
A Study on the Plan of Activation of Library by Utilizing the Virtual Reality and Augmented Reality

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ABSTRACT

In this study, in line with the era of the fourth industrial revolution, general concepts, technologies, trends, and examples of virtual reality and augmented reality were examined, and based on this, a plan that could be applied to libraries in the future was proposed. As a result of the study, first, it is necessary to construct a smart space as an experiential play space that can satisfy cultural desires transcending time and space by providing immersive contents using 4th technology such as VR and AR. Second, it is necessary to expand experiential cultural support services through VR, AR and MR. Third, to develop educational contents based on augmented reality technology. In order to apply and activate virtual reality and augmented reality in libraries in the future, based on a survey of librarians and users of public libraries, a survey on the application status, satisfaction, and demand of current public libraries should be conducted.

1. Introduction

The fourth industrial revolution has been discussed with great enthusiasm across almost all areas since it made its appearance at the World Economic Forum in Davos in 2016, and has also rapidly emerged as an essential keyword for responding to the future society. At the advent of the era of the fourth industrial revolution, IT technology has been introduced throughout the society, and all areas are undergoing transformation at such a rapid pace. To adapt to such challenging environment, many have become interested in IT technologies, and hence, relevant fields are undergoing continuous development, which is expected to significantly contribute to the convenience of our daily lives as well as the development of all fields across the society.

Schwab (2016) defined the fourth industrial revolution as “a revolution which maximizes automation and connectivity by digital, artificial intelligence, robot, Internet of Things, Internet of Everything, Big Data, and nano and bio technologies, etc., based on the third industrial revolution, which is

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a digital revolution“ Together with which, it was predicted that the new concepts of physics which take on the characteristics of the ICT convergence, hyper-connectivity, and the super-intelligence (unmanned means of transportation, 3D printing, robotics, and new materials), digital technologies (Internet of Things and block chain technology), and biological technologies (genetics, synthetic biology, and gene editing) would create added values, and an “intelligent information society” will lead the society (Kwon & Koo, 2020). In response to such rapid social changes taking place due to the convergence of intelligent information technologies, relevant ministries led by the Ministry of Science, Technology and Information and Communication of Korea united to devise the mid-to long-term plans and policy tasks in preparations for the intelligent information society (jointly by the relevant ministries in 2017). In the same context, the education sector also set the directions for education for Korea in the intelligent information society, and presented a corresponding strategy.

Examining the current status of the VR service adoption by and for the library sector, while the VR equipments and supplies have recently fell in their prices, they are still expensive to purchase under the library’s budget, and most of the library staffs do not have the programming skills to create VR, AR, and MR softwares, the relevant facts which indicate that they are experiencing difficulties with implementing various introductions (Brigham, 2017; Lee, 2020a). Notwithstanding which, there were many cases where the library's VR service was perceived to have greater advantages (Greene & Groenedyk, 2019), and furthermore, the students who were interested in the VR offered help to the students who came to use the VR service and handled the often recurring technical issues related to the VR, while believing that they can directly utilize or promote this service (Cook et al., 2019).

Accordingly, in this study, the overall concept, trends, and other fields and the cases of the application of library in regards to the virtual reality and augmented reality would be examined in general, and based on which, a plan for the future utilization of library will be sought to be derived.

2. Literature Review

2.1. Previous Studies

Entering the era of the fourth industrial revolution, many related researches have in progress in the field of library and information science as well. It was evident that the studies were in progress in regards to the concepts of various information technologies including the Internet of Things, Big Data, and Cloud computing, domestic and foreign cases of their utilization, future introductions, and the directions of application.

Among which, examining the studies related to the AR the VR, Kwon (2019) conducted a study for investigating the extent of perception and requirements of the college and university students for using the virtual reality (VR) related technologies and contents in tandem with library services, following which, recommended caveats in applying the virtual reality related technologies and contents to the library services, and the details and strategies to consider and prepare them for the libraries.

Further to which, Kwon and Koo (2020) investigated the extent of the perception and requirements which the college and university librarians currently have in regards to the integration and utilization of the virtual reality and augmented reality related technologies and contents with the library services for the purposes of presenting directions for the development and operation of the college and university library services by utilizing the virtual reality and augmented reality (VR and AR) related technology and contents, and based on the results of the investigation, discussed the contents and strategies which ought to be considered and prepared for the program development as well as the matters of consideration for and when applying the virtual reality and augmented reality related technologies and contents to the college and university library services.

Lee and Chung (2020) conducted a research which proposed plans of service improvement via the user evaluation of the college and university libraries which provide the VR services among the domestic college and university libraries, and towards this end, analyzed the types and current status of the library VR services, after which performed the user evaluation via the VR service user surveys and in-depth interviews, while gathering the users' opinions, previous studies, and cases and proposing the plans for improving the VR services.

As such, it seems that the studies related to the libraries based on virtual reality or augmented reality are still in their early phase, and it may also be evident that all of the studies conducted to date have been focused on the college and university libraries.

