

A Study on Training Contents Using Virtual Reality Technology

¹ Jung Un Jang, ^{2*} Jae-Young Jang

¹Professor, Department of Optometry, Eulji University, Korea

²Professor, Department of Optometry, Eulji University, Korea

Abstract

Smart health care is an industry that deals with information, devices, systems, and platforms on personal health and health care, including services that incorporate personally-owned, portable, wearable devices, and health care services, which are key technologies of the recent fourth industrial revolution. Recently, medical and healthcare have been in the spotlight as an application of virtual reality. This study aims to develop a virtual reality content and present a model suitable for providing a more efficient vision training content service in virtual reality. The study used HTC VIVE hardware to implement eye training content, and Maya and Unity 3D game engines to create the virtual environment and virtual objects. Five training contents were suggested, and it is thought to be used as basic data for training contents in the virtual reality space according to the change of the times.

Keywords—Content Platform, Health Care, Content, Virtual Reality

1. Introduction

Virtual Reality is a technology that makes people interact with real surroundings without experiencing an environment that is difficult to experience daily. Previously, it was used as a surgical practice, and tank and aircraft pilot training aircraft pilot training. Now, HMD-type mobile devices for head-mounted devices that can conveniently enjoy virtual reality content have been applied in various fields [1]. Creating a new virtual reality-based industry that combines virtual reality with various fields to provide new experiences has accelerated and expanded into a variety of fields, including defense, manufacturing, games, tourism, sports, and broadcasting, and is emerging as a driving force for creating a value-added industry [2-5]. Recently, medical and healthcare have been in the spotlight as an application of virtual reality. This technology is emerging as an alternative to fostering medical experts and psychotherapy to respond to increased demand for medical services such as psychological diseases caused by the aging era and intensifying competition. It is a technology that creates similar perceptions and makes people feel as if they exist elsewhere, and in the U.S. and Europe, treatment using virtual reality is applied to cognitive behavior therapy for patients with social anxiety, flight phobia, and conversational phobia. This is expanding its scope of application to all medical areas such as surgery, treatment, and rehabilitation, away from the limited use of virtual reality for trauma treatment [6-8]. It enables training by implementing virtual patients and allows medical staff to plan and pre-test before surgery. This is because one medical team can respond to a number of medical services demands by using virtual reality technology for psychotherapy and rehabilitation therapy, which is one-on-one face-

to-face treatment. It also has developed into a realistic content field along with augmented reality content. It is forming a virtuous cycle of infrastructure, devices, and content/application [9]. However, the research on virtual reality vision training contents is still insufficient. Therefore, this study aims to develop a virtual reality content and presents a model suitable for providing a more efficient vision training content service in virtual reality.

2. Literature Overview

This technology is applied as an advantage of virtual reality healthcare, it can improve productivity and increase value added medical services. Virtual reality simulation, which can be reproduced close to actual human organs, can save human bodies, organs, medical equipment, etc., required for medical students or training, and improve efficiency by utilizing surgical surgery, psychiatry, and rehabilitation among other medical services and procedures. Using virtual reality, it is possible to examine and reproduce the causes of diseases or disorders in a safer and more controlled environment, to facilitate the connection of absolute vision and brain in the human cognitive structure, and to increase the therapeutic effect by adding game elements. In the health care field, it is actively applied in the field of medical education, overcoming various phobias and physical rehabilitation programs, and in the field of home medical devices. It is effective for people who are unable to move or move freely due to disability or old age, because it is a passageway to the outside world for them. Robotic surgery can also be performed with it, decentralized patient management is also very useful, and virtual reality applications are being designed to learn about patients and examine patients in the same way as healthcare workers.

2.1. Medical field

The use of VR in the medical field is widely used as an aid to doctors, to reduce stress for patients, as a learning tool for medical students, and for training and simulation of medical personnel. Medical and healthcare workers can obtain useful information before directly operating on the human body by using a real virtual environment or a virtual model of the human body. In addition, it is possible to obtain useful information before performing the procedure directly on the human body, and it is necessary not only for learning purposes, but also for skilled medical personnel who perform high-risk surgery. The spatiality, real-time interaction, and self-transmitting elements of virtual reality can be involved in perception, consciousness, and behavior, so they are being introduced in imaging diagnosis, foreign science, and rehabilitation medicine. Distraction therapy using virtual reality medical video games for pain management of burn patients has been proven effective. It relieves side effects and pain by allowing cancer patients to experience cancer treatment in advance through virtual reality, and virtual reality-based robot rehabilitation is more effective than conventional treatments in stroke patients and is also used to manage Alzheimer's disease and attention deficit hyperactivity disorder (ADHD). Modeling, diagnosis and surgical practice of 3D human organs are possible, and virtual reality is used for surgical operation education and training through 3D virtual surgery simulator, which can simulate the patient's surgical field freely [11-14].

2.2 Psychological Training Field

Virtual reality is a technology that creates a sense of presence in space by giving the brain a pseudo-perception. By building such virtual spaces according to the characteristics of psychosis, difficult experiences can be achieved in the space. Virtual reality therapy is emerging as a new mechanism for treating mental disorders. In the areas of Generalized Anxiety Disorder (GDA), Obsessive-Compulsive Disorder (OCD), Social Anxiety Disorder (SAD), Panic Disorder, Agoraphobia, Posttraumatic Stress Disorder (PTSD), and Body image disturbance (BID), research using VR was conducted [15-18].

