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A Study on Application Method of Virtual Reality for Preservation and Utilization of Intangible Cultural Properties

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Virtual Reality (VR) technology has been used to preserve cultural heritage in the era of the Fourth Industrial Revolution. Nowadays VR technology has a system that focuses on management rather than the use of cultural heritage. Since virtual reality technology is mainly confined to the external aspects of cultural heritage such as digital reconstruction, there are very few examples related to the use of intangible cultural properties. The content of intangible cultural heritage could be preserved throughout the process of transferring the technology of the cultural heritage holders. In preserving the intangible cultural heritage, there may be, however, difficulties such as the loss of succession, due to the death of the cultural heritage holder, and/or the lack of transferors. In this paper, a methodology in which VR technology is applied for preserving and utilizing effectively intangible cultural properties is proposed. Firstly, types of intangible cultural properties are classified to effectively apply VR technology. Lastly, a methodology in which virtual reality, augmented reality, and 360°VR video technology is applied to better represent the characteristics of classified intangible cultural properties is proposed.

Keywords: virtual reality; intangible cultural property; cultural heritage; augmented reality; 360°VR video

I. INTRODUCTION

Cultural heritage is a legacy left by our ancestors and is a precious heritage that shows the history of our lives and the wisdom of life. Therefore, we should preserve and utilize cultural heritage well. With the emergence of cultural contents as the main keywords of the 21st century industry, interest in culture is being increased. Cultural content plays an important role in promoting Korea and promoting its status.

The social interest in cultural heritage, which is the basis of this, is also being increased. Culture Technology (CT), which combines cultural contents and IT technology, is emerging as a new growth engine. In CT, new areas where IT technology and cultural heritage are converged are attracting attention. IT technology is, here, actively utilized in preserving, researching, recording and utilizing cultural heritage (Kim & Kim., 2016).

The era of the Fourth Industrial Revolution (IR) has witnessed the development of VR technologies mostly in such fields as education, industry and medical services. But it is expected that it can also be applied to other areas including exhibition, training and experiential marketing of cultural assets. At present, VR technology is largely confined to the external aspect of cultural assets such as digital restoration and reconstruction of cultural assets, whereas not much attention has been paid to how to utilize the assets and how to connect the heritage with science and technology. It is not easy to find actual cases of applying science and technology to the utilization of intangible cultural heritage (Park., 2008; Lee & Cho., 2012).

In particular, as research results in which virtual reality contents could interact with users and enhance their understanding of cultural heritage have been published, they have attracted attention as technologies that may be able to

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effectively present various information related to cultural heritage and interpretation thereof. Virtual reality technology is, however, currently being applied to manage cultural heritage rather than cultural heritage utilization. It is confined to the external aspects of cultural heritage, such as digital restoration and reconstruction. There are few examples of applying VR technology to the utilization and preservation of intangible cultural heritage.

The purpose of this paper is to explore the ways of preserving and utilizing intangible cultural heritage through virtual reality technology in order to spread awareness about importance of intangible cultural heritage and to preserve and utilize it. To effectively utilize and preserve intangible cultural properties in Korea, we classify the types according to the characteristics of virtual reality is classified and an application methodology is proposed.

II. RELATED RESEARCH

A. Virtual Reality

In this study, 'virtual reality' refers to a comprehensive concept that includes all kinds of methods shown in Figure 1 (Milgram & Kishino, 1994). There is 'Real Environment' which is a real world, and 'Virtual Environment' which is a virtual environment created by using computer software tools exists. There are 'Augmented Reality' and 'Augmented Virtuality' between these two concepts, and the concept of combining all these is 'Mixed Reality'.

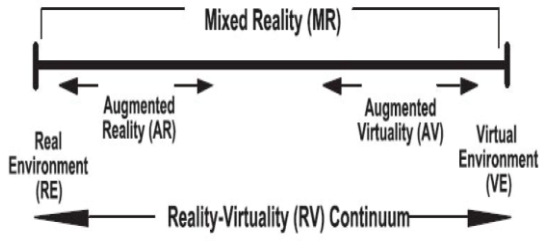


Figure 1. Categories of Virtual Reality

As the virtual reality ecosystem evolves from the concept of existing virtual reality to the domain of augmented reality or mixed reality, as the technology develops and the industry expands, the size of the Korean virtual reality market reaches 1,300 billion won by 2016. It is expected to grow to 5.7 trillion won in 2020, four years later.