Accordingly, in this study, the overall concept, trends, and other fields and the cases of application of library for the virtual reality and augmented reality were sought to be examined in general, and based on which, a plan for the future utilization at and for the library was sought to be derived.

2.2. Design and Methodology of the Study

In this study, and in line with the era of fourth industrial revolution, the overall concept, technologies, trends, and cases of the virtual reality and augmented reality were sought to be examined, and based on which, a future plan for application to the library was sought to be proposed.

Examining the detailed research procedures to this end, first, the relevant previous studies were collected and analyzed in order to identify the overview of the virtual reality and augmented reality. Through which, the concept, types, and characteristics, etc., of the virtual reality and augmented reality were identified. Second, based on the papers, reports, policy materials, and collections of cases related to the virtual reality and augmented reality, the concept, technologies, and domestic and foreign industries, technologies, and policy trends were identified, and the cases utilized for each field were investigated to explore the directions for future application for the libraries. Third, the cases applied domestic and abroad in connection with the virtual reality and augmented reality were investigated and analyzed. Based on which, the extent and scope of the current introduction to and for the library were identified. Fourth, based on the contents of the investigation conducted earlier, a plan for utilizing the virtual reality and augmented reality at the domestic libraries was derived. This study is expected to lay a basis for reference when the domestic libraries introduce and utilize the virtual reality and augmented reality moving forward.

3. Methodology

3.1. Applied Technology for the Virtual Reality and Augmented Reality

In recent years, while the interest in the virtual reality (VR) and the augmented reality (AR) has risen very steeply, the mixed reality (MR) has also been added to provide an immersive experience for the users, and the expectations for the service and device market are growing (Yoon, 2019). In the “Top 10 Strategic Technology For 2019” announced by Gartner, the technology for immersive experiences was selected as a key future technology for building the digital business ecosystem of the next generation. In particular, Korea defines the contents combining the virtual reality (VR), augmented reality (AR), mixed reality (MR), and the artificial intelligence (AI) technologies, which are the core technologies of the fourth industrial revolution, as the “New Contents” (Lee, 2019).

Virtual reality is a system and related technologies which build a specific environment, situation, or a virtual scenario of the actual reality through the computer modeling, and which helps the users to interact in such a virtual environment (Im & Seo, 2018). Such virtual reality primarily utilizes a head-mounted display (HMD) which is capable of filling the entire viewing angle of a user with virtual images, and there is also a cave automatic virtual environment (CAVE) which utilizes the projection technology. To improve the immersion amidst the virtual reality, autonomy (capable of responding autonomously to various events and stimuli), interaction (capable of interacting with objects or environments in the virtual reality), and presence (providing experiences of multi sensors and stimuli) are important (Yoo & Kwon, 2019).

Augmented reality means a system and related technologies which provide a virtual information about space and situations by superimposing virtual objects (i.e., objects, texts, and videos) created via the computer modeling in the real environment (Song, 2018). In addition to the HMD, various devices such as smartphones and projection technologies may be utilized, and as a technology which implements an intermediate phase between the real and virtual, continuous frames, it provides the virtual information on a real time basis to the user's real environment (Yoo, & Kwon, 2019).

Recently, it is developing into the concept of mixed reality (MR) or eXtended reality (XR) which combines the strengths of the device-free AR with the strengths of the VR which provides a great sense of immersion (Lee, 2019). Mixed reality (MR) means a new environment where virtual objects which combine the reality and the virtuality coexist, and extended reality (XR) is expressed in English as “XR,” where X means a variable. That is, it encompasses the VR, AR, and the MR, and is also a term which may encompass other forms of reality to emerge in the future.

3.1.1. Core Technologies of the Virtual Reality and Augmented Reality

The difference between the virtual reality and the augmented reality is that, while the former allows one to experience the contents which are disconnected from the real world via an immersive device, the latter presents the contents which are infused with the real world (Yoon, 2019). Recently, as an extension of the augmented reality, mixed reality, where the combination of the virtual world

and the real world becomes even more natural, the technology for maximizing the user's immersive experience is undergoing development.

The core technologies of the virtual reality include the immersion visualization technology, sensory interaction technology, and the virtual reality environment creation and simulation technology, and as for the core technology of the augmented reality, real and virtual images are synthesized and matched to a three-dimensional real space. The sensing and tracking technologies, image synthesis technology, and the real-time augmented reality interaction technology may be selected among the core technologies since it ought to be possible to interact on a real time basis (Kim, 2019).

