurately locate and interact with multiple people on the site.

(6)The solution sets up viewing points and uses VR model to accurately nest the site space, which solves the current problem of difficulty in using AR to scan large-area buildings, match complex structural features and obtain accurate positioning data.

Through intertextual interpretation, interweaving experience of the audience, the site display information design based on the alternation of VR, AR and reality relates to

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

understanding towards the past and today's architectural structure, landscape, environment and life, which is a method of constructing heritage cultural value through communication. It can contribute new ideas and new plans for protection and utilization of cultural relics in the new era, consensus guiding in cultural significance, and era value enhancement of cultural sites in China.

ACKNOWLEDGEMENT

This achievement is the phased result of the planning fund for the research of Humanities and Social Sciences of the Ministry of Education of China "Research on the normal form of personalized interpretation of wisdom Museum Exhibition" (project number: 21ZX038); Supported by the 2021 Guangdong province graduate education innovation plan project "Guangdong joint postgraduate training demonstration base" (Talent training project of joint postgraduate training demonstration base of teaching practice base of Guangzhou Academy of Fine Arts & Guangzhou Ruifeng Audio Technology Corporation), and 2017 Graduate education innovation plan of department of experimental arts of Guangzhou Academy of Fine Arts (project number: 60409180156).

REFERENCES

[1] Wang YT et al. (2008) On-site Digital Reconstruction of the Old Summer Palace Based on Augmented Reality Technology. Science & Technology Review (3): 36-40

[2] Kong LM, Kang J (2007) Evaluation of Building Site Display Based on Mobile Augmented Reality. China Cultural Heritage 77(1): 40-45

[3] Vassilios V, John K, Manolis T, Michael G, Luis A, Didier S, Tim G, Ioannis T. Christou, Renzo C, Nikos I (2001) Archeoguide: "ARCHEOGUIDE: First results of an Augmented Reality, Mobile Computing System in Cultural Heritage Sites", VAST' 01: Proceedings of the 2001 conference on Virtual reality, archeology, and cultural heritage. ed. David Arnold, Alan Chalmers, Dieter Fellner, ACM: 131–140

[4] Magnenat-TN, Papagiannakis G (2007) Virtual Worlds and Augmented Reality in Cultural Heritage Applications. International Journal of Architectural Computing 5(2): 396-415

[5] Canciani M, Conigliaro E, Del GM, Papalini P, Saccone M (2016) 3d survey and augmented reality for cultural heritage. The case study of aurelian wall at castra praetoria in rome. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences XLI-B5: 931-937

[6] De GG, Cordisco A, Cucchiara F (2018) Immersive Virtual Reality as a Resource for Unaccessible Heritage Sites. IOP Conference Series: Materials Science and Engineering 364: 012-035

[7] Hoang TN, Cox TN (2018) Alternating Reality: An Interweaving Narrative of Physical and Virtual Cultural Exhibitions. Presence Teleoperators & Virtual Environments 26(4): 402-419

Forest Chemicals Revew
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2021 Page No. 529-544
Article History: Received: 12 May 2021 Revised: 25 June 2021 Accepted: 22 July 2021 Publication: 31 August 2021

[8] Suzuki K, Wakisaka S, Fujii N (2012) Substitutional Reality System: A Novel Experimental Platform for Experiencing Alternative Reality. Scientific Reports 2(1): 459

[9] Simeone AL, Velloso E, Gellersen H (2015) Substitutional Reality: Using the Physical Environment to Design Virtual Reality Experiences. Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI 2015)

[10] Liestøl G (2014) Along the Appian Way. Storytelling and Memory across Time and Space in Mobile Augmented Reality. Euromed: 248-257

[11] Heller C (2017) How We Become Post-human. Liu Yuqing (Trans) Beijing: Peking University Press, ISBN 9787301280768

[12] Raul RM (2014) The Transformation of Stories. Zhang Xinjun (Trans) Nanjing: Yilin Publishing House ISBN 9787544749152

[13] Golden Sun Securities Research Institute (2020) AR/VR in 5G. Available at http: //www.microbell.com/. 22 March 2020

[14] Ministry of Industry and Information Technology (2020) Notice of the Ministry of Industry and Information Technology on Promoting 5G Development. Available at http: //www.gov.cn/zhengce/zhengceku/2020-03/25 /content_5495201.htm. 26 March 2020

[15] General Office of the Central Committee of the Communist Party of China, General Office of the State Council (2020) Several Opinions on Strengthening the Reform in Protection and Utilization of Cultural Relics. Available at http: //www.gov.cn/gongbao/content/2018/content_5335360.htm. 22 March 2020

[16] State Council (2016) Guiding Opinions on Further Strengthening Cultural Relics Work. Available at http: //www.gov.cn/zhengce/content/2016-03/08/content_5050721.htm. 22 March 2020