As the virtual reality technology spreads and spreads throughout the society, the expectation for the virtual reality industry is gradually increasing. Therefore, large companies in the domestic and overseas IT fields such as Google, Facebook, Samsung, and LG have recognized virtual reality as a future growth engine and are concentrating on preemption of early ecosystem through R & D and merger and acquisition.

Since the field of applying virtual reality technology is very wide, there is a high possibility of growth and development of virtual reality market, and there are many start-ups related to virtual reality in domestic and small and medium enterprises in recent years. However, it is a reality that there is not enough environment to compete with the global market, and related companies are reluctant to invest in an uncertain market.

Virtual reality contents tend to be focused on games and entertainment, but they can be applied to various fields such as medical, education, culture, broadcasting, defense, sports, architecture and manufacturing. Therefore, we need to find ways to further expand the virtual reality market and activate the industry.

Recently, interest in virtual reality contents, which is one of realistic media, has increased, and interest in 360 ° VR video contents, which is one kind of virtual reality, is increasing.

Samsung Gear 360, Rico Theta and other 360-degree cameras have become popular, allowing individuals to easily take picture 360-degree images without expensive imaging equipment. The number of people making, and broadcasting YouTube media has increased.

Strictly speaking, the 360 ° VR video taken at 360 ° in real environment is not a type of virtual reality made of 100% computer graphics.

However, it differs from the existing image and is generally regarded as the 'Virtual Reality' category in the sense that it gives a high immersion feeling.

As described above, the term ‘virtual reality’ is used as a term including augmented reality and mixed reality as well in this research. Virtual reality has recently attracted much attention as a very effective technique that can effectively present a variety of information on cultural assets and, thus can help users better enjoy and understand cultural assets by providing them with various kinds of interaction as well as immersion.

In this paper, virtual reality includes three concepts such as general virtual reality, augmented reality, and 360 ° VR video

as shown in Table 1.

Table 1. Virtual reality concept

Virtual Reality	A technology that makes 100% virtual space and objects according to human imagination in a computer and enables them to experience it as real
Augmented Reality	A computer graphics technology that looks like it actually exists by adding virtual objects or environments to existing objects or environments
360°VR Video	During playback, you can use various devices to select the direction or point you want to see, that is, you can rotate the video 360 degrees

B. Cultural Heritage Using Virtual Reality

Existing VR contents for cultural assets includes the following. Seokuram HMD Travel Experience Center, firstly introduced to the public in Silk Road 2015, seems to be the first exhibition content of its kind opened to the public using VR technology. This movable VR experience center enabled users to wear a VR HMD and feel as if they had been really seeing in and around the Seokuram by utilizing location-based technology.

In this VR experience, they could have an interesting live tour of the Seokuram and listen to an exciting set of storytelling presentations about the history and background of the cultural property.

Figure 2. A photo of AR participatory contents for Hyeumwonji Palace in Paju

The city of Paju developed a package for AR (Augmented Reality) experience of Hyeumwonji Palace of Paju with the help of Social Cooperation for Korean Cultural Heritage Contents as shown in Figure 2. This is the first empirical case of applying AR technology to a on-site cultural asset. The original state of the whole palace area was restored by using AR technology, and a pilot AR was developed for the palace. The restored AR was designed in such a way that anybody can use it with his or her smartphone without any special equipment. Thus, with a smartphone, anybody could view and experience the original scene of the palace.

These cases mentioned above are all confined to the application of VR technology to the external aspect of these cultural assets: they are all examples of digital restoration or reconstruction. VR contents for intangible cultural assets are all produced by 360 ° VR videotaping of the scenes in such areas as performing arts. Thus, not many attempts or efforts have been made for utilization of intangible cultural assets or for the relationship with science and technology.