Table 1. Core Technologies of the VR and AR

Name of Technology	Characteristic
Virtual reality	Immersive visualization <ul style="list-style-type: none"> • Technology providing the users with an immersive virtual reality environment • Visualization device technology such as HMD and the projection, image visualization technology SW
	Immersive interaction <ul style="list-style-type: none"> • Technology corresponding to input and output for virtual reality participants and the system based on the user's five senses • Motion based simulator, virtual reality participant's location tracking, tactile, haptic, olfactory, and taste related technologies
	Creation of virtual reality environment and simulation <ul style="list-style-type: none"> • Technology create a virtual reality environment based on the 360 degree panoramic images or restorations • Scenario based immersive visualization and interactive environment provided for virtual reality participants
Augmented reality	Sensing and re-tracking <ul style="list-style-type: none"> • Technology precisely providing position for virtual objects in real space for augmentation • Developed in a variety of manners such as by using already known information including marker and technology supporting tracking of new spaces such as visuals
	Image synthesis <ul style="list-style-type: none"> • Technology expressing virtual objects consistently with images of real space • Device technology providing augmented reality environment to the users and the technology seamlessly synthesizing images with real space are included
	Real time augmented reality interaction <ul style="list-style-type: none"> • Technology enabling participants to experience augmented reality space via real time interaction with virtual objects synthesized in real space (best example : Pokemon Go)

Source: Restructured "Best Technologies Building the Virtual Reality and Augmented Reality," February 7, 2018, Digital Times

3.1.2 Policies Related to the Virtual Reality and Augmented Reality

As for the virtual reality (VR) and augmented reality (AR) related policies, the main policy status of Europe, the US, China, and Korea are, when examined, as follows.

First, advanced economies such as Europe and the United States have designated VR and AR among the 10 key future strategic technologies, and are actively investing in their research and development. The United States has the best technologies in the field of basic research related to VR and AR, and while private companies are primarily conducting the R&D focused on their commercialization and industrialization, experimental commercialization has also been underway through the various content production supports in the field of virtual training including national

defense. In Europe, countries are promoting a comprehensive plan which encompasses a variety of R&D policies, from basic research to the infrastructure maintenance and commercialization, and through a national research institute, virtual engineering technologies applied for the automobile industry have been developed and applied for the automobile industry such as BMW and Mercedes Benz. Furthermore, VR and AR were selected among the research projects for “Horizon 2020,” and VR was designated among the 9 largest technologies for “Industry 4.0” of Germany. The United Kingdom has invested 58 million Euros in the immersive technology (2018-2019), and tax deductions are provided. To secure leadership of the VR industry, in 2016, the State Council announced the “White Paper on the VR Industry Development,” which specified the current and future policy directions for the VR industry, and announced policies related to the industrial promotion by and for each ministry, thereby creating an environment for the development of the VR industry and leading companies to make their active investments. Selected among the 9 largest strategic emerging industries, digital creative industry was selected, and the R&D investments utilizing VR and AR is stressed, while the VR and AR utilization program undergoing implementation via the 5G industrial development action plan. As for Japan, VR and AR were chosen among the “strategic technologies to usher in the future of 2030,” and a fund of 200 billion won for the public and private sector collaboration is formed via the “VR Techno Japan” policy.

Table 2. Status of the Major Policy Support for the Areas of VR and AR by and at Major Countries.

Country Major Technology Development and Policy Trends	
US	<ul style="list-style-type: none"> • Since the mid-2000s, mixed reality technology has been designated among the “10 core strategic technologies for the future” and invested in, and the R&D centered on private companies such as Facebook, Google, and Microsoft has been in progress. • The US military uses the AR wearable called ‘HUD’ and invests heavily in the AR development, and the US military’s SCENICC project carries out studies of the AR display contact lenses • The U.S. General Services Administration (GSA) introduced VR for the veterans' PTSD treatments
Europe	<ul style="list-style-type: none"> • The EU 7th Framework Program has been devised, and core technologies related to immersive media are undergoing implementation as industry, academia, and research projects, and the government led Fraunhofer IGD has been established to provide support for private companies. • In France, the government subsidized CNC funds provided funding for the AR and VR producers to produce contents jointly with local teams. • Innovate UK, one of the UK government's innovation project, is expected to invest £210,000 in the areas of VR and AR
China	<ul style="list-style-type: none"> • In 2016, the “13th Five Year National Science and Technology Innovation Plan” was announced, and virtual reality (VR) and augmented reality were included among the areas of focus for building a modern industrial technological system to secure leadership. • In early 2017, acceleration of the development of the areas of core technologies including VR, AI, and AR was proposed via the "opinions related to the promotion of the healthy development of the mobile Internet.”

Source: Korea Institute for Advancement of Technology (2017); Yoon (2019)

In the case of Korea, approximately KRW 244 billion of government R&D investments have been made in the areas of VR and AR for 3 years (2018-2020). It was selected among the 13 largest areas of innovative growth engines (December 2017), and the expansion of inter-ministerial R&D investments has accelerated. Following the commercialization of 5G as an opportunity, an

announcement was made on the VR and AR related fostering strategy, and other announcements followed on the 3 largest innovative strategies for the contents industry (September 2019), with the strategy for activating the immersive content industry (October 2019 by the Information and Communication Strategy Committee), and the Pan-Government Immersive Contents Policy Council was formed and has been in operation.

In August 2020, a phased-in regulatory innovation roadmap was devised to predict the technological development of the VR and AR and the scenario of service application and expansion by sector (jointly by the ministries, 2020b). In terms of the usability (interface) and the system advancement (platform, intelligence), the evolutionary direction for the VR and AR technology was derived into 3 stages.

Table 3. Status of the Major Policy Support for the Areas of VR and AR by and at Major Countries.

