

# A Study on VR Content Service Design for Experiential Hall of Baekje Historic Area

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## Abstract

It has been increasingly necessary to press ahead with promotion and provide new experience in the wake of designation of Baekje Historic Areas as world heritage and surge in tourist inflow. Against this backdrop, the purpose of this study was to provide experience and service of various contents based on virtual augmented reality technology capable of arousing the interest and attention of tourists. The author investigated major technologies related to VR both at home and abroad, on which basis the author analyzed the cases and types, depending on VR content production techniques. Based on analyses of such materials, the author presented production details and final results in connection with development of VR and AR contents in Baekje Historic Culture Experience Hall. VR experience content production techniques that tap into history and culture of Baekje were presented into 3 categories: wireless walking VR, wireless VR streaming, and wireless VR multi-access. For the method of VR content experience, types of VR experience were presented which allowed users to experience historic space while walking and looking outside, along with the method of exploring the inside of relics based on circles by using position sensors. Particularly, the VR contents proposed in this study were synchronized wirelessly with external displayer or projection to allow viewers in the surrounding area to experience VR contents directly or indirectly. Baekje Historic Culture Experience Hall is the nation's first permanent facility to provide visitors with opportunities to experience both virtual and augmented reality and is expected to spur expansion of virtual reality/augmented reality education, local industry and provide a link with tourism industry.

**Key Words:** Baekje Historic Areas, VR experience hall, VR contents, walking VR, VR streaming, VR simultaneous connection.

## 1. Introduction

It has been increasingly necessary to provide new opportunities for experience by tapping into historic and cultural foundation of Baekje amid the surge in tourist inflows in the wake of designation of Baekje Historic Areas<sup>1</sup> as world heritage. Baekje Historic Areas consists of 8 historic sites in 3 regions, i.e., Iksan-si(city) of Jeollabuk-do, Gongju-si and Buyeo-gun(county) of Chungcheongnam-do. Baekje Historic Areas has value as historical sites for architectural technology and dissemination of Buddhism which Baekje promoted through the exchange involving China, Japan, and Korea's 3 kingdoms of Goguryeo, Baekje, and Silla. However, most relics and architectures which could provide a window into the mode of lives disappeared, leaving little trace, during the period of Japanese colonial rule and the Korea War. Thus, it would be necessary to establish experiential halls that can arouse the interest and attention of tourists and to offer various experiential services accordingly. The purpose of this study was to present technical background, production details and final outcomes of VR contents that could be used for simulation, such as observation of relics, reproduction of the mode of lives, etc., in Baekje Historic Areas based on immersion, interaction, and presence<sup>2</sup> which characterized virtual reality technologies.

## 2. Materials and Methods

This study presented technical background, production details, and final outcomes in the development of contents necessary for establishing the experiential hall of Baekje Historic Areas and investigated general characteristics of Baekje Historic Areas and those of historical sites. Based on that, the author examined theoretical backgrounds of VR technology, AR technology, and cultural technology(CT) necessary for education and experience of Baekje Historic Areas, and analyzed cases of applicable contents in order to present the types, direction, and development details of contents founded on VR, AR, and CT technologies

### **Understanding of Baekje Historic Areas**

#### *Historicity of Baekje Historic Areas*

Baekje Historic Areas were placed on the list of UNESCO cultural heritages in 2015 and straddle Iksan-si(city) of Jeollabuk-do, Gongju-si and Buyeo-gun(county) of Chungcheongnam-do in Korea. Main factors that contributed to its designation as UNESCO cultural heritages included the architectural technologies of Baekje and dissemination of Buddhism spurred by the exchange among kingdoms of ancient Korea, China, and Japan. Moreover, unique culture, religion and artistic beauty in Baekje kingdom were illustrated by the location of capital in Baekje Historic Areas, Buddhist temples and tombs, architectural characteristics and pagodas, etc <sup>3</sup>. Baekje is one of the 3 ancient kingdoms on Korean Peninsula, which existed from 18 BC to AD 660 <sup>4</sup>. The capital of Baekje

straddled 3 regions(Iksan, Gongju, and Buyeo). The relics that remain in those cities serve as testimony to Baekje's cultural golden age achieved through the exchange among the 3 ancient kingdoms of Baekje, Japan, and China. Particularly, mountain fortresses, royal palace site, outer fortresses, royal tombs, and Buddhist temples, which were essential elements for ancient capital city, show the excellent universal value of Baekje Historic Areas, all of which are incorporated into the heritages. Those remains keep the important evidences of Baekje architectural structure, technical advancement and development intact<sup>5</sup>. All elements of the heritages are cultural assets designated by government. The 3 cities are ancient capital cities for which comprehensive and sustainable preservation policies have been implemented.