2.3 Ophthalmology Field

Various surgeries can be simulated through virtual reality. There is no risk that the patient has when using the simulator to perform surgical training, and it can be performed whenever necessary, regardless of the operating room situation or the patient situation, and objective evaluation and effective feedback on the technique are possible in the field of ophthalmology. In the eye field, cataract surgery training is the most common virtual reality-based simulator, and reports on its effects are the most common, and virtual reality is also used in various eye examination exercises. There have been reports of increased proficiency through direct examination training using virtual reality [19,20]. Although there is not much research yet on eye examination using virtual reality, studies on visual field examination are often reported. Development of a visual inspection device using fast-threshold 3 dB step staircase algorithm for 24° field of view and its test was conducted on glaucoma patients. A full 30-2 threshold test and a suprathereshold test were conducted using smartphones, Samsung Gear virtual reality, and controllers. Moreover, virtual reality simulates the evaluation of visual disability in clinical care by providing clinicians a new perspective to understand how visual impairment imparts vision-related disability in patients with glaucoma [21,22]. In addition, if you attach an eye tracker to the HMD VR and look at the flashing visual stimulation instead of pressing the button, the eye tracker reported a visual inspection of the eyeball position to measure if it saw it correctly. In addition to visual inspection, eye exercise tests can also be performed with virtual reality, and studies have also been reported on dichoptic training, which stimulates ambivalence to pharmacotherapy [23,24].

2.4 Vision Training Field

It is normal for our eyes to clearly recognize an object and both eyes to see it as a single object. In order to see an object normally, the eye must be able to see it while feeling a stereopsis effect while recognizing it as one by combining the left and right eyes with the function of accurately recognizing the object. This function is called the visual function. The visual function includes accommodation that focuses on an object to see clearly, and vergence movement and eye movement, in which both eyes cooperate with each other to see as a single image. Dysfunctions and abnormalities may cause objects or letters to look blurred (blur), look like two objects overlapping (diplopia), tremulous afterimage (after image), and monocular vision without using binoculars.

Vision dysfunction means that there is no physiological abnormality in the brain, including the eyes, but a dysfunction. If there is such an abnormality in vision function, it is difficult to concentrate and read the book during learning, and comprehension may decrease, which may negatively affect the

learning of school-age children. Visual training is aimed at acquiring comfortable and stable binocular vision by alleviating these symptoms and visual function. To this end, through training, visual skills are developed or improved, and visual information can be viewed comfortably, easily, efficiently, and methods of processing or interpreting visual information are improved. The most practiced training for people with visual impairment is vision function training [25]. Visual training normalizes, improves, and reinforces abnormal movements by forming feedback through repetitive training of muscle strength. It is a non-surgical method among the treatment of vision dysfunction, eye movement disorders, and binocular dysfunction, accommodative dysfunction, vergence dysfunction, and amblyopia. This training is conducted by orthoptist and is conducted as an individualized program according to individual vision function requirements. It is difficult for the public to use vision training tools such as special lenses alone without the help of experts, and it is not easy without patience. Up to now, visual training has been progressed by using traditional training tools by orthoptist (subjective training) and a home therapy program method using a computer (objective training) [26]. Subjects requiring visual training are based on a comprehensive eye function test and a College of Optometrists in Vision Development-Quality of Life questionnaire (COVD-QOL) score. In general, the training program suitable for the subject is selected and conducted, and the software can be performed by the subject using a computer at home. Traditional vision training tools are used in various ways depending on the programs used, as shown in Table 1. The vision training specialist considers the advantages and disadvantages to each training method when using these tools and methods and conducts appropriate training for those who complain of symptoms. The software, Home Therapy HTS, is an automated program that can be carried out at home to improve vision. This program is designed to arouse the subject's interest while the program automatically adjusts its steps according to training performance. Several studies have been published on the effects of vision training program and its uses [29].

Table 1. Classification of Traditional Vision Therapy Instrumentation and Procedures

| Criteria | Instrumentation and Procedures |
|--------------------------------|--------------------------------|
| Stereoscopes | Brewster stereoscopes |
| | Wheatstone stereoscopes |
| | Haploscopes |
| | Cheiroscopes |
| Anaglyphs and Polaroid filters | Tranaglyphs |
| | Vectograms |
| | Bar readers |
| | TV Trainer |

| | |
|--|---|
| | Computer programs using red/blue or red/green glasses |
| Lenses, Prisms, and Mirrors | Flip lenses |
| | Loose lenses |
| | Flip prisms |
| | Loose prisms |
| | Prism bars |
| | Hand-held mirrors |
| Septums and apertures | Aperture Rule |
| | Remy Separator |
| | Task base on Turville test |
| Paper, pencil, and miscellaneous tasks | Lifesaver cards |
| | Free Space cards |
| | Eccentric Circles |
| | Barrel card, Three-Dot card |
| | Brock String |
| | Computer techniques |
| | Hart Chart other miscellaneous charts |
| | Letter Tracking |
| | Tracing |
| Afterimages, Entoptic Phenomena, and | Devices for creating after image |
| | Maxwell's spot |

| | |
|---------------------------------|----------------------|
| Electrophysiological techniques | Haidinger's brush |
| | Auditory biofeedback |

We suggest to use the content of virtual reality that enhances its effectiveness while simplifying the visual function training which is a familiar culture in the current society. Amblyopia training contents using virtual reality have been developed in various ways and used in the field and are used for examination in the ophthalmology area and for surgical training of ophthalmologists. However, virtual reality training programs for people with visual impairment are inadequate, and thus, we intend to propose contents and programs that are possible in virtual reality so that the subjects can be safely trained using virtual reality even in COVID-19 situations. In this study, we tried to make the principle of the existing traditional vision training tools and methods and use its contents to be able to train in virtual reality of binocular dysfunctions. This study proposes a new program that includes the content of vision training in virtual reality among who need training using pencils and paper when they show symptoms of binocular dysfunctions.