Classification	Phase 1	Phase 2	Phase 3
Year	2020~2022	2023~2025	2026~2029
Usability	Visual and auditory centric	Expression and Haptic input and output	Five senses and brain input and output
Platform	Single use	Multiple use (remote collaboration)	
Intellectualization	Unilateral acceptance of contents		

Source: Jointly by the relevant ministries (2020)

As for the major fields of application following the technological development and commercialization, 1) entertainment and culture, 2) education, 3) general industries such as manufacturing, 4) transportation, 5) medical care, and 6) public (security, fire, and defense) were derived. First, the field of entertainment and culture was consisted of rht 5 tasks of the rationalization of virtual reality (VR) motion simulator’s conformity evaluation, relaxation of the virtual reality (VR) simulator scale standards for the expansion of installation in the downtown, and the improvement of the facility standards for the video viewing provision business to provide virtual reality (VR) movies, respectively. Second, the area of education was consisted of the 5 tasks of the preparation of the guidelines on the use of virtual and augmented reality (VR and AR) devices and contents for the area of education, relaxation of the restrictions on the use of the online networks and platforms in schools, and the improvement of the digital textbook review system. Third, the general industrial areas such as manufacturing was consisted of the 5 tasks of the preparation of the standards on the utilization of the virtual and augmented reality (VR and AR) utilized remote safety inspection and examination, preparation of the standards for the data collection and use from the site, and the preparation of highly sophisticated technology and training device standards and guidelines. Fourth, the area of transportation was consisted of the 2 tasks of the expansion of the types of video display devices (wearables) and the preparation of the safety technology standards for video display devices such as HUD and smart glass. Fifth, the area of medical treatment was consisted of the 4 tasks of the establishment of the virtual and augmented reality (VR and AR) medical device items, and the utilization of the augmented reality (AR) for the contactless medical treatment

service for the expatriates overseas. Sixth, the area of public service (police, firefighting, and national defense) was consisted of the 4 tasks of the preparation of provisions on the use of augmented reality (AR) for the police work, and systemic development for the safe utilization of the national defense data.

Through which, and based on the expansion of the VR and AR, they seek to build a contactless social and economic system early, and take a leap towards a powerhouse for the immersive contents, while further expanding the immersive contents market and pursue the development and growth of the immersive contents specialized companies economically, and further advancing the contactless and hyper-connected society and building a stable infrastructures even in the event of national emergencies and crises such as pandemics.

3.1.3. Trends in the Virtual Reality and Augmented Reality

Immersive contents are utilized as a tool for innovations across the economy and society, thereby creating the newly added values (Lee, 2020c). It is expected that the immersive contents will also contribute to the economic growth as the era of popularization in which immersive contents are utilized for personal lives and industries has advented.

In the case of the overseas, and in terms of investments, major countries including the US, European Union, and China have established and are pursuing the national VR and AR development strategies, and the privately led investments in the area of devices is making progress very aggressively. Facebook has invested approximately 600 billion won or more in the VR since acquiring Oculus in 2014, while HTC officially announced that it will stop developing smartphones, and instead, will focus on the VR devices. In terms of the products, companies such as Facebook (the US) and HTC (Taiwan) are launching their 2nd and 3rd generation products for the VR, and the high performance and multi-functional MS 'Hololens2' product best represents the AR. Furthermore, the small and medium-sized startups are developing the AR devices, specializing in the demand by industry (manufacturing, medical care, and sports, etc.).

In terms of dissemination, the products are released and distributed primarily by the large companies capturing the market. For the VR, Oculus and HTC are pursuing the strategies to further grow their market share in conjunction with related platforms (Facebook and Steam, etc.). While for the AR, Microsoft is executing a B2C strategy targeting companies of the areas of demand including the industries, manufacturing, and national defense, and Nreal, etc., have pursued their strategies of targeting the real life consumers. As for the limitations, various products are released overseas, yet there exist difficulties in expanding the devices given such issues as the gap with consumer needs and the lack of relevant contents.

In the case of Korea, the "5G+ Strategy for the Realization of Innovative Growth" was announced with the goal of securing global leadership for the 5G based new industries and of realizing a leading country for the fourth industrial revolution by integrating 5G for both Korea's economy and society (Beom, Kim, & Kim, 2019). Based on the maximized immersion and realism, the immersive contents, which have emerged as high performing contents for the 5G era, were selected among the top 10 largest industries even for the "5G+ Strategy for the Realization of Innovative

Growth.”

In terms of the investments, the government has endeavored to focus on fostering the immersive contents industry by taking advantage of the world’s first commercialization of 5G (April 2019) as an opportunity, however, investments in the area of devices are yet insufficient. In terms of the products, Samsung’s VR devices, “Gear VR” and “Odyssey+” etc., are the sole products released in the market, however, the additional development plan is yet unclear even for them, and hence, the reliance on foreign products has intensified. There are some cases of the AR development such as the “Pin Mirror” glasses of the optical system company called Retinal, and the development of the AR device for cancer surgery (2020). However, there are currently no domestically finished products in the market. In terms of the distribution, the device market is yet immature, and the products and related investments in the market have been minimal at best, and hence, they are entirely dependent on the foreign products. In Korea, the growth of the area of devices continues to be stagnant due to such issues as the lack of investments, lack of market launched products, and the low consumer interest and perception.