In addition, Baekje Historic Areas preserves architectural structure of archeological historical site, mountain fortress, royal tombs and pagodas and authenticity of overall urban layout. All elements forming the heritages still hold historic evidences in all aspects that determine the authenticity<sup>6</sup>.

#### *Characteristics of 8 Historic Sites in Baekje Historic Areas*

**Gongsanseong Fortress** is a mountain fortress built to protect Gongju, the seat of government in Baekje era, and located at Sanseong-dong, Gongju-si, Chungcheongnam-do<sup>7</sup>.

**Songsanri Tomb Complex** houses ancient tombs of Baekje era, which is located in Gongju-si, Chungcheongnam-do, and is known as royal tomb of Ungjin era of Baekju<sup>8</sup>.

**Gwanbuk-ri Relics and Busosanseong Fortress of Buyeo** are presumed to be the royal palace site of Sabi, the last capital city of Baekje. Busosanseong Fortress, located at Busosan, Ssangbuk-ri, Buyeo-eup, Buyeo-gun, Chungcheongnam-do, is a mountain fortress built in the era of Baekje<sup>9</sup>.

The ancient town chronicle of Gongju in Joseon Dynasty shows that royal tombs of Baekje era in **Neungsan-ri Ancient Tomb** area were located about 4 km to the east from government office of Buyeo prefecture<sup>10</sup>.

Jeongrim-sa Temple Site represents a symbolic space linked directly to the destiny of Baekje Dynasty and is located at the center of Buyeo, surrounded by Mt. Geumseong to the east and Mt. Buso to the north<sup>11</sup>.






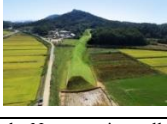


Buyeo Naseong Fortress was built to protect Sabi, the capital of Baekje, in the period of the Three States and has the walls stretching 8km<sup>12</sup>.

Wanggung-ri Relics was established as royal palace during King Muwang of Baekje Dynasty and later became a temple. The 5-story pagoda of Wanggung-ri has attracted academic attention and was researched since the period of

Japanese colonial rule<sup>13</sup>.

Mireuk Temple Site is nestled in a broad flatland under Mt. Mireuk with a height of 430m, located in Geumma-myeon, Iksan-si and is the largest in the East Asia. Samgukyusa(Heritage of the Three States) contains a folk tale about establishment of Mireuk Temple, which is unprecedented for any temple built in the era of Baekje Dynasty<sup>14</sup>, as shown in table1’.

Table 1: The 8 historic sites in Baekje Historic Areas

			
the Geumseoru	the Songsan-ri related	the Busosanseong Fortress and Gwanbuk-ri administrative buildings	the Jeongnimsa Temple
			
the royal tombs in Neungsan-ri	the Naseong city wall	the royal palace at Wanggung-ri	the Mireuksa Temple

## Understanding of VR

General characteristics of VR, types of experiential devices(HMD: Head-Mounted Display), and characteristics of VR contents can be presented as below.

### *General Characteristics of VR*

Virtual reality refers to the interface which allows users to interact with and simulate various situations as if they were in real space by programming the digitally configured environment with computer graphics, and is defined as artificial reality and cyberspace<sup>15</sup>. In addition, Steuer defined the virtual reality as a realistic or simulated environment where the presence of virtual reality is perceived and experienced based on previous experiences<sup>16</sup>, and Hillis defined the virtual reality as network system of de-material contradicting the physical and real world from the standpoint of humanities and social science<sup>17</sup>. Paul Milgram and Fumio Kishino differentiated between the virtual and reality into 4 states, and defined virtual reality as real space, augmented reality, augmented virtuality, and virtual reality from virtual continuum(VC) based on media center<sup>18</sup>. ‘Insert Figure 1’

### *VR Experiential Device(HMD)*

The first modern virtual reality experiential device(HMD) was Sensorama developed by Morton Heilig in 1962, the first prototype VR device based on fusion technology that provided experience by tapping into five senses(visual 3D, auditory, tactile, olfactory)<sup>19</sup>. Later, innovative concept HMD provided capability to experience innovative virtual reality based on sensors, such as high resolution display, GPS, Geo-magnetic, Gyroscope, etc., through Oculus Rift DK1 which rolled out in 2012<sup>20</sup>. Recently, a series of new HMD products have

been announced by Samsung, Google, Apple, LG, Sony, Oculus Rift, etc. These HMDs are largely divided into wired type and wireless type. Their main features are presented below 'as shown in table 2'