2. Method

2.1 Virtual Reality Framework

In this study, virtual reality content basically consists of head mounted display (HMD) virtual reality (VR) equipment, virtual reality content that can be experienced through equipment, controllers to receive input from users, and auxiliary sensors. It uses HTC VIVE products such as HMD VR devices. The specifications of the HTC VIVE used in the study are as follows; Resolution: 2880X1600, Frequency: 90Hz, Visibility Angle: 110°, Sensor: Inter pupil distance sensor, Eye Tracking, Gyroscope. Controllers that receive input directly from the user are HTC. It uses a basic controller for VIVE products. As an auxiliary sensor, a station based on a lighthouse sensor was used as an equipment to recognize the location of HMD VR devices. We implemented the virtual reality content used in this study's experiment using the unity physics engine. Unity 3D has the advantage of being used on multiple platforms and has a very intuitive graphical user interface. In a virtual reality environment, the number of frames per second (FPS) is very important. If the FPS is low, the screen does not move smoothly and may cause problems such as dizziness on the user, so it was set to 70 FPS and over to implement the training content. Virtual reality content blocks the view all around and provides only a completely new space created by developers.

2.2 Planning

Based on the principles of training using pencils and paper among traditional training methods, the creation of content can be trained while maintaining interest in virtual reality space. Pencils and training methods are designed to train vergence, accommodation and eye movement. Various kinds of targets were used to effectively carry out the runaway training, and the training effect was demonstrated in virtual reality as follows. A method to maintain the control so that the visibility is clearly visible in the viewing plane changes the version of the stimuli while the target is clearly viewed. In order to move the version plane towards the target, the targets of the content were moved to the target's port, and the contents that could distinguish the difference in depth were put into the plan to

maintain interest. Also, since the order of visual function training should be considered before starting, when developing the visual function training program, the goal was to form contents at a level that can be easily implemented by the target. The size of the training space was based on the field of view, and the content for city training was the size of the training content for the virtual reality training in consideration of the installation space of the VR equipment for the training effect. The content flow arrangement in this training space was carried out according to the visual function training method carried out offline.

2.3 Rebuild of 3D Resource(Modeling)

The 3D software using Maya, which has the same coordinate system as unity and an application authoring game engine, was used in the study. The training content to be realized in the virtual reality space was modeled in the form of a ball, a box, etc., which are basic forms according to the basic training stage principle. By adjusting the points, lines, and planes in this way, the desired 3D object shape was produced and modified to model the training unit.

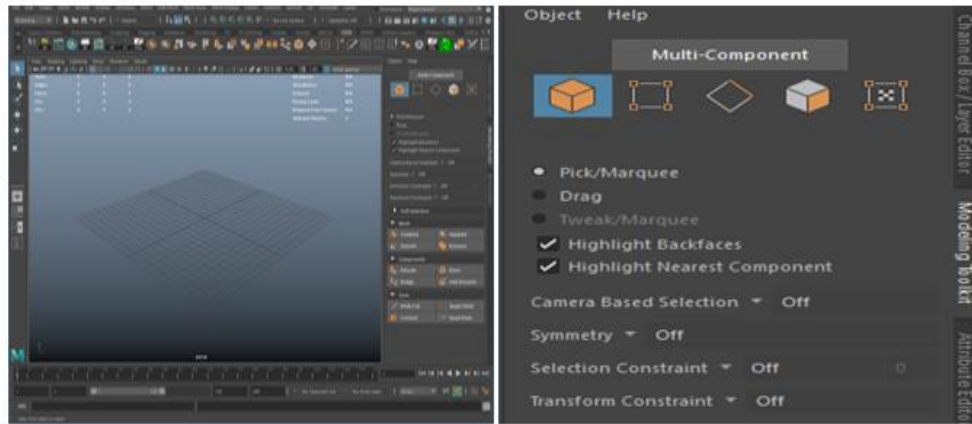


Figure 1. Maya Basic Screen and Modeling Toolkit

2.4 Material Setting and Mapping

Mapping means applying a 2D image to the surface of the modeling in 3D, and the texture was produced in Photoshop, an image authoring tool. Material setting and mapping was done after modeling. The created texture was applied using Maya's HyperShade, and the desired material was created by editing the reflectance and opacity.

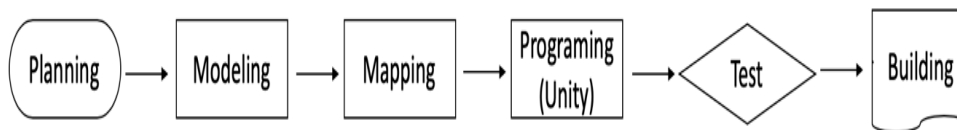


Figure 2. Infrastructure of the platform and Content Production Process

3. Result

3.1Content Configuration

In order to produce the virtual reality content, it is important to adjust the size of the virtual space to the same size as the actual space. The size of a grid in Unity is 1m x 1m, and the actual world moving values tracked using the above vive configuration sensors are equally implemented in virtual space as shown in Figure 3A. Considering the actual environment experience space in virtual space, a 3D space in contents was constructed. In the actual environment, if the user moves 1m to the left, the base station tracks the headset and controller that the user is wearing, and the camera in the content moves 1m to the left, as shown in Figure 3B.

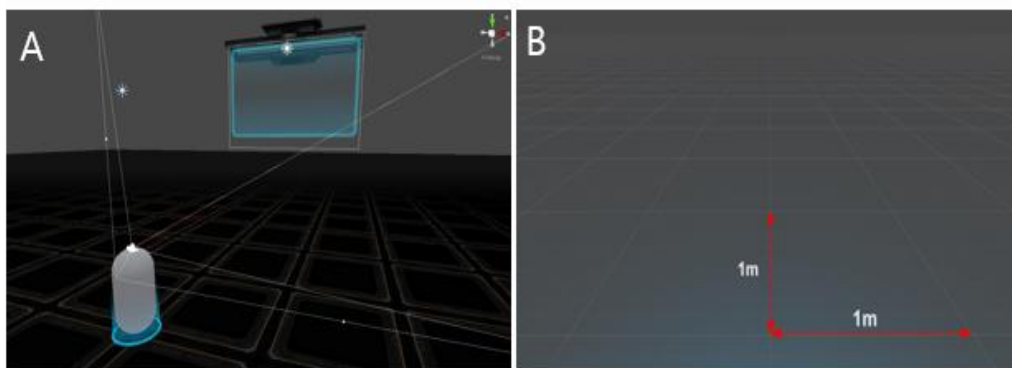


Figure 3. Configuring Content in a Virtual Reality Space.A: Unity Grid Units,B: Level Design Referenced to Actual Environment Size