Recently, as “contactless” has emerged to be important since the expansion of COVID-19, the demand for contactless services including video conferencing and remote education linked with the VR and AR devices has exploded. Spatial, a US company dedicated to the VR and AR collaboration platform development, announced that the use of related solutions, such as the augmented reality meetings, has grown by over 10 times due to COVID-19. It is also possible to realize the large capacity and high quality contents by utilizing the ultra low latency characteristics, along with the production of high performance and ultra light devices by utilizing 5G edge Cloud since the advent of 5G. In the case of Korea, the “5G MEC Test Bed’ (2020-2022, Pangyo, NIPA) which performs functions such as providing the 5G MEC test network and infrastructures is undergoing development.

4. Results

4.1. Cases of the Application of the Virtual Reality and Augmented Reality

4.1.1. Cases of the Application by Area

Visual Capitalist, which is a global market research institute, presents the scope of future application of the AR and VR technologies by classifying them into the industrial and consumer aspects. From the industrial aspect, the utilization is expected to grow in the order of medical care, manufacturing, and defense, respectively, and from the consumer aspect, it is expected to develop with a focus on the entertainment such as games and movies, followed by the utilization in and for the areas of medical treatment and distribution. The cases of application of the virtual reality and augmented reality domestic and abroad, when classified into and examined as the ① area of entertainment, ② area of manufacturing industry, ③ area of education, ④ area of medical treatment, and the ⑤ area of transportation, etc., are as follows (Lee, 2019).

1) Field of Entertainment

By combining the 5G communication technology and sensor technology which recognizes precise movements, the AR and VR games are developing into the games which may be enjoyed with the 5 senses beyond a simple provision of visual pleasures. Lotte World VR Theme Park is expected to be converted into a highly advanced theme park utilizing the virtual reality and augmented reality technologies for the theme parks, water parks, aquariums, kids' parks, and observatories. The New York Times has developed the NYT VR, a VR contents platform, and is making its transition from the reading media to the visual, auditory, and experiential media.

2) Field of Manufacturing Industry

In the manufacturing sector, following the utilization of the AR and VR technologies, the product design, manufacturing environment, and the purchasing methods have changed. Designers and engineers can virtually create exteriors and test real products in a virtual space without the need to create multiple models, thereby saving much time, energy and costs. Furthermore, as the AR and VR technologies are integrated with the product manuals, the users can check in the product manuals with a sense of realism with their smartphones. MAXST, a Korean AR source technology company, already developed a Hyundai Genesis vehicle manual application in 2016. Through which, the consumers can examine the inside of the vehicles and engine rooms, while rotating the camera 360 degrees, and can also check the information on the maintenance methods through the three dimensional simulations.

3) Area of Education

It has emerged as an innovative technology for and in the area of education in terms of the increased reality in education and learning, replacement of high risk and high cost, and the safety and efficiency secured.

As for the case for the elementary education, the VR and AR contents are provided, such as life in the past, unfolding courses of wars, principles of natural phenomena, and space exploration in the social studies and science subjects, and a program of conducting virtual experience across famed regions of the globe by utilizing Cardboard, a low-cost VR device developed by Google. As for the case of the junior high and high school education, there are situational experience where it is difficult or dangerous to experience the real world in a virtual space blocked away from the real space through the VR, and the utilization of the AR for the basic programming subjects, among others. As for the cases of the college and university education, the VR Educational Library of Hanyang University developed and distributed the VR educational contents which may be simulated for safe and various experiments, and developed a "virtual dissection table" by utilizing the 3D technology to place organs such as heart or stomach and kidneys in the air at will, allowing them for observation.

4) Area of Medical Treatment

While the market share of the area of medical treatment is yet small among the AR and VR applications, it is a rapidly growing area, and is also primarily utilized to treat such mental disorders as trauma. The Alzheimer's Research Institute of the United Kingdom utilizes the AR and VR contents to educate caregivers for the Alzheimer's disease patients, thereby allowing them to experience what it is like to suffer from Alzheimer's via the virtual experience. Emery Care of the UK is utilizing the VR to provide treatments to help reduce stress and anxiety by showing 3D images of places they have often visited in the past or memories they want to retain. Neurable of the UK plans to develop a VR headset which is capable of manipulating movements by using the brain waves, and is expected to be used as an assistive device for the users with movement disorders such as the patients of cerebral palsy. Samsung officially announced (2018) "Relūmīno," an application dedicated for the Gear VR for the users with visual impairments, providing an environment where the visually impaired can see the screen with clarity.