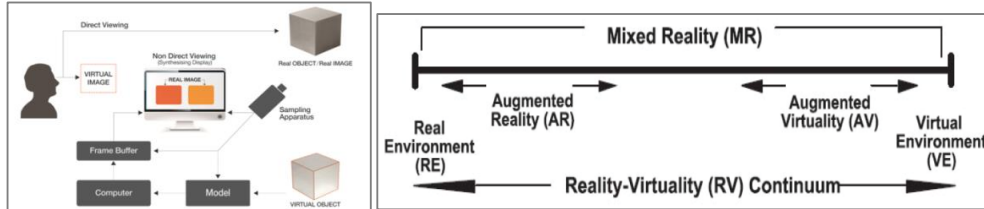




Figure 1: A Taxonomy of Mixed Reality Visual Display & Virtuality Continuum<sup>21</sup>

Table 2: Characteristics of Wired and Wireless HMD

Wireless HMD	Wired HMD
	
<p>Advantage: 2160*1200 resolution, 90 Hz frequency, 2.3 million pixels processed per second, continuous use, easy access to various VR platforms</p> <p>Disadvantage: Connection of cables to PC results in limitation of activities.</p> <p>Type: Oculus DK2, Sony HMZ-T3W, HTC(VIVE),</p>	<p>Advantage: The resolution is QHD(2560×1440). It has excellent mobility, usability, and scalability due to the use of wires. Disadvantage: Battery has to be charged constantly. So far, wireless connection results in slower motion response rate compared to that of wired connection. Type: Galaxy Gear VR, Carl Zeiss (ONE), LG(G3)</p>

### Characteristics of VR Contents

Depending on wired and wireless access, VR contents have the characteristics and give rise to technique issues as described below.

#### *Characteristics of VR Contents Based on Wired and Wireless HMD*

**Wired VR:** It is the VR content providing experience based on devices such as Oculus Rift, Soji, Vive, etc. It is mainly room-scale contents, using PC and connecting cable, which limits experience. For this type, VR contents are experienced while sitting in a fixed place or standing with movement being restricted except for slight motion. Experiential contents are mostly VR games and 360 VR contents and have advantage that many different contents can be enjoyed through VR platform without battery problem. The drawback is related to the cable problem which may threaten safety when experiencing VR contents.

**Wireless VR contents:** Examples of wireless HMD include Samsung's Galaxy Gear, which uses the VR contents provided by gear VR platform. This type provides excellent mobility, usability and scalability via wireless connection, depending on the type of contents. As VR experiential contents based on position sensor, this type allows users to move through the space and view or experience objects on exhibition. Moreover, this type has the advantage that VR contents can be enjoyed as active experience type via wireless connection. Thus far, the disadvantage is that there is limitation to rendering various experiential

contents 'as shown in table 3'.

### *Technical Characteristics of VR Contents*

VR contents have been evolving from the first stage of viewing, through the second stage of using input device, to the third stage of walking and sharing experience with multiple users at the same time <sup>22</sup>. Therefore, there are 3 technologies that can be highlighted as issues for VR contents experience as below.

**Walking VR:** It represents the technology allowing users to walk without restraint and experience VR contents synchronized with the HMD, a wearable device, based on position sensor (Opti-track, depth sensor), etc., and incorporates the best technology that can be implemented in VR thus far. In particular, there is a difference in precision, depending on which position sensor is used. The opti-track provides the greatest precision and sense of experience, while the depth sensor is very cheap but is based on motion recognition which limits recognition of movements.

**VR Streaming:** Overcoming the HMD's limitation of isolation, VR streaming applies VR streaming enabling wireless transmission of images to external display (monitor, projector) while contents are experienced by a user wearing a HMD, thus allowing multiple users to share same experience simultaneously, along with the technology enabling wired transmission of images experienced by users with HMD to external display via wired connection.

**VR Simultaneous Access:** It is a system that allows multiple users to access simultaneously from the experience of Room Scale and VR game contents. It is a technology allowing people to recognize the existence of one another and experience together in virtual space. Currently, up to 2 users can access the system at the same time 'as shown in table 4'.

Table 3: Characteristics of Wired and Wireless VR Contents



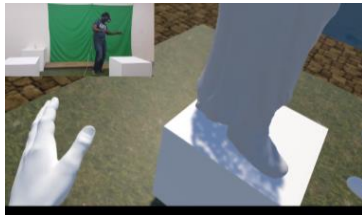


Wireless VR Contents	Wired VR Contents
	
Seokguram Grotto VR <sup>23</sup> .	VR game contents using the blue screen <sup>24</sup> .