Table 2. Content case classification according to cultural heritage type

Cultural heritage type	**The name of Contents**
Tangible cultural heritage (17)	Namhansanseong
	Changdeokgung Palace Complex
	Andong Hahoe Village
	Buyeo Jeongnimsa Temple Site
	Changdeokgung Palace
	Deoksugung Palace
	Gyeongbokgung Palace
	Buseoksa Temple
	Yongcheon cave
	Bulguksa Temple
	Baekje Historical Site
	Stonehenge
	Turkey
	Kulangsu
	Argentina
	The Western Wall

	Scotland Kilda
Intangible Cultural Heritage (13)	Gochang farm music
	funambulism
	Pansori
	Chundohun Song
	Anseong Namsadang Pungmul Play
	Mimaji Mask dance
	Deoksugung Palace gatekeeper change ceremony
	Namsadang Play
	Farm music
	Dance of monk
	Jeju Haenyeo(sea women)

Table 2 shows the results of a survey of domestic and foreign cases applying 360 ° VR video technology to cultural heritage contents. Table 2 shows that the difference between the number of tangible cultural heritage contents and the number of intangible cultural heritage contents using 360 ° VR video technology is small. 360 ° VR videos for intangible cultural heritage content are now being commercialized, indicating that 360 ° VR video technology is an effective technology for content that utilizes intangible cultural heritage.

However, among the fields of intangible cultural heritage, contents using virtual reality technology in the traditional technology field are insufficient. The intangible cultural heritage is classified into seven categories as traditional performing arts, traditional knowledge, play martial arts, rituals, lifestyle customs, word of mouth and expression, and traditional techniques (Lee & Cho, 2012; Kim, 2017).

The examples in Table 2 are mainly contents of performing arts such as performances, arts, traditional knowledge, play and martial arts, and contents using traditional techniques that are traditional functions cannot be found.

In this study, we propose a methodology to utilize virtual reality technology for all intangible cultural properties, including the traditional technology field.

To apply the virtual reality technology according to the characteristics of intangible cultural property types, the types are firstly classified. Virtual reality, augmented reality, and 360 ° VR video technology are then applied to each type of intangible cultural property.

III. APPLICATION OF VIRTUAL RREALITY FOR INTANGIBLE CULTURAL PROPERTIES

In order to apply virtual reality technology effectively, intangible cultural properties are defined and classified as art type, knowledge type, and information type as shown in Table 3.

Performances, arts, oral presentations, expressions, rituals, plays, and martial arts are types of arts that experience artistic behaviors emotionally, and appreciate them in an environment where they can maximize their presence and immerse them. Traditional technology is a type of knowledge that can be used to acquire knowledge through actual actions reflecting the contact and movement of the body using interfaces. Finally, traditional knowledge and lifestyle are classified as information type.

This is a type of learning through information and data through physical interactions between real and virtual environments and multimedia experiences through various media (Min & Choi., 2017; Lee & Cho., 2012).

Table 3. Types of reclassified intangible cultural properties for applying virtual reality

Reclassification type	**Existing type**
The types of art	Traditional Performing ·Arts
	Oral tradition and expression
	Ceremony Rituals
	Traditional play Martial art
The types of knowledge	Traditional techniques
The types of information	Traditional knowledge
	Traditional life custom

A. Types of Art

Intangible cultural properties classified as art forms are effectively implemented as 360 ° VR video. Existing spectator type events have been experienced in an environment where viewers are seated in a seats and actors are separated in a time and space on the stage.

This one-sided form is impossible to give a detailed impression of detailed expression or motion. The 360°VR movie shooting method provides a better visual information and immersive experience because it is composed of a 360-degree panoramic shooting, which is out of the square frame shooting mode.

As shown in Table 4, 360°VR video contents shot on the stage can be watched through HMD, allowing users to experience on-stage viewing beyond the conventional flat viewing, and feel a vivid presence feeling.

Table 4. Characteristics comparison of 360°VR video and the type of art

Type of art	**360°VR video**
Exhibition, performance-oriented event	Appreciate of active video
The importance of visual and auditory immersion	Providing excellent visual information
The type of culture and artistic appreciation	Experience and immersion experience using HMD
A vivid presence is important	Easy to make, compatible between products, with a variety of content

B. Types of Knowledge

Traditional technology areas classified as knowledge-based are quite vulnerable to preservation and utilization. At present, some traditional technologies are at risk of disappearing because there is no one to inherit it. Knowledge type is a field where technology is transferred. It is a field that can realize the environment necessary to acquire traditional technology by realizing using virtual reality technology. Table 4 shows the characteristics when the intangible cultural property of knowledge type is implemented as a virtual reality.

The biggest advantage of virtual reality technology is that it can be used repeatedly because of using computer, so it can save time and manpower cost.

Table 5. Characteristics comparison of VR and the type of knowledge

Type of knowledge	**Virtual Reality**
Acquire functional knowledge	3D virtual world of 100% computer graphics
Practice type through physical movement	Interact in virtual environments
Interactive via interactive interface	Suitable for education and training
Repetitive experience possible	Not only visual and auditory, but also sense of touch
Unfamiliar items	Possible to implement a world that does not exist in reality

C. Types of Information

Traditional knowledge and customs are classified as information type. Living custom, which is this type, shows the culture that is the most basic type of human lifestyle, such as food, clothing and shelter.

Traditional knowledge is a newly designated field in Korea as UNESCO recognizes community consciousness, customs and knowledge extensively as intangible cultural heritage. The type that contains such a wide range of values is difficult to understand as appreciation or experience like the previous types. It should be provided with an environment in which information can be received and learned by oneself.

It is effective to use the augmented reality technology for the intangible cultural property corresponding to this information type.

Augmented reality represents additional virtual information on a realistic situation. Therefore, the

application of augmented reality technology can increase the effectiveness of information transmission through active participation. Table 6 shows the characteristics of the augmented reality according to information type. Table 7 shows the definition of intangible cultural property types for applying virtual reality.

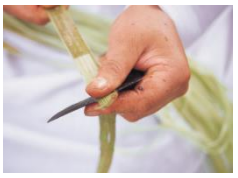
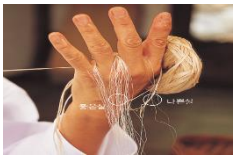
Table 6. Characteristics comparison of AR and the type of information

The type of information	**Augment reality**
Information transmission	Add computer graphics to reality
The range of contents is wide.	The generation, provision and communication of information
Active information acquisition and learning	Physical interface
Various media experience possible	Add, delete, and modify images in the real world

Table 7. Definition of intangible cultural properties to utilize virtual reality

Type	**Definition**
The type of art	This is a type of experiencing artistic activities in an emotional way and appreciating it by providing an environment that can maximize the sense of presence and immerse.
The type of knowledge	Using a sensible interface, a type that acquires knowledge by the actual action that reflects the direct contact of the body sensation and the movement of the body
The type of information	This is a type of learning through physical interaction of physical environment and virtual environment, multimedia experience through various media, and learning through information and materials through it

Table 8. The contents of the Hansan Mosi weaving

No	**Process**	**Contents**	**Figures**
1	Making TaeMosi	Peel off the outer layer of the harvested Mosi, and make the Taemosi with the skin. This process is repeated 4 to 5 times in the process of drying in water to remove impurities.	
2	Splitting of Mosi	The process of making the thickness of the Mosi fibers to be constant by dividing the TaeMosi with a tooth by one strand, the quality of the Mosi is determined in this process	
3	Making thread	. It is the process of making the thread after the splitting of the Mosi. .. The connecting thread is wrapped around and tied with a string to make a bundle.	
4	Adjust the number of thread	Take out the thread from all ten frames, pass it through the hole, make the bundle, hang it on the frame, and adjust the thread count.	
5	Mosi Pasting	. Insert the thread into the body, one end to the frame, the other end to fix and paste.	

6	Mosi Weaving	It is a process of weaving Mosi using Battle.	

The 3D modeling technique is a modeling technique that utilizes a skeleton that expresses objects, an outline polygon and cubic representation technique, and the entire polygon and surface area.

Virtualized objects that are realistically modeled can interact and manipulate through the Unity3D engine. To do this, haptic interaction processing technology and input device technology are needed. This is the most necessary skill when a person experiencing the Hansan Mosi weaving process experiences and trains like the actual environment or the movement of the real world.

Haptic is a technology that inputs and receives our physical approach and reaction through a computer or a mobile device, which is a processing device, and applies it to the virtual and augmented reality technology to converge. The most commonly used is the controller, which is used to convey the movement of the human hand or finger and focuses on the user's manipulation.

In the course of the experience, you should be able to experience the actual training through the technology that uses the controller with delicacy, the technology that feels like it is in reality, and the synchronization technology with peripheral devices.

IV. APPLICATION EXAMPLE

So far, a methodology for applying virtual reality technology as an effective method for preservation and utilization of intangible cultural properties is proposed.

In this chapter, we design virtual reality contents for Hansan Mosi weaving, which is listed as an intangible cultural heritage of humanity, as an application example of the proposed method.

Hansan Mosi weaving refers to the technique of weaving woolen fabrics according to traditional methods in a traditional loom using natural materials called Mosi that is a kind of plants.

Recent decline of product prices and difficult labor work have let young people stay away from the ramie fabric industry. As a consequence, worsened reputation for the quality of ramie products has failed to attract apprentices and trainees for the traditional technology. At present, Hansan Ramie Fabric Hall and Hansan Ramie Fabric Festival have barely kept the tradition. However, lack of interesting cultural contents and systematic management systems have failed to produce fruitful performance.

In order to solve these problems, we try to develop hands - on experience - based contents which can experience the process of weaving with Hansan mosaic using virtual reality technology and practice it directly. Hansan Mosi come from Hansan, and its quality is superior to other regions.

Hansan Mosi weaving is divided into traditional knowledge based on type classification and knowledge type among reclassified type. Table 8 summarizes the contents of the Hansan Mosi weaving process**.**

It is effective to apply general virtual reality because Hansan mosaic weaving is classified as knowledge type according to the intangible cultural property classification method proposed above.

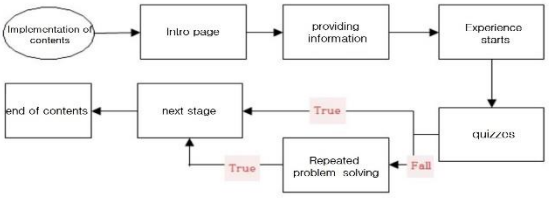


Figure 3. Development procedure for VR contents

General virtual reality builds content based on the development process shown in Figure 3. Reciprocal interactions and functions are programmed by using Unity 3D engine. 3D tools such as Cinema 4D are used for modeling the environment of Mosi weaving and equipment. UI works for introduction page, information pages, and quizzes are created by 2D tools such as Photoshop and Illustrator (Lee *et al.*, 2017).

Figure 4. Procedure of Hansan Mosi Weaving

The whole process of Mosi weaving can be summarized as in Figure 4. Users of the VR contents can lead self-directed learning of the process by solving the quizzes provided at some designated steps. That is, the VR contents should be produced in such a way that it would focus on the steps where problem-solving activities can be implemented for users' experience and participation. With a correct answer, users can go on to the next stage and, if not, they need to repeat solving the provided quizzes (Youn *et al*., 2017).

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V. CONCLUSION

Virtual reality contents that are immersive and can interact with users are attracting attention as a technology that can effectively interpret various related information through the research result that it is applied to the cultural heritage and improves understanding about the cultural heritage.

VR technology is now being applied to a number of cultural properties, but VR contents for intangible assets can be hardly seen. The biggest issue in preservation of intangible assets is clearly severance of transmission of the heritage to the next generation (Oh, 2015). The number of apprentices and successors has rapidly been decreased perhaps due to the ever-changing environment and the financial hardships of life.

Insufficient public relations and promotion programs might also lead to the problematic situation under discussion, although there are 150 training centers for traditional culture across the country.

In this paper, we proposed a methodology for developing intangible cultural contents using virtual reality technology to effectively preserve and utilize intangible cultural properties in Korea.

The types of intangible cultural properties are firstly classified so that they can be efficiently applied according to the characteristics of virtual reality technology. Based on the analysis of various intangible cultural properties of Korea, it was classified into three types of art form, knowledge form, and information form. A method of applying 360 ° VR video, virtual reality, and augmented reality according to the characteristics of classified type is proposed.

As an application example of the proposed method, virtual reality contents for Hansan Mosi weaving, which is listed as an intangible cultural heritage of humanity, was presented.

The proposed contents can be used as one of the programs in traditional culture training centers and may help preserve and vitalize local cultural assets. It is also expected to help attract attention and participation from the public.

VI. ACKNOWLEDGEMENT

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