3.2 Start Screen and Difficulty Adjustment

The start screen consists of a button to select a stage and a 'Play' button to execute the selected stage, and each menu consists of a Toggle button to select and deselect the stage to experience. When selected, the UI image of the default button is dimmed, and the text 'Select' is displayed to remind the user of the selected button. These selected stages are recorded as True in the 'Select Stage Array', while those not selected are recorded as False. If you select a stage and press the "Play" button, it is designed to search in Array for the selected stage, move on to the difficulty control stage if there is a stage, and to prevent any response if there is no stage selected. These are shown in figures 4A and 4B.

The program allows users to select the stage to experience at the stage selection stage of the start screen, and to select the level of difficulty for each stage when they go through the stage by pressing "Play".When the stage is selected, the difficulty adjustment value for each stage is set, and the configuration values are grouped to adjust.When a stage is selected, there are values that adjust the level of difficulty for each stage, grouped together to adjust the composition.In the difficulty setting window, the experience explanation window was set according to the stage so that the experience explanation could be shown.In addition, it was programmed to show the effectiveness of training by setting different experience times by stage or difficulty level.Experience times by stage and difficulty level are set differently, as shown in Figure 4C.

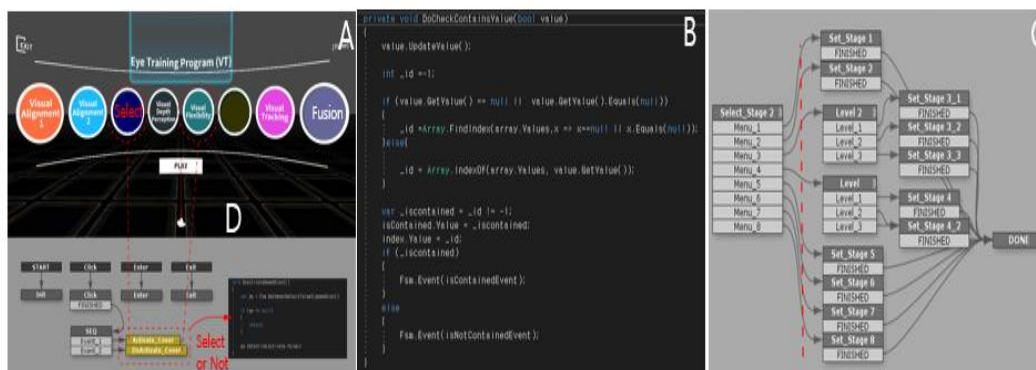


Figure 4. Development process of training contents.

A: Main Menu Selection and Flowchart, B:Stage search function registered in Select Stage Array, C: Difficulty Setting Flowchart

3.3 Vision Training Implementation

3.3.1 Contents I

In order to train vergence capabilities, we envision content to improve motor sensitivity awareness of runaway and calculated states. It was located at 70cm in difficulty level 1, and the distance in front of each difficulty level was different. In this process, random X and Y values were generated from the World Axis reference using a random function, and Z values were varied (0.70) by difficulty to change the position of the box in which the ball was placed. In this way, the screen that the subject can see in the virtual space that the gray ball floating at an arbitrary position in 3D space is selected using the trigger button of the right controller and placed in a hexahedron frame. When the controller reaches the selection area of the ball, the ball can be selected. When the ball is selected, the color of the ball changes to blue. When you draw the ball into the frame, the ball turns red, and the score increases. The higher the level, the smaller the ball and frame area, so more sophisticated manipulation is required to select a ball that appears at a long distance, medium distance, or close range on the screen by clicking the trigger button of the controller. As the difficulty increases, the size of the ball becomes smaller and the quantity to be selected increases as shown in Figure 5.

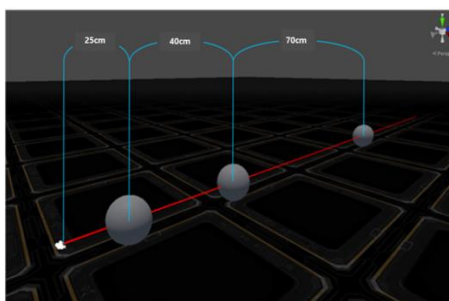


Figure 5. Change ball position according to entered distance variable

3.3.2 Contents II

The forward ball will appear in one of the four directions, east, west, south and north, based on the HeadSet. This was implemented by pre-creating four vector 3 values and randomly importing them. First is to take one of the four predefined position values and place the front position based on the HeadSet at the value set according to the difficulty adjustment and randomly place it in one of the four positions. It implements movement in which the ball is close to the front on the Head Set basis. These are shown in figures 6A and 6B. Instead of using 'key animation' to implement moving to a constant value every frame, we implemented smooth movement using twin eye type. The shape of movement can be measured in advance using various Ease types defined. Various Ease types are graphically represented in Figure 6C.

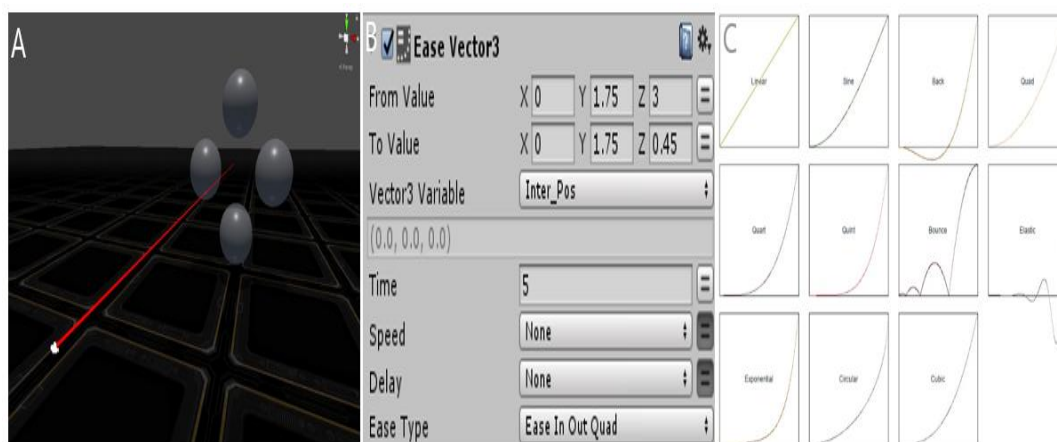


Figure 6. Content Implementation Settings. A: Direction randomly, B: Movement Implementation, C: Ease Type graph image

3.3.3 Contents III

The third content is implemented so that the position of the matching marker at the bottom changes every time by finding the pattern that protrudes from the noise pattern image in the front and placing it in the right position at the bottom. For this, the objects at the bottom are registered in the Array, mixed with the Shuffle function, and placed from the front. If you look at the screen for training, various types of shapes can be seen such as triangle, square, and circle. You must select the shape with the trigger button of the controller and place it on the same shaped button at the bottom. When the selected shape is the same as the button at the bottom, it is counted as a correct answer. Recognition execution was designed as follows. When you see the guide arrows appearing in the front timer panel, align the directions of the arrows in the top, bottom, left, and right directions in front of your eyes, and click the trigger button of the controller to successively make the same shape. As the level increases, the number of guide arrows that must be adjusted increases.

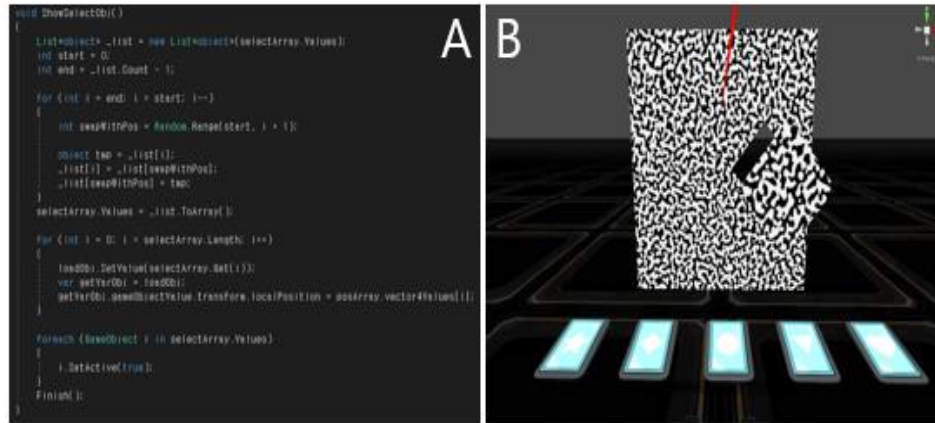


Figure 7. Content Implementation Settings.A:Randomly shuffle the objects in the Array, B: Newly sorted Array from the front.

3.3.4 Contents IV

The fourth content differentiates the intensity of the training, the two stages were organized, and the function name was implemented differently to position the Rect Transform. anchored Position3D to rearrange the new location by Shuffle. The user must find one hint arrow that appears at any position on the front and align the arrows in the same direction among eight directions of up, down, left, right, and four diagonals, then click the trigger button of the controller as shown in figure 8. If you hit the same direction, the arrow turns blue, and the score goes up. If it is wrong, the arrow turns red.

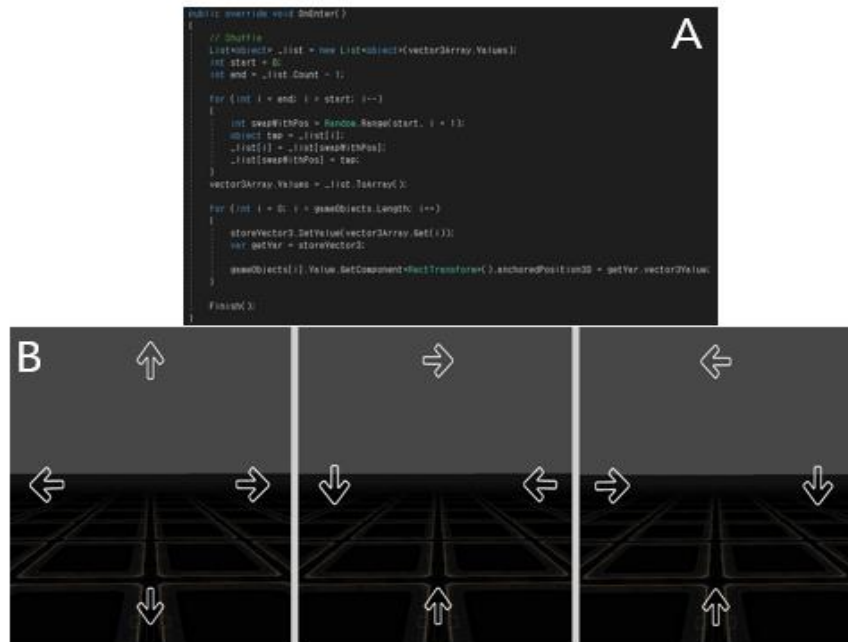


Figure 8. Content Implementation Settings.A: Arrange the shuffled images in order,B:Implement random arrow position every time

3.3.5 Contents V

The last content was important to place the vive Controller in the matching arrow area in eight directions as the matching content by looking at the hint arrow appearing in the front. A branch is created so that different events occur depending on whether you entered, exited, or clicked while entering the matching arrow area. The trainer can increase trainee score by moving both objects with the controller and positioning them accurately in the center dotted guide area. All of these contents are based on the principles of existing vision training programs. However, new contents were developed by interpreting the contents of virtual reality-based programs. A program for vision training must be designed to match the specific goals. Test matching, training procedures, and the use of these contents may be essential to the successful handling of a vision problem. Vision training aims to improve the coordination and effective functioning and processing of the vision system.

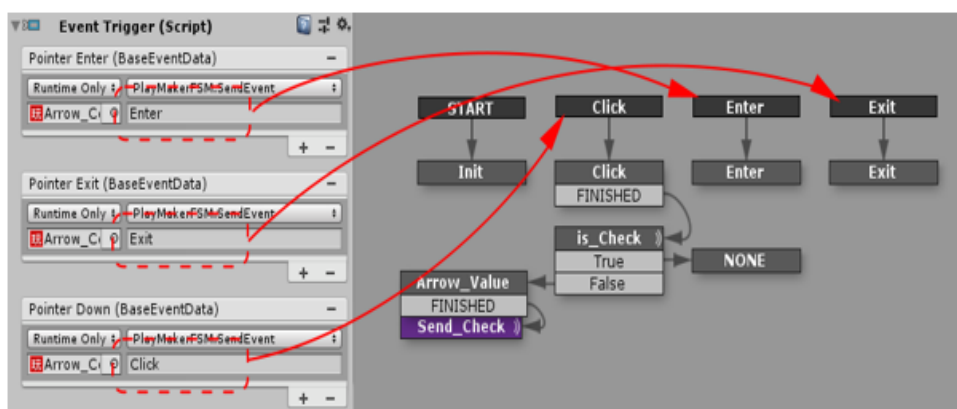


Figure 9. Event execution according to the trigger type in the arrow area

3. Discussion

Virtual reality is a useful technology currently applied in the smart healthcare market. It consists of a virtual environment. The most advanced Virtual Reality experiences even provide freedom of movement where users can move in a digital environment. These technologies raise some concerns and opportunities for vision care market. Hence, this virtual reality training program can be an opportunity of another program for vision training. Virtual Reality technology is a key technology area in the era of the fourth industrial revolution. This technology is actively undergoing with industries such as education, medical, manufacturing, and defense. In the case of entertainment, it uses experience-oriented content-based experience, which can feel immersion and realism, training-oriented content, which provides realistic experiences in medical care, and education-oriented content, communication, which is based on the platform services that share the object [17-20]. In a changed media environment, users can interact in a virtual environment, as well as in an expanded space that connects physical and virtual space. In the case of virtual reality, it is possible to expand the senses such as tactile and olfactory, to use the media in the viewpoint of the participant rather than the observer, and to satisfy the primitive desire of human to observe and experience the objects by communicating with objects. Also, virtual reality can expand the user's perspective, enhance the experience, and evolve into media that induces

behavior and provides diverse experiences, as the biggest characteristic of virtual reality is that it can lead to active participation from users. It implements virtual environments or objects with immersion, a key element of providing new experiences to users, so that users do not recognize the experiences mediated by the media by interacting with the environment or objects, but rather live experiences such as reality. Various studies are being conducted in the medical field for such virtual reality. Cambridge Consultants developed a VR device that can test glaucoma with a smartphone. Because light is emitted from all directions, it has a similar effect to an actual glaucoma tester, and it shows a light pattern expressing various colors by linking with a mobile app and Bluetooth. Subjects were asked to press a button to distinguish whether they were colored or not according to the test [27]. In addition, an app has been developed to ease inconvenience for low vision by converting images that are compatible with gear VR and smartphones into AR cameras that are easily recognized by blind people. Active Motion Control provides VR games and allows users to experience race tracks, battlefields, rising skies, and rural landscapes such as pictures in the form of F1 drivers, tank commanders, cyclists, and Pegasus. It has also been announced about VR rehabilitation platform 'MindMotion Pro', which promotes neural regeneration with motion capture technology digitally converts body movements of patients [28,29]. A program was also developed for children with disabilities to play the piano by applying 'Eye tracking' technology to VR and VR headset FOVE, which can be used for rehabilitation of stroke and traumatic injury patients [30]. Virtual reality is being used in various fields. In general, various training contents are used not only in the medical field but also in the field of psychological training and Ophthalmology. As described above, virtual reality used in various fields was also intended to be applied in municipal training.

In this study, we studied contents that can conduct visual function training in virtual reality and developed a virtual reality training program consisting of five contents. The five developed programs carry out the most basic principles of the session. To maximize, the effect of the training, the program should be fun to use, train vergence, and apply localization to improve the performance. The first content consists of guide arrows appearing in the front timer panel. The user must align the directions of the arrows in the top, bottom, left, and right directions in front of the eyes, and click the trigger button of the controller to successively make the same shape. The second step increases the level of the program where the number of guide arrows that must be adjusted increases. The right-hand controller should be moved to the inside of the guide by moving the right object, and the left-hand controller should be moved to the outer guide by moving the left object. Scores are obtained by moving both objects with the controller and positioning them accurately in the center dotted guide area. All of these contents are based on the principle of vision training program.

The program was designed to minimize the stimuli for the accommodation of the plane of the display content. The display content is dynamic and 3D, which is a common property for display contents. The disparity that produces stereovision, or 3D, can stimulate convergence, which in turn stimulates accommodation. All of the vision training contents were considered to be useful for the treatment of visual alignment and fusion dysfunctions, which are among binocular dysfunctions. Binocular dysfunction patients find it difficult to focus on objects in a close range. As the technology develops, it is hoped that the training for binocular dysfunctions virtual reality methods will provide a

way for the users to train in a comfortable and familiar environment, so that those who has a symptom with binocular dysfunctions can train in easy and familiar surroundings.

Among the use of virtual reality in the ophthalmic field, amblyopia and strabismus treatment using VR show similarities with this study. Vivid Vision has developed a VR headset for patients with amblyopia or strabismus. Using games, it stimulates the brain that was sleeping by subtly projecting different images into the left and right eyes and strengthens vision by restoring the connection between the eyes and the brain. More than 90 hospitals in the U.S. introduced this program to eye doctors and hospitals, and it can be purchased directly by visually impaired patients and used at home in order to enhance convenience for patients.

Dichoptic training to stimulate binocular vision for amblyopia treatment can also be implemented in virtual reality. However, in the case of HMD-type virtual reality, most of them are due to stability issues such as weight, size, and distance between the pupils. It is recommended for use by children over 12 years of age. There are few studies on pediatric amblyopia treatment using virtual reality, but rather studies on the treatment of amblyopia in boys and adults are being reported [31]. As a result of conducting a preliminary study on adult amblyopia patients aged 17-69 using dichoptic training through HMD virtual reality, it was reported that the mean maximum corrected visual acuity improved from logMAR 0.58 to 0.43. However, more clinical trials are needed to determine whether dichoptic treatment has the same effect as occlusion treatment in children and adults [24].

It should be able to cover treatments not only for amblyopia but also strabismus patients. Dichoptic also uses virtual reality for intermittent exotropia patients. It has been reported that visual training was performed for six months and there was some improvement in strabismus and stereopsis [32].

Visual function is a function performed by the eyes for visual activities in daily life, and includes accommodation, vergence, stereoscopic vision, and contrast sensitivity. The goal of visual function training is to help patients meet the visual needs of various and complex situations. This goal is achieved by the application of a planned series of experiential presentations. Through vision training, it is possible to improve the quality of life by improving various symptoms such as decreased concentration, cloudiness, double vision, headache, and hyperactivity caused by binocular dysfunction. Vision training is a specialized program that applies a professional and gradual course of training method and is used in an effective way for children and adults. As the times change, training in virtual reality space should be easy to access to improve the visual function of the users. It is meaningful to propose components of the model that consider the specificity of the training. These results are believed to be the foundation research that can be expanded from a practical perspective of vision training model research, which is expected to facilitate the development of models related to virtual reality application field, thereby providing an opportunity for the creation of new competitive vision training content.

Conclusions

Virtual reality-based vision training is thought to provide an interesting and immersive environment that can improve subjects' interest and be effective in a COVID-19 situation. Using the eye

tracking function HMD, data accuracy will be improved to implement virtual reality content of these training in future studies, and convergence research will need to be continued accordingly. Further study will be considered as the next step of vision training content for Virtual Reality. It will also accumulate training data for actual subjects and conduct follow-up research based on whether or not the subjects effectively perform the virtual reality training contents.

Acknowledgments

This study was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIP) (NRF-2017R1C1B5077002).

References

- J. E. Bae, S. I. Kim. "Proposal of fitness service based on virtual reality game and u-healthcare for improving leisure satisfaction." *The Journal of Korea Digital Design Council* 15.5 (2015): 133-144.
- J.Y. Choi, J.H. Lee, Y.S. Kim, S. Kim. "Virtual reality based operation training system for steel making process." *Journal of Institute of Control Robotics and Systems*. 21.8 (2015): 709-712.
- JeongwonBaik, Heeeun Nam, YujinIm, Jounghyeon Jang, Eunsuk Bae. "A Study on the Social Welfare Application of the 4th Industrial Revolution: Focus on Social Welfare Major Student." *Asia-pacific Journal of Convergent Research Interchange FuCoS* 6.5 (2020): 103-110.
- B. H. Kang, J. S. Kim, H. W. Kim. "Study for operation teaching machine using 3D virtual reality system." *Journal of Digital Contents Society* 17.4 (2016): 287-293.
- S. Y. Hong. "Countermeasures for side effects of online virtual reality games." *Digital Contents Society* 15.3 (2014): 405-412.
- Geun-Ho Lee. "Effect of Virtual Reality-based Training Program on Patients with Mild Cognitive Impairment." *Asia-pacific Journal of Convergent Research Interchange, FuCoS* 7.1(2021):71-80.
- I. Adnane, M Chahbi, M Elbelhadji. "Virtual simulation for learning cataract surgery." *Journal FrancaisOphthalmologie* 43.4(2020): 334-340.
- JCaroline, R Aitor, A.K. John, G Paul. "Embodying self-compassion within virtual reality and its effects on patients with depression." *BJPsych Open* 2.1 (2016):74–80.
- Slater M, Spanlang B, Sanchez-Vives MV, Blanke O. "First person experience of body transfer in virtual reality." *PLoS One* 5(2010): e10564.
- RKhan, J Plahouras, B.C. Johnston, M.A. Scaffidi, S.C. Grover, C.M. Walsh. M.W. Catharine."Virtual reality simulation training for health professions trainees in gastrointestinal endoscopy." *Cochrane Database of Systematic Review*17.8 (2018): 141-148
- Nagendran M, Gurusamy KS, Aggarwal R, Loizidou M, Davidson BR. "Virtual reality training for surgical trainees in laparoscopic surgery." *Cochrane Database of Systematic Review*27.8 (2013): CD006575.
- C.M. Walsh, M.E. Sherlock, S.C. Ling, H Carnahan. C.M. Walsh. "Virtual reality simulation training for health professions trainees in gastrointestinal endoscopy." *Cochrane Database of Systematic Review* 13.6 (2012): CD008237.

- Andrea C, Fabio L, Michele DL, Carla M, Alessandro N, Antonio G. "Virtual Reality in Health System: Beyond Entertainment. A Mini-Review on the Efficacy of VR During Cancer Treatment." *Journal of Cellular Physiology* 231.2 (2016): 275-287.
- Curry M, Malpani A, Li R, Tantillo T, Jog A, Blanco R, Ha PK, Califano J, Kumar R, RichmonJ.Curry. "Objective assessment in residency-based training for transoral robotic surgery." *Laryngoscope* 122.10 (2012):2184-2192.
- Caroline JF, Aitor R, John AK, Paul G, Angus A, Pasco F, Neil R, Mel S. Chris RB."Embodying self-compassion within virtual reality and its effects on patients with depression." *BJ Psych Open* 2 (2016): 74–80.
- Valmaggia L. "The use of virtual reality in psychosis research and treatment." *World Psychiatry* 16.3 (2017): 246–247
- Javier FA, Daniele DL. Giuseppe R. "Virtual Reality for anxiety disorders: Rethinking a Field in Expansion." *Advances in Experimental Medicine and Biology* 1191 (2020): 389-414.
- M. Rus-Calafell, P. Garety, E. Sason, T.J.K Craig, L.R Valmaggla. "Virtual reality in the assessment and treatment of psychosis: a systematic review of its utility, acceptability and effectiveness." *Psychological medicine* 48.3(2017):362-391.
- Sikder S, Luo J, Banerjee PP, Luciano C, Kania P, Song JC, Kahtani EX, Edward DP, Towerki AE. "The use of a virtual reality surgical simulator for cataract surgical skill assessment with 6 months of intervening operating room experience." *Clinical Ophthalmology* 9(2015): 141-149.
- Wilson AS, O'Connor J, Taylor L, Carruthers D. "A 3D virtual reality ophthalmoscopy trainer." *The Clinical Teacher* 14.6(2017): 427-431.
- Tsapakis S, Papaconstantinou D, Diagourtas A, Droutsas K, Andreanos K, Moschos MM, Brouzas D. "Visual field examination method using virtual reality glasses compared with the Humphrey perimeter." *Clinical Ophthalmology* 7.11(2017) 1431-1443.
- Alexander KN Lam, Elaine T, Robert NW, Marco Y, Heather M, Gilda L, Vivian Ch, Ken W, Xiujuan Z, Timothy PH Cheng, Philip YG, Christopher KS Leung. "Use of Virtual Reality Simulation to Identify Vision-Related Disability in Patients With Glaucoma." *JAMA Ophthalmology* 38.5(2020): 490-498.
- Swampillai AJ, Waqar S, Park JC, Modi N, Kersey TI, Sleep TJ. "The development of a virtual reality training programme for ophthalmology: study must take into account visual acuity and stereopsis." *Eye (Lond)* 28.4(2014): 503.
- Žiak P, Holm A, Halička J, Mojžiš P, Piñero D. "Amblyopia treatment of adults with dichoptic training using the virtual reality oculus rift head mounted display: preliminary results." *BMC Ophthalmology* 105(2017):1-8.
- Mitchell S, Bruce W. "Clinical management of binocular vision" 2th Ed, Lippincott-Raven, USA, 2002, pp147-163.
- Bade A, Boas M, Gallaway M, Mitchell GL, Scheiman M, Kulp MT, Cotter SA, Rouse M, CITT Study Group. "Relationship between Clinical Signs and Symptoms ofConvergence Insufficiency." *Optometry and Vision Science* 90.9(2013): 988-995.
- Sircar T, Mishra A, et al."GearVision: Smartphone based head mounted perimeter for detection of visual field defects." *Annual International conference of the IEEE Engineering in Medicine and Biology Society, Honolulu, HI, USA, 18-21 July 2018. IEEE Engineering in Medicine and Biology*

- Society, pp. 5402-5405, IEEE Xplore, ieeexplore.ieee.org/document/8513574.
- Kim HD, Joo AR. "The Study of Promoting Method for VR Contents to Reduce Pain of Child Patient - Focusing on The Case Studies of VR Contents at Home and Abroad." *The Journal of the Korea Contents Association* 20.6(2020):167-176.
- Lee GH. "Effects of Wii Virtual Reality Exercise Program on the Balance Function of Elderlies Living Alone with High Fall Risk." *Asia-pacific Journal of Convergent Research Interchange FuCoS7.4*(2021): 1-12.
- An HW, Kim JM. "A Study on the Development of Physical Examination with VR Content and User Satisfaction." *The Journal of the Korea Contents Association* 21.6(2021): 318-326.
- Tsirlin I, Colpa L, Goltz HC, Wong AM. "Behavioral training as new treatment for adult amblyopia: a meta-analysis and systematic review. " *Invest Ophthalmology and Vision Science* 56.6(2015): 4061-4075.
- Li X, Yang C, Zhang G, Zhang Y, Lan J, Chu H, Li J, Xie W, Wang S, Wiederhold BK, Wiederhold MD, Yan Li, Zeng J. "Intermittent exotropia treatment with dichoptic visual training using a unique virtual reality platform." *Cyberpsychology Behavior and Social Networking*. 22.1(2019): 22-30.
- VU, Nguyen Thanh, et al. "The Application of Advancement Technologies in Studying Customer Experiences In Vietnam." *International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)* 10.3, Jun 2020, 8233-8238
- JOSE, Neethu Maria. "Technical Innovations as an Aid For Enhancing Customer Experience in Emerging Marketing Landscape." *International Journal of Sales & Marketing Management Research and Development (IJSMMRD)* 9.2, Dec 2019, 57–68
- TRANG, NGOTHITH. "The Fourth Industrial Revolution and its Impact on the Field of Industrial Design." *International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD)* 9.3, Jun 2019, 29–38
- RKJ, De Silva, and Thashika Rupasinghe. "Characterization of new product development (NPD) models applicable to enhance the overall performance of the apparel industry." *International Journal of Textile and Fashion Technology (IJTFT) ISSN (P)* (2016): 2250-2378.
- YAP, Hwajen, et al. "Development of an augmented reality-based G-code generator in a virtual Cnc milling simulation." *Int J ComputSciEng (IJCSE)* 5.2 (2016): 63-72.