Table 4: Technical Characteristics of VR Contents

Walking VR Contents	VR Streaming Contents	VR Multi-Access Contents
		
Creating an exhibition hall in virtual space <sup>25</sup> .	Wireless sensor VR performance <sup>26</sup> .	Ogyeongjeongsa House VR <sup>27</sup> .

### 3. Results and Discussion

Based on the study in Chapter 2, the author presented the directions for application of technology enabling experience of VR contents in Baekje Cultural Area Experiential Hall, type of experience, and details of development.

#### Implications for VR content Experience Technology

The author presented 3 leading technologies for experience with VR contents in Baekje Historic Cultural Area Experiential Hall, which were wireless walking VR, wireless VR streaming and wireless VR multi-access.

##### *Experience with Wired and Wireless Walking VR*

VR experience via wired connection had been limited thus far as the experience was rendered by cables. Furthermore, walking VR using the backpack was also limited in enabling the elderly and children to experience VR contents due to the weight of backpack. However, the technology, which maintains large capacity data transmission speed with real-time wireless transmission-based MTP latency below 20ms, is allowing users to experience VR contents of Baekje Historic Areas via wireless connection while moving freely. Thus, technical direction can be presented ‘as shown in table 5’.

##### *Wireless VR Streaming*

The external image output of VR contents has been limited or recognized as a limitation hindering unrestrained experience with VR contents for reason of cables. Wireless VR streaming technology enables of H.265 codec support and real-time streaming of images with improved quality, allowing multiple users to experience the details or methods of experience directly or indirectly ‘as shown in table 6’.

##### *Wireless VR Multi-Access (Multi Access Support)*

Wireless VR multi-access technology creates an environment that allows users to enjoy various VR contents through multi-access. It does not use cables which



degrades room-scale VR games and VR contents and enables 2 or more users to enjoy VR contents at the same time. Wireless VR multi-access technology is expected to find wide-ranging commercial applications, a technology important for commercialization such as VR karaoke, VR game room, etc., 'as shown in table 7' in the period ahead.

Table 5: Technical Characteristics of Wired and Wireless Walking VR

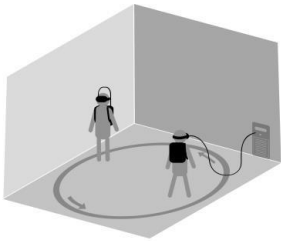
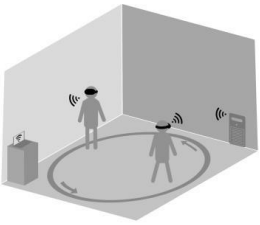
	
Experience with walking VR contents via wired connection or using the backpack	Experience with unrestrained walking VR contents via wireless connection

Table 6: Technical Characteristics of Wired and Wireless VR Streaming

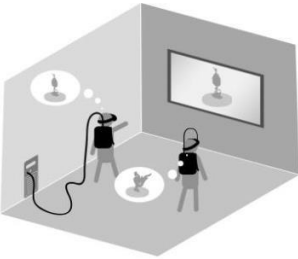

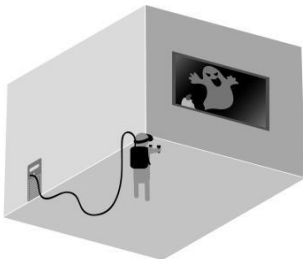
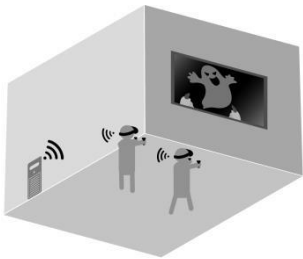
	
External image output via wired connection	Wireless real-time external image streaming

Table 7: Technical Characteristics of Wired and Wireless VR Multi-access

	
Wired VR private connection	Wireless VR multi-access

### Presentation of Types of VR Content Experience

The author resolved safety problems through wireless connection of simulator that had relied on wired connection thus far and proposed a new type of VR experience. Based on case studies of VR contents and 3 types of major VR, the



experience types (relic-centric and space-centric) of Baekje Historic Areas VR contents and development details were presented as below.

