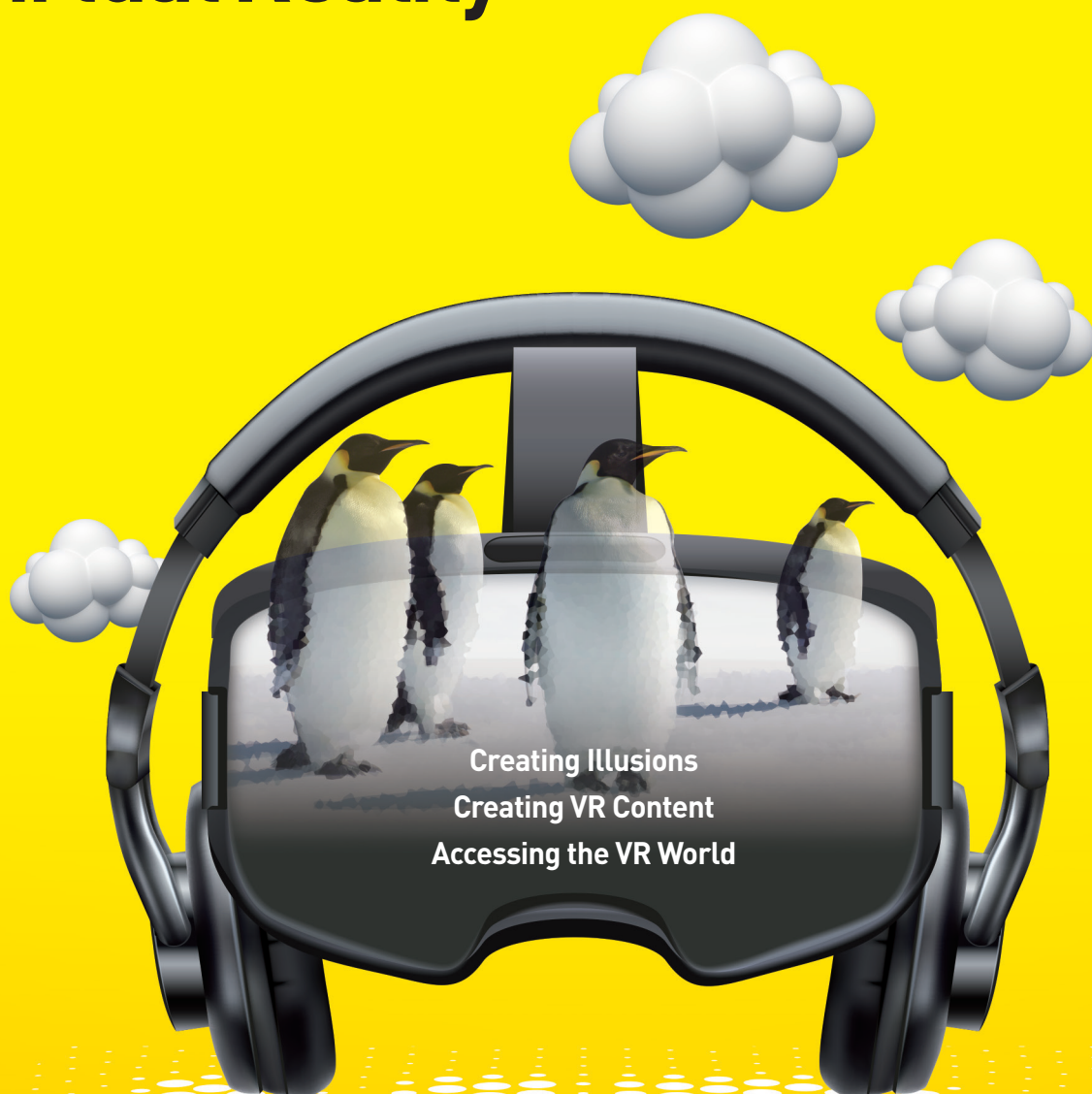


Truer than True Virtual Reality



How to Use
This Program

Software is changing the world. The programs installed in computers and apps that make it more convenient to use smartphones are all software. Software is in every part of our lives, so it is difficult to find areas where we are not affected by software.

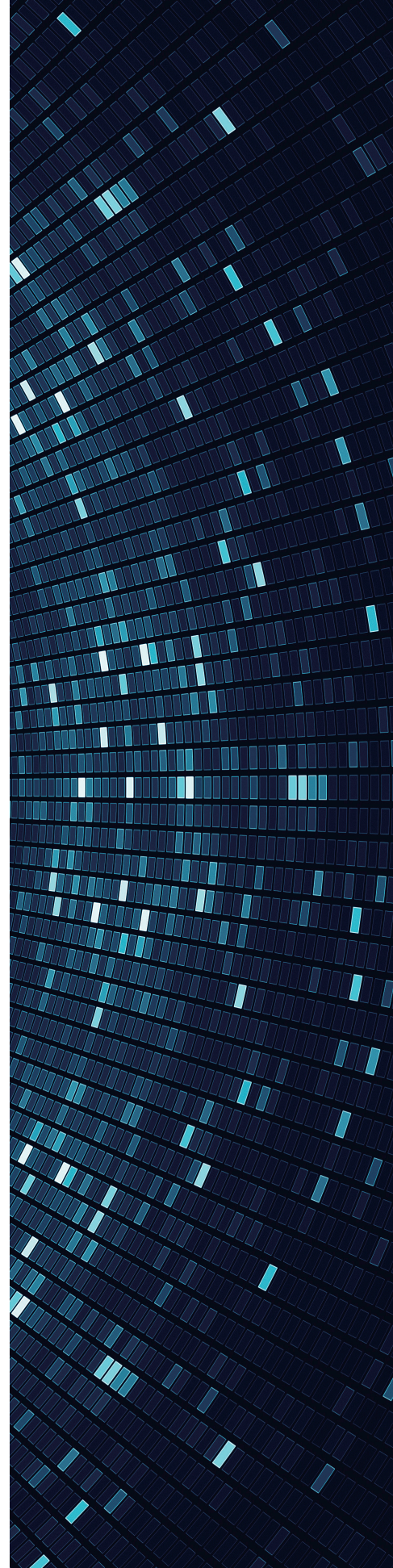
The state-of-the-art science and technology that we see in the news is also helped by software. In turn, progress in math, science and technology advances software further. As such, math, science and technology are closely related with and cannot be separated from software.

These module series were created through collaboration between experts in related fields and software education, and its suitability for classrooms has been verified. As students follow teachers' direction through each module, they will be able to better understand the world that has been changed by software.



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Truer than True? Virtual Reality

The buzzword of 2016 for the IT and electronic device industries was virtual reality. Even those who have just had a glimpse of an online virtual world are quick to declare that this technology will control the future. Will we actually live in a world like the one described in Avatar? Let's find out more about virtual reality (VR) and its limits.



VIRTUAL REALITY, ILLUSIONS AND TRICKERY!

At the Mobile World Congress 2016, people kept lining up in front of Samsung Electronics' booth. After a long wait, each visitor put on a large pair of glasses, sat on a chair and began to scream with joy. They were no longer at Samsung's booth but were riding a rollercoaster at an amusement park.

Realistic-looking but not real

This thrilling rollercoaster ride could be experienced indoors thanks to Samsung Electronics' Gear. It is an HMD (head-mounted display) that enables users to experience VR. The fact that this VR experience became the center of attention at a

showcase of cutting-edge technologies testifies to the public's growing interest in VR.

VR refers to an environment that appears realistic but is imaginary. All that is needed is an HMD to ride the world's steepest and fastest rollercoaster or hike along a trail deep in the mountains. You can also witness the tragedy of war up close, fly high in the sky, and explore the ocean's depths. VR makes the impossible possible, and this is why it can be applied to diverse areas from entertainment to cultural property exploration.

HMD - the Key Device for VR!

The core of VR is the technology to trick users' eyes and make them believe that the images played are real, not just realistic-looking. The more elaborate the images are, the more real VR appears.

An HMD is a small monitor for one. It is equipped with an LCD the size of a smartphone, upon which VR images are played. In front of the LCD is a lens that magnifies the images played. From Google Cardboard to the upscale Oculus Rift, all HMDs are based on the same principle: completely enclosing the eyes and displaying VR images through a lens.

The invention of the HMD dates back 50 years ago. Ivan Sutherlands, a US computer engineer, first developed

The popularity of the VR experience at the Mobile World Congress 2016 testifies to the public's growing interest in VR.
© catwalker/Shutterstock



an HMD in 1968. Then, in 1979, an HMD built with layers of convex lenses to provide a wider view was invented. HMDs began to be used in full scale in 1985 when NASA introduced them for its astronaut training.

In 1991, Japan's SEGA developed a technology called head tracking. Head tracking records the motion of the head and makes images move in line with the eyes. It is a critical factor to maximize the sense of reality, and most HMDs produced these days are mounted with head tracking.

The critical point was to widen the viewing angle

The main challenge of the past 50 years was to replicate the field of vision on the HMD screen. The total viewing angle of human eyes, when looking ahead, is 120° on average. In order to achieve immersion into VR, the viewing angle of an HMD should also be 120°. However, in the early stages, it was only 40°. The experience was similar to watching a small TV in a dark room. The viewing angle was expanded to 120° only after wide-field technology using layers of convex lenses was developed. Head tracking also made an important contribution.

Then, another problem arose. Because the view-



HMDs succeeded in realizing the human viewing angle of 120° but had yet to improve picture quality accordingly. © Tinxi/Shutterstock

ing angle was widened with a display only the size of a smartphone, the picture quality degenerated. Developers were faced with the dilemma of whether to choose a wider viewing angle for immersion or to choose higher picture quality.

The next breakthrough was the use of a beam projector, which projects high-resolution images onto a tiny display. Thanks to this technology, high-performance HMDs such as Oculus Rift enable users to experience VR via full HD images.

Advanced HMDs offering HD images brought VR closer to everyday life. Experts say HMDs will replace smartphones within 10 years. Everybody will be wearing an HMD and can experience VR anytime, anywhere.

FUTURE OF VR

Turning reality into VR with a camera

To produce VR, images played on an HMD should be viewed in all directions. Game images can be freely created through computer programming, but VR images are made from actual images recorded with a special 360° camera. Thus, the development of VR hinges not only on HMD technology but also on camera technology.

Rig-type cameras are usually used by experts and all-in-one type cameras by non-experts. The former have a series of cameras connected in a round shape and can shoot all directions at once. These cameras have a multitude of eyes. It is easy to shoot and the picture quality is superior, but it does not come cheap.

Other than the rig-type cameras, HMD makers typically produce all-in-one cameras for non-

experts. All-in-one types have 1-2 lenses, with each lens capable of covering beyond the range of human sight. The image edges may appear stretched, but these cameras are small, cheap, and therefore accessible.

Enjoying VR to the fullest

One more factor needed to improve immersion is 'touch and feel'. This factor helps provide a strong sense of reality by allowing users to feel what appears on the screen.

Japan's Bandai Namco utilized stuffed animals in its cat-saving VR game. When players grab a cat hanging from the balustrade of a high-rise in the game, they can feel the fuzzy fur of a stuffed cat as if they are actually holding it.

The interaction device, which recreates the motions of the user via VR, also adds the feel of reality to the images. Microsoft's Kinect, a line of motion-sensing devices, identifies the user's location through an infrared laser projector and RGB sensor. This information is reflected on VR images to elaborately replicate the user's movements on the screen.



Images recorded from 360° are needed to realize VR. The above rig-type camera can record images in all directions. © betto rodrigues/Shutterstock

Some games require the player to wear a location-sensing bracelet or a sensor that resembles a game controller.

From entertainment to psychotherapy

The game industry was the first to successfully take advantage of VR. Oculus Share, a VR game platform, is loaded with hundreds of games and apps. Amusement parks can also benefit from VR. The Walt Disney Company is developing a VR Disneyland Park that can be visited with an HMD on. VR tours to explore the world's must-see attractions are currently under development. Korea recently released an app that allows users to explore Seokguram Grotto, which is off-limits to the public offline.

VR is also rising as an instrumental tool in the healthcare industry, particularly for use in psychotherapy. A USC research team has employed VR technology to treat war veterans with post-traumatic stress disorder. The research team simulated wartime physical environments via VR and used this system to help veterans cope with their war trauma.

VR is also used to treat phobias, such as acrophobia and anthrophobia. Such extreme fears tend to decrease as patients become familiar with the conditions or places that trigger their fear. VR



Motion capture devices, such as Kinect, are required to realize VR. © Barone Firenze/Shutterstock

proved effective by recreating the experience feared by patients (standing in an elevated place or being surrounded by a crowd) and exposing them to the experience in stages. In Korea, a team led by Professor Kim Jae-jin at Gangnam Severance Hospital is currently putting this system to use.

However, VR technology has yet to overcome some side effects, such as nausea and eye strain. In addition, exposure to repeated psychological stimulation may result in insensitivity. The true era of VR will arrive when technology can fully respond to the smallest changes the human body makes.

PART 1

Recommended target
Elementary and Secondary Curriculum

Relevant subjects
structure of our body, 5th grade science,
elementary school

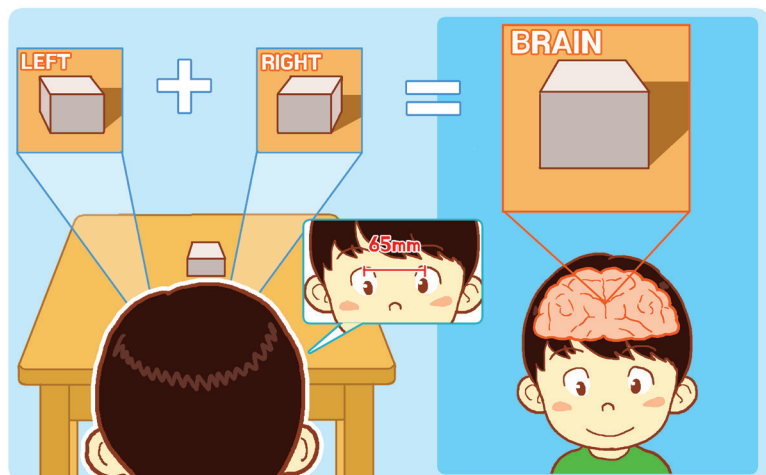
Creating Illusions

VR is a technology that makes the unreal appear and feel like reality using computers and other diverse devices. It helps users freely go back and forth between the real world and imaginary world by simulating experiences. Complex devices were necessary to realize VR in the past, but the process has become much simpler thanks to technological innovation. What are the scientific principles that serve as the platform for VR?

The three-dimensional appearance is an illusion!

Our eyes collect the most information of all our sensory organs. As VR is about showing images in all three dimensions and making them feel real, visual presentation is critical.

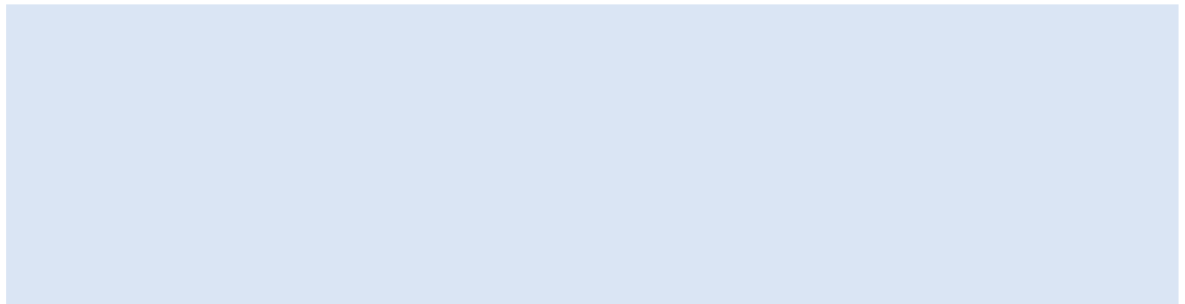
We view objects with two eyes. The left eye and the right eye, as they are located at different points, each have a slightly different image. Human eyes are set apart by about 65mm, and thus the image viewed by the left eye is slightly different from that viewed by the right eye. This “binocular disparity” creates perspective and the three-dimensional effect.



The brain combines the visual information received from both eyes. This process takes place so naturally that we mistakenly believe that the images viewed by our two eyes are identical.

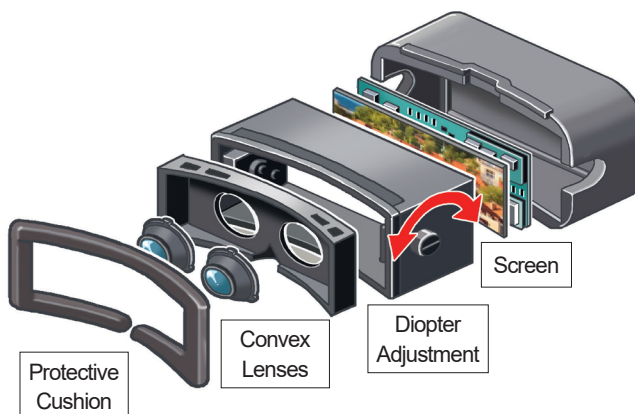
Binocular disparity enables us to generally estimate the distance between objects. Try to touch the tips of your forefingers with one eye closed. You will not be able to do it on your first try. One eye alone is not enough to create perspective.

VR capitalizes on binocular disparity to make images appear real. How should a device be designed to create a binocular disparity? Think of a method and discuss it with your friends.



Key VR device - HMD

Have you seen a head-mounted display? It looks like a protruding pair of goggles. This device is called an HMD or simply a headset. A headset is a small monitor for one individual. It is mounted with a small LCD, which shows images just like a computer monitor does. Since human eyes have binocular disparity, two LCDs are needed.



Structure of a headset



When a tiny screen is positioned too close to the eyes, it cannot be brought into focus, just like when an object is held too close to your face. This is why the headset is equipped with a pair of convex lenses - to bring images into focus and magnify them for a clearer view.

The earliest headsets were very expensive because they were built with high-resolution LCDs. However, after the development of smartphones with high-resolution displays, they were able to be used as the headset screen. The price naturally went down as the most costly component was replaced with an affordable alternative. Google's Cardboard headset can be purchased with only a few thousand Korean won.

The headset has one more key component, which is the head motion sensor. When users turn or raise their head, the sensor recognizes the movement and changes the image displayed accordingly. Headsets are supposed to fit tightly as the slightest leak of light from the outside obstructs immersion. As no edge of the screen is seen, users feel as if they are within the displayed images.

Future of VR demonstrated by Facebook

Many companies have pointed to the VR sector as their next-generation growth engine and advanced into the field. Google released a YouTube video about VR, while Samsung Electronics and other electronics makers are developing VR headsets and 360° cameras. Facebook bought Oculus VR, touted as the forerunner of VR technology, for a price of over KRW 2 trillion. At the time, many wondered why the SNS-centered Facebook would purchase VR technology at such a steep price.

In October 2016, Facebook's VR technology demonstration cleared up all the doubt. When CEO Mark Zuckerberg put on a headset, game characters appeared on stage along with him. Zuckerberg played cards with them, explored the undersea world, and even went to Mars. The Facebook video gives us food for thought about how VR can apply to and change our lives.



Google's Cardboard VR headset provides a VR experience with the LCD replaced by a smartphone. © misszin/Shutterstock



Facebook's VR demonstration at an event entitled Oculus Connect. When the user begins to talk wearing a headset, game characters appear as partners. They move into VR and continue to have a conversation. © Captures from a Google YouTube video

Activity ①

Experiencing VR

A smartphone and a cardboard kit are all that you need to experience VR. The cardboard kit costs only a few thousand Korean won and can be easily bought online. Assemble a cardboard headset yourself, install a VR app on your smartphone, and enjoy the VR world.

What to prepare Cardboard VR kit, smartphone



Activity

1 Making a Cardboard VR Headset



- ① Place the lenses on the piece with two holes as above.



- ② Cover the piece with the lenses with the identical piece with two holes.



- ③ Fasten the smaller piece shown in the illustration to the center of the upper and lower pieces.



- ④ Fasten the smaller piece shown in the illustration to one side of the upper and lower pieces.



⑤ Fasten the smaller piece shown in the illustration to the other side of the upper and lower pieces.



⑥ Attach the two vertical pillars to the widest piece.



⑦ Connect the piece with lenses to the pillars as above.



⑧ Attach the lid piece.



⑨ The VR headset is complete.



⑩ Place the smartphone with its display facing the lenses.



⑪ Close the back to securely fasten the smartphone in its place.



⑫ Hold the headset with both hands to watch VR images.

2 Find an App for VR Experience

A headset alone is not enough for a VR experience. You need an app to turn your smartphone into a VR device. Here is how to do it.

- ① Search “VR” on Google Play and select a VR app. Explain why you selected that specific app.
- ② Install the selected app on your smartphone. Attach your smartphone into the VR headset you just made for a VR experience.



- ③ Access the Internet using the QR code on the left to find a list of popular VR apps. Leave your opinion next to the app you selected (if on the list) or newly add your app to share with others. (It is a space shared with many. Do not delete or modify others' comments without approval. Observe online etiquette.)

3 Let's look at the principle of VR and the characteristics of the device and think about the reason.

Parts	Characteristics
Smartphone display	
Motions of smartphone display	
Part between the eyes	
Part touching the eyes	

PART 2

Recommended target
Elementary and Secondary Curriculum

Relevant subjects
Elementary Art

Creating VR Content

When you turn your head wearing a VR headset, you can look around in 360° as if you are actually there. This is because images shot from all directions unfold on the screen. A photo typically displays as much as the camera's viewfinder can cover. It is impossible to shoot what is behind the camera. Then, how can the headset show 360° views? The method is simple. Photos of all directions are connected to each other. This process of connecting multiple photos and completing one image is called "stitching."

How are VR images created?

Look around the room you are in. It most likely consists of a ceiling, walls and a floor. As you keep turning your head, different views are captured by your eyes, from the ceiling lights to paintings on the walls and a pencil on the floor. The world that we live in is a 360° space.

Therefore, VR should also be able to provide 360° views to enable full immersion. For a vivid visual representation of a background for VR, actual landscapes have to be photographed manually. This requires a special camera that can shoot 360° views.

By shooting landscapes or objects with a 360° camera and stitching the photos together, a VR image that can offer total immersion via the VR headset is created.



Two types of cameras are used to take photos for VR images. One is the rig type with multiple lenses attached to a round framework. These multiple lenses shoot up, in the four directions and below. When these images are combined together, a 360° image is completed. The other is the all-in-one type mounted with one or two wide-angle lenses. As a single lens alone can offer wide coverage, not many lenses are required. However, the edges of an image sometimes appear bent or distorted. This defect must be corrected by software.



The all-in-one type has one or two wide-angle lenses and thus offers wide coverage, but may distort the image. Next to the above photo is an all-in-one VR camera from Samsung Electronics.
© Samsung Electronics

Stitching photos

Editing 360° images is as important as shooting them. In order to combine images taken in all directions, overlapping parts must be trimmed and certain parts must be extended. This process is called “stitching.” One photo is meticulously connected to another so that no part stands out unnaturally in terms of color or shape. This work is highly complicated and thus must be done on a computer.

When users view VR images completed through stitching via a headset, they feel as if they are present on the spot as different angles of a scene are provided in accordance with the movements of their eyes.



Activity ②

Stitching Photos

A VR image is created by connecting multiple photos taken from all directions. This process is called “stitching,” which is typically done by a computer program. However, less complex photos can be connected manually. Stitch photos together yourself and try to find the algorithm needed for stitching.

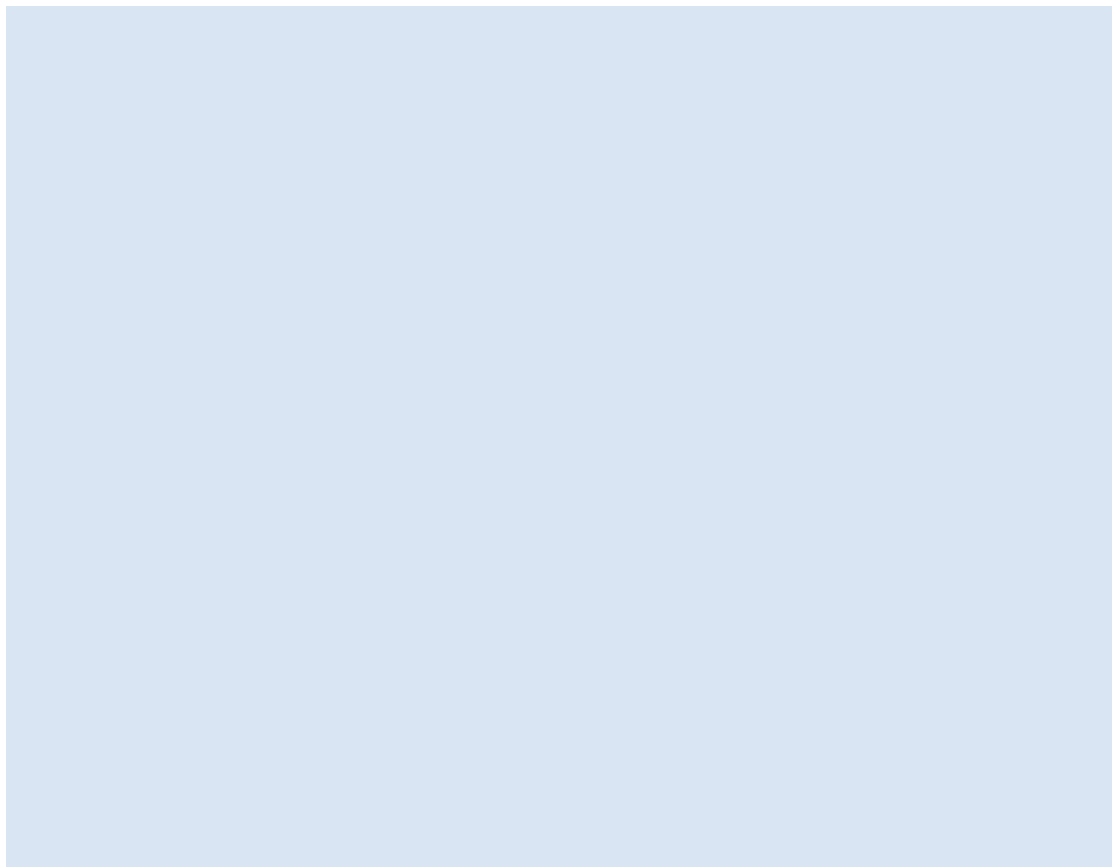
What to prepare Activity Materials 2-①~2-②, glue, scissors

Activity

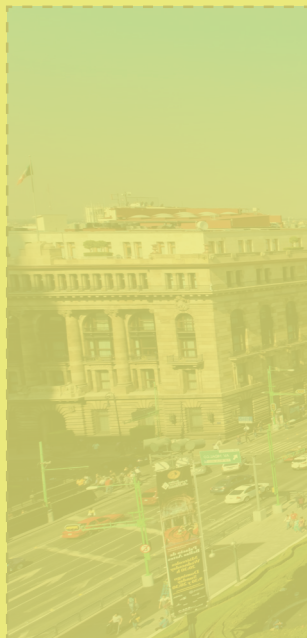
1

Making a Panorama

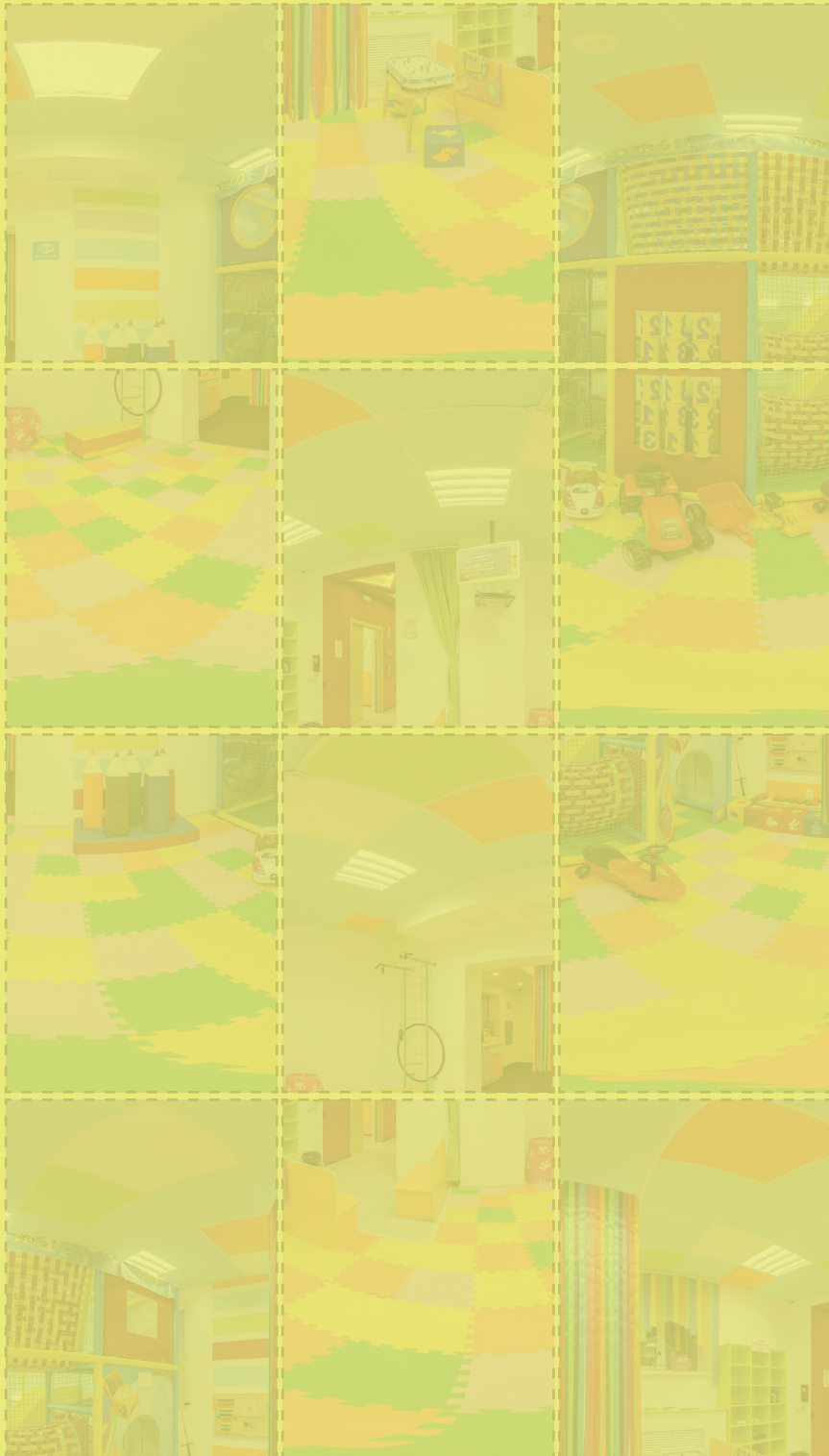
- ① Find the parts that overlap with another in each photo of Activity Material 2-① and mark it with ○.
- ② Lay out the photos to form one complete photo.











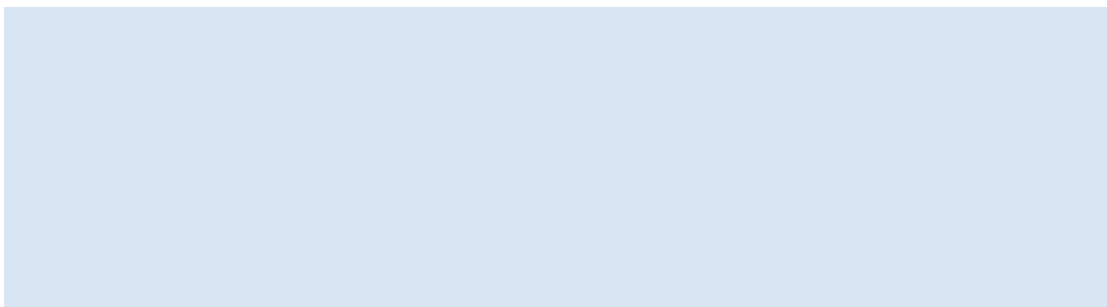
2

Making VR Images

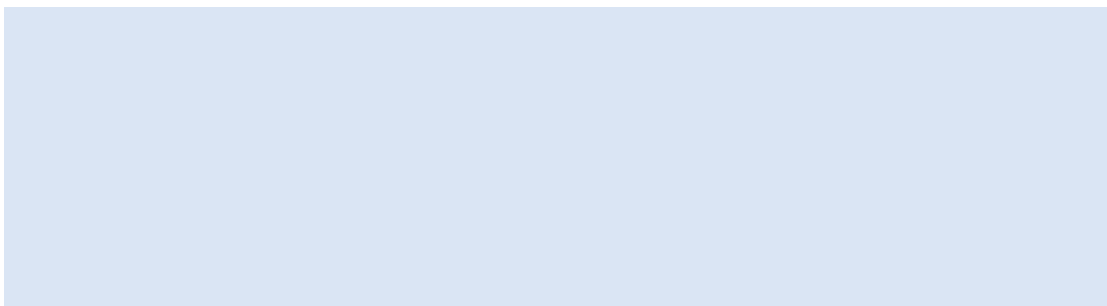
① Layout Activity Material 2-② as below.



② How is the laid out photo different from the image viewed via the headset?



③ What should be done to make the photos appear as one as viewed via the headset?



PART 3

Recommended target
Elementary creative experience activities

Relevant subjects
Practical course, Science

Accessing the VR World

In order to search AI online, a user has to access the search engine on a computer or smartphone. For a VR experience, a user has to access a VR device first. The system of information input and output between the user and computer is called the “interface.” A keyboard and mouse are common examples.

An interface is a communication tool, and thus its design must be able to cater to the needs of its user and comply with the characteristics of the device.

A VR interface, the gateway to the VR world, is notably different from those designed for other devices as it provides access to an imaginary world. Let's find out more about it.

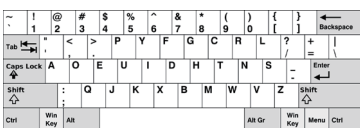


QWERTY Keyboard was named as such because the letters Q, W, E, R, T and Y are placed along the left-hand side.

Is the keyboard an inefficient interface?

The interface we are most familiar with is the keyboard. It consists of over 80 keys, each of which is pressed to enter a letter or number to form simple commands. This interface was first introduced with the release of electric typewriters long before the advent of computers. The most frequently used keyboard type is the English QWERTY keyboard. However, this keyboard was intentionally designed to be inefficient through a mixed arrangement of the letters of the alphabet to prevent overly rapid typing as it could lead to mechanical glitches.

This is why the more efficient Dvorak Simplified Keyboard was developed later. However, users stuck to the inefficient QWERTY. They were so used to it and were reluctant to make a change. This shows the important impact of habits. Thus, user responses are carefully studied when designing an interface. A variety of VR keyboards were created with the development of smart devices, but people still prefer the one that requires the most manual labor.



Dvorak Simplified Keyboard created to address the problems of the QWERTY Keyboard. © Wikipedia

Mobile interfaces

Computer interfaces are evolving in a manner that allows users to think less and enter information more intuitively. The relatively recent mouse is much more convenient than the keyboard, and icons, in lieu of text, are filling today's computer screens.

The shift to smartphones and tablet PCs has led to a dramatic change in IT device interfaces. To enter commands and check output on a tiny display, more elaborate and easy-to-use interfaces were needed instead of the mouse and keyboard. Apple is the undeniable trailblazer in this area. Its iPhone can be operated by pressing a button, swiping, and using just two fingers. Apple was also the first to introduce the mouse as an input device for its Macintosh.

Most smart devices employ a touchscreen system as an interface. Users only have to lightly touch what they want to view or exit an app. Even toddlers know how to use icon interfaces as if they have always been using smart devices. This proves that the simple touchscreen system does not have to be learned; it is intuitive. Research on interfaces requires an understanding of how users accept information and how they respond to received information in addition to an understanding of mechanical systems.

The touchscreen system enables users to operate smart devices just by lightly touching icons without the need to type in keywords and commands.



The mouse first appeared as an input device with the release of Apple's Macintosh.
© Anthony Hal/Shutterstock

Technological development continues to accelerate the evolution of interfaces. Following Macintosh's mouse, the touchscreen system (right) emerged. Some of the latest computers can even sense hand gestures.
© photo on left: www.leapmotion.com





The touchscreen system enables users to operate smart devices just by lightly touching icons without the need to type in keywords and commands.

What interfaces are best for VR?

How should we communicate with computers and smart devices in the world of VR? VR viewed only when wearing a headset is quite removed from the real world. In the real world, users input information using a keyboard, mouse and touchscreen and check the results on the screen. However, in VR, it is as if users are input into the device along with information. Therefore, a different interface approach is required. Let's explore what VR interfaces are currently available.

Hands-free | VR interfaces utilizing smartphones, such as Google's Cardboard headset, often cannot be combined with a separate input device. In such cases, the eye-tracking method, in which the menu is navigated and icons are selected through eye movement, is useful. It lets users navigate VR hands-free, but the downside is that menu and icon selection is slow and inaccurate at times. A good example is Iron Man's suit; the superhero operates his suit only by wearing his helmet and selecting from the menu with the movements of his eyes.

Controller | Sometimes VR-specific controllers, similar to those used for PlayStation and Xbox, are used. They can be held in or worn on the hands. This type of controller can be converted into a game item such as a sword or gun in VR. Information input can be carried out easily and quickly as it is operated by hand, but the downside is that it has to be purchased separately.

Hand tracking | A sensor that tracks hand and finger motions and inputs commands accordingly can be used as an interface. This technology was showcased in the film *Minority Report*. It has yet to be brought to perfection, but Leap Motion is making notable strides in this sector.

Voice tracking | This interface can enter commands in VR without the need for a separate controller or hand gestures. Thanks to AI, voice-sensing technology is making rapid progress. However, it is still not functional unless preset commands are used.

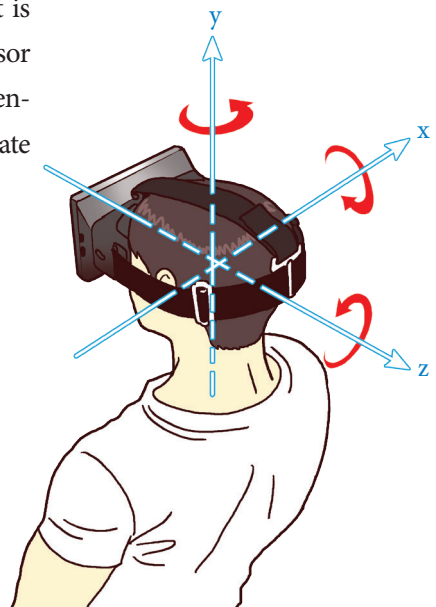
BCI (brain computer interface) | BCI is a communication pathway between the brain and a computer. BCI utilizes the electrical activity of the human brain. Think of the film Avatar, in which a person lying in a remotely located device manipulates an avatar just through the mind. This is the ultimate VR interface that requires no words or body gestures. However, this field has yet to be developed and requires further research.



HTC's Vibe is a controller-type VR interface, which allows users to enter detailed commands using different sensors. © salajeau/Shutterstock

Sensors improving immersion

Sensors are essential to increase immersion in VR. The headset is mounted with a triple-axis acceleration sensor and revolving sensor to recognize the user's motions. When the user's head turns, the sensors instantly identify the direction and angle so that the appropriate image among the 360° images and interface can be offered.



The triple-axis acceleration sensor built into the headset senses motions in x, y and z directions and thereby offers images and interfaces in accordance with the user's motions.

Activity ③

VR and Sensor Values



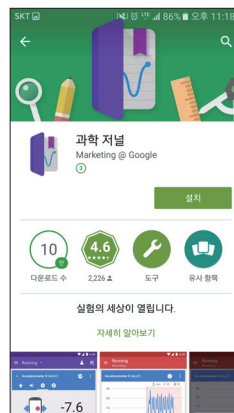
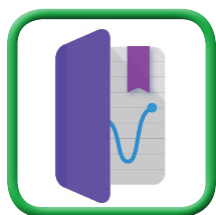
VR devices are designed to offer different images in accordance with the user's motions tracked by sensors. This ensures the user's full immersion in VR. A VR headset is typically built with sensors and a display. However, as shown by making the cardboard headset in Activity 1, headsets utilizing smartphones require a smartphone to function both as the display and sensor.

Is your smartphone able to track your motions (head turning, standing up and sitting down) without error? Let's find out if your smartphone can function as a motion sensor by downloading the Science Journal app.

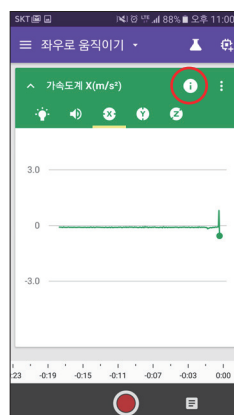
What to prepare A smartphone that can download the Science Journal app

Activity

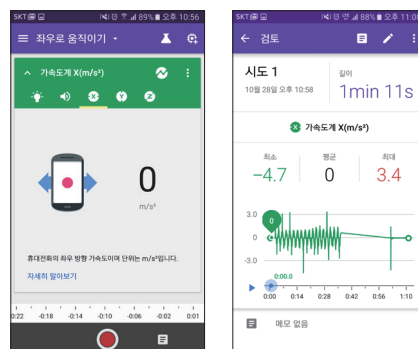
- 1 Search "Science Journal" on the App Store or Google Play Store and download the app.



- 2 A graph showing the current motions of your smartphone can be