5) Area of Transportation

Its utilization is expected for the area of transportation as well. Oppo, a Chinese smartphone manufacturer, uncovered the first AR walking navigation system in China in 2018, which is a service by which a virtual character guides the user in the real world by combining the location recognition and the map generation (SLAM) technologies based on the GPS, mobile phone camera, sensors, and the artificial intelligence (AI). Furthermore, as the AR pathfinding service, Korea piloted the AR pathfinding service during the 2018 Pyeongchang Winter Olympics. The navigation app "AR Waze" has the indoor spatial information and precision positioning technology applied, and hence, the user can check the routes of the major Olympics related facilities through the AR by displaying guidance signs on the real road on the smartphone screen.

Table 4. Cases of the Major Utilization of the AR and VR by Area

Classification	Cases of Utilization
Entertainment	<ul style="list-style-type: none"> • From watching to experiencing in such areas as games, movies, theme parks, and sports, it evolved from experiencing alone to participating by multiple people at the same time.
Education	<ul style="list-style-type: none"> • Training in dangerous environments such as medical practice and sites of fire
Transportation	<ul style="list-style-type: none"> • Pathfinding app such as AR Ways utilizing location recognition and map generation (SLAM) technology
Medical treatment	<ul style="list-style-type: none"> • Education for the Alzheimer's patient caregiver • Utilized as an assistive device for the visually impaired and motor impaired patients
E-commerce	<ul style="list-style-type: none"> • Virtual shopping mall and automated payment system : Payscout and Amazon, etc.
Customer service	<ul style="list-style-type: none"> • Service is provided to enhance customers' shopping experience and convenience for consumers • Kimberly-Clark and Farmers Insurance Group, etc.
Manufacturing	<ul style="list-style-type: none"> • Utilized for the areas of product testing, assembly, repair and monitoring • Ford Motors and Hyundai Motors, etc.
National defense	<ul style="list-style-type: none"> • Used for military training





Source: Lee (2019)

4.1.2. Cases of Application for the Area of Library

1) Cases of Application for the Virtual Reality of Library

Most of the services at the library are the rental services related to the virtual reality and augmented reality, such as Oculus Rift VR Simulators, HTC Vive, Samsung Gear VR, and Microsoft HoloLens. Some of the libraries also provide virtual reality exhibitions which satisfy the five senses by utilizing the virtual reality devices. Bibliothèque et Archives nationales du Québec (BAnQ) provides the virtual reality exhibition by utilizing the virtual reality devices, which, as part of a project called “The Library at Night (La bibliothèque, la nuit)” led by BAnQ, provided services for the users to experience 10 libraries around the world with the virtual reality devices. Furthermore, public libraries and university libraries are utilizing the VR in terms of education (Kim et al., 2017).

Table 5. Virtual Reality and the Reading Activity

Book	Experiential Activities
	<ul style="list-style-type: none"> • In the software (SW) education of a new concept integrating VR and coding, basic education including coding theory, coding basics, and scratch basics is provided, and a program is produced by using scratch based on children's books where scratch practice is completed. • Create your own children's book based on Scratch and link it with VR Wear School to create virtual reality children's books.
	<ul style="list-style-type: none"> • Books are evolving beyond e-books towards VR books. • Hyundai IT&E released new VR contents based on the best-selling novel of "The Little Prince" at VR station. • The "Little Prince" VR is characterized by gaining experience of main scenes in the novel as the protagonist via VR.
	<ul style="list-style-type: none"> • The Fraser Valley Regional Library (FVRL) has disclosed an interactive VR novel entitled "Inanimate Alice: Perpetual Nomads" at 3 libraries of Delta, Mapleridge, and Abbotsford since November 2018. • In VR novels, sound, image, text, and game functions, etc., become important factors for attracting the users. • The main focus of this project is that, the users can be immersed in the story, the novel may be very useful by unfolding and transforming like a landscape in VR, and it is also possible to create and explore an infinite fantasy environment directly.
	<ul style="list-style-type: none"> • VR Book Reader (alpha) is a web based application enabling one to read digital books in a beautiful and immersive VR environment. • This app enables uploading books and enjoying reading in a VR environment.

2) Cases of Application of the Augmented Reality for Library

The “Experiential Fairy Tale Story,” which is installed at 39 national and public libraries, including the National Children’s Library, provides learning via experiential learning by blending live videos of the learners with the virtual worlds such as other countries or worlds in the fairy tales. Furthermore, the augmented reality based educational contents are in service, and the cases of utilization of

the augmented reality for reading are as follows.

Table 6. Augmented Reality and the Reading Activity

Book	Experiential Activities
	<ul style="list-style-type: none"> • The series of "Moshi Monsters : Color Alive" transforms everyday coloring books into a completely user definable action game of augmented reality. • Each book provides personalized AR experiences, and Incredder Books characterizes conversation type activities related to each plot, focusing on colors, shapes, words and numbers.
	<ul style="list-style-type: none"> • Library Ideas introduces Immersive Reality Books, which is a new line of the children's non-fictions featuring integrated virtual reality (VR) and augmented reality (AR) contents. • The AR and VR contents operate by opening the app and scanning the QR code inside the page, offering the users the option to view VR contents even without a headset, allowing for an interactive 360° view of the conversion type for the screen
	<ul style="list-style-type: none"> • '3D Interactive' developed by Metaio of Germany • When the camcorder is lit indoors in the air, the display shows the car against the indoor environment, allowing one to see the exterior as well as the interior of the car as in reality, i.e., when children's book is opened in front of a display equipped with a webcam, the main characters of the storybook move while talking on the 3D screen inside the screen
	<ul style="list-style-type: none"> • The AR technology based interactive book released by Woongjin Think Big is characterized for providing three-dimensional reading in augmented reality communicating interactively by stimulating both auditory and tactile senses. • When dedicated teaching aid and book are connected, the character's voice is audible, manipulating the 360-degree rotating 3D image, and enjoying reading in three dimensions.
	<ul style="list-style-type: none"> • In 2015, "Smart," a startup producing convergence and complex contents in Korea, introduced a service and teaching materials (AR coloring book) integrating augmented reality technology to coloring books. • Coloring books are utilized as one of the art educational methods used to prevent Alzheimer's for children as well as senior citizens as it is effective in learning the structure of objects and synesthesia by coloring uncolored pictures, and is also effective in developing fine muscles such as fingers. • When the user recognizes QR code with a smartphone after coloring the paper on which the character is drawn, the character comes to life on the smartphone screen.

In addition, examining the cases of the AR and VR based application of library, there are the virtual library tour service, library information service experience via the virtual reality and augmented reality, and the augmented reality program which allows the users to experience the world renowned tourist destinations.

Table 7. Domestic and Foreign Cases of the AR and VR Based Application of Library

Classification	Service Applied	Library Applied	
Domestic	Virtual reality	Virtual library tour service Library information service experience via virtual reality and augmented reality	The Academy of Korean Studies Sungkyunkwan University, The National Library of Korea at Sejong
	Augmented reality	Experiential storytelling program provided where a large screen projects children in various backgrounds in fairy tales in a virtual space, offering a sense of reality in touching the background and where joyful experiences may be gained along with the background	The National Library of Korea at Sejong, National Library for Children and Young Adults, Central City Library of Wonju, etc.
		Augmented reality program provided to enable traveling and taking photos of famous destinations around the world at the information technology experiential room	Mapo Central Library
Abroad	Virtual reality	Virtual reality exhibitions provided by utilizing Oculus' Rift VR Simulators and Samsung's Gear VR devices The Library at Night's virtual reality tour project	Bibliothèque et Archives nationales du Québec (national / Canada), The University of Adelaide Library (university / Australia), etc.
	Augmented reality	Microsoft's HoloLens - augmented reality device rental service provided	NC State University Libraries (university / US)

Source: The National Library of Korea (2017); Kim et al. (2017)

5. Discussion

The modern society may be summarized into the 3 categories of hyper-connection, hyper-convergence, and super-intelligence, and the core major technologies may be seen to be the artificial intelligence, Internet of Things, cloud, Big Data, robots, and the VR and AR, respectively. Recently, as “contactless” has been highlighted since the expansion of COVID-19, the demand related to the contactless services including video conferencing and remote education linked with the VR and AR devices has exploded. In particular, it has emerged as an innovative technology for the area of education in terms of increased reality, replacement of high risk and high costs, and the safety and efficiency secured for education and learning. It enhances the educational effect by allowing the learners to immerse themselves in the contents of learning and induce the proactive and active learning, as well as accumulate the contents of learning (Beom, Kim, & Kim, 2019).

Currently, the utilization of the “virtual reality and augmented reality” devices and the “wearable” devices in domestic and foreign libraries is still in its early phase (The National Library of Korea, 2017). In the case of Korea, as a type of experiential learning system using the augmented reality, the experiential storytelling programs are provided to stimulate the children's interest in reading, and in the case of foreign countries, the users are provided with exhibitions or field trip programs utilizing the virtual reality devices, or with experiential spaces where they can make or rent wearable devices themselves.

According to the AR and VR related perception survey of the National Library of Korea (2017), it turned out that the group of librarians demonstrated a high interest in the services for which new technologies are applied (70%) in connection with the services they desired to implement or provide at the library. The technologies which the librarians selected to be applicable for their work were identified to be the artificial intelligence (AI), Internet of Things (IoT), and robots, and the technologies of interest to them were identified to be the 3D printing and the VR contents. It is intended to propose a plan for the application of library utilizing the AR and VR in the future.

1) Installation of Space for the Virtual Reality and Augmented Reality

By providing the immersive contents by utilizing the fourth technology such as the VR and AR, it is possible to provide an experiential space of play which may transcend the time and space and satisfy cultural desires.

As a related case, McGill Library installed a space for the virtual reality and augmented reality at the Humanities and Social Sciences Library in 2017. This space provides support for the various research projects on campus, and may be used by all of the faculties, professors, and the students of the university. Various educational media and softwares based on the virtual reality and the augmented reality are provided for free of charge. The users may select the equipments (HTC Vive or Microsoft HoloLens), time, and the date to use via McGill Library's reservation service, and the users can arrive 15 minutes before the reserved time and listen to the rules of the equipment use, then use them. As such, the largest advantage of the virtual library within the virtual reality is that, it actively introduces the advantages of digital, and creates an environment for not only reading but also for the book immersion.

Such an environment enables more people to immerse themselves in reading regardless of age and location. Furthermore, the augmented reality provides the immersive information via the three-dimensional three-dimensional objects of 3 dimensions which provide support for such various senses as the virtual reality. The characteristics of the augmented reality, which naturally connects the real world and the virtual world, enhances the effect of learning by maintaining the environment of the real world. This may be expected to have an effect beyond a simple acquisition or understanding, and a more natural interaction may be expected.

2) Expansion of Support Services for the Experiential Culture via VR, AR and MR

The experiential cultural support services via the VR, AR, and the MR ought to be expanded. They are already utilized across many industrial areas, and can also build tourist destinations, historic sites, and museums, etc., in the 3D virtual reality and provide the users with indirect experiences similar to those of the actual visits made. As for a related case, a game developed by Nintendo called “Pokemon Go” is a representative one, and the experiential storytelling which is currently in progress for children at many libraries in Korea is the augmented reality technology by which the children's real faces are projected into the fairy tales.

As for the service which the library can provide in the future, there are the space where the users can directly touch and experience the heritage of the past by reproducing the archives of ancient documents in a virtual space and providing old documents and rare books as for the immersive contents, space where the users can experience global cities or historical sites, where they have not usually been to, by reproducing them in a virtual space, space where the users can directly experience famous concerts, performances, and shows, and the virtual space where the users can satisfy their artistic needs such as science experiments, music, and art.

3) Development of Educational Contents Based on the Augmented Reality Related Technologies

It is necessary to develop the educational contents based on the augmented reality technologies. The augmented reality technologies have such a great advantage for the educational contents more than adequate to be considered as an educational revolution. Opening a book, run the augmented reality app on the smartphone, and shoot the book with the smartphone’s camera, then the videos and stories related to the contents may be played and displayed on the smartphone in various forms (Han et al., 2018). Accordingly, the library ought to continuously monitor and introduce various contents for the VR and AR, and it is also required to enhance the manpower and the administrative resources to plan and promote them.

4) Considerations for the Application of Library

As for the matters to consider if and when applying the AR and VR technologies within the library, there are the 1) lack of devices, 2) lack of contents, and the 3) security problems. First is the lack of devices. In the case of VR, a “head mounted display (HMD),’ or a dedicated device, is required to enjoy the contents, and most of the HMDs are expensive, and hence, it is expected that there will be difficulties in purchasing them for and by each library. In Korea, the growth of the area of devices is stagnant due to such issues as the lack of investments, lack of the market released products, and the low consumer interest and perception. Second is the lack of contents. The lack of contents is a chronic problem for the areas of AR and VR, and even with devices, various contents to provide to the users are inadequate. The utilization of the AR and VR at the library is still in its early phase, and the AR and VR contents which the library may provide are very limited at best. Third is the issue of security. The AR and VR technologies enable the users to continuously collect information while in motion, and hence, there is a risk of the personal information leakage, copyright infringement, and the security related problems due to the acquisition of information. Beyond which, the location, weight, mobility, convenience, and the usability due

to the operation of devices are have much declined, and since there are health issues caused by cyber sickness and the issued caused by excessive immersion, which ought to be considered.

6. Conclusion

In this study, the overall concept, trends, and other areas and the cases of application of library for the virtual reality and augmented reality are sought to be examined overall, and based on which, it is sought to derive a plan for their utilization for and at the library in the future.

Currently, at the libraries domestic and abroad, the utilization of the “virtual reality and augmented reality” devices and the “wearable” devices is still in its early phase (The National Library of Korea, 2017). In the case of Korea, as a type of experiential learning system using the augmented reality, the experiential storytelling programs are provided to stimulate the children's interest in reading, and in the case of foreign countries, the users are provided with exhibitions or field trip programs utilizing the virtual reality devices, or with experiential spaces where they can make or rent wearable devices themselves. According to the AR and VR related perception survey of the National Library of Korea (2017), it turned out that the group of librarians demonstrated a high interest in the services for which new technologies are applied (70%) in connection with the services they desired to implement or provide at the library. The technologies which the librarians chose to be applicable in their work were identified as artificial intelligence (AI), Internet of Things (IoT), and robots, and technologies of interest were identified as 3D printing and VR contents. The technologies which the librarians selected to be applicable for their work were identified to be the artificial intelligence (AI), Internet of Things (IoT), and robots, and the technologies of interest to them were identified to be the 3D printing and the VR contents. It is intended to propose a plan for the application of library utilizing the AR and VR in the future.

Accordingly, first, it is necessary to provide an experiential space of play which may transcend the time and space and satisfy cultural desires by providing the immersive contents by utilizing the fourth technology such as the VR and AR. Secofnd, the experiential culture support services must be expanded via the VR, AR, and the MR. Third, the augmented reality technology based educational contents ought to be developed.

To apply and activate the virtual reality and augmented reality of the library in the future, and based on the survey targeting the librarians and users of public libraries, the current status of application for the public libraries, level of satisfaction, and the suvey of demand, etc., ought to be conducted.

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