#### *Relic-Centric VR Experiential Contents*

For the development details related to relic-centric contents of Baekje Historic Areas, those contents can be produced and distributed in the form of application allowing users to observe and experience the details inside the circle while walking based on opti-track sensor via wireless connection. Regarding the method of producing VR contents for excavated relics, the modeling is optimized based on the scanned data on the relics. In particular, VR streaming technology is used to output external images to allow visitors, along with those waiting the experiential opportunities, to experience contents directly or indirectly.

#### *Space-Centric VR Experiential Contents*

For the development details related to historic space-centric VR contents of Baekje Historic Areas, those contents can be produced and distributed in the form of application enabling users to observe and explore the view of historic space at 360-degree while walking and looking outside based on wireless connection. Concerning the method of producing the VR contents, the 8 places of historic space are photographed, photo-scanned three-dimensionally, and stitched to optimize the panorama images. Images are transmitted wirelessly to external output devices such as monitor, display, projection, etc., so that multiple users can experience the VR experiential contents directly or indirectly 'as shown in table 8'. Final results, obtained through convergence of the 3 major VR technologies for Baekje Cultural Area Experiential Site, can be presented as below. Various types VR contents of Baekje Historic Areas can be experienced by 2 or more users at the same time while walking. Furthermore, visitors in the surrounding area can gain indirect experience through the images streamed wirelessly 'as shown in table 9'

Table 8: Types of VR Contents Experience



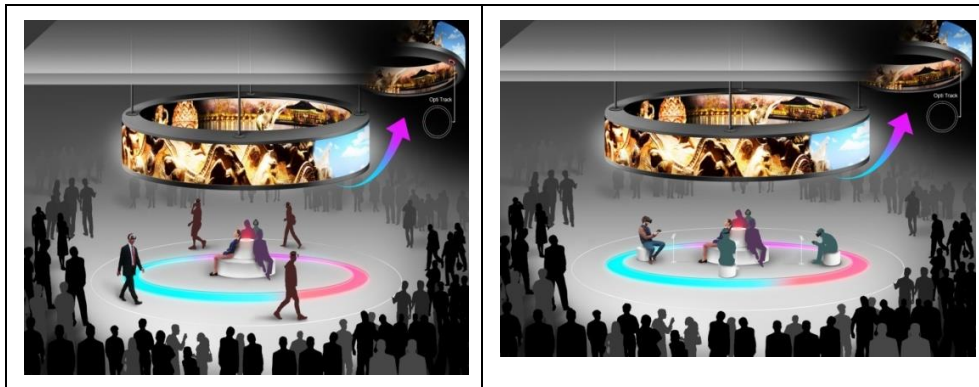
	
<p>VR experience focusing on relics in Baekje Historic Areas</p>	<p>VR experience focusing on the space of Baekje Historic Areas</p>

Table 9: VR Content Experience System in Baekje Historic Cultural Experiential Hall



## 4. Conclusion

The Baekje Historic Areas consist of cultural heritages at 8 places: Gongsanseong Fortress, Songsanri Tomb Complex, Gwanbuk-ri Relics and Busosanseong Fortress, Neungsan-ri Ancient Tomb, Jeongrim-sa Temple Site, and Wanggung-ri Relics, etc. Based on these historical contents, the technical implications, development details and final results of VR contents applicable to the Baekje Historic Areas Experiential Site can be presented as below. First, there are 3 technologies for VR contents, which have recently come into spotlight. First, it is the walking VR technology, a wireless active experiential type VR system which allows users to move through the space freely without constraints from cables and to view or experience the objects on exhibition. For the development details related to walking VR, the VR contents are developed in such a way so as to provide users with experience during their walk inside experiential space through the use of position tracking equipment based on VR Input System Integration.

Second, VR streaming is a technology for wirelessly streaming experiential images from HMD to external monitor and projection in real time, allowing multiple users to experience simultaneously through streamed images. For the development details related to VR streaming, this VR streaming technology enables of H.265 codec support and transmission of VR images which results in improved image quality while maintaining large capacity data transmission speed with the MTP latency below 20ms. Finally, wireless VR multi-access is a technology allowing 2 or more users to enjoy VR experience and VR games simultaneously. VR multi-access need to be developed in such a way so as to support multiple user access on single server and 3D sound. For the final results obtained through convergence of the 3 major VR technologies for Baekje Cultural Area Experiential Site, the Baekje Historic Areas VR contents can be experienced by 2 or more users inside and outside the circle while walking based on position. Particularly, viewers in the vicinity can experience indirectly through the images outputted wirelessly via external monitor or projection. Those technologies can be commercialized for domestic and overseas museums,

art galleries, experiential halls, etc., in the period ahead and are expected to serve as platforms for VR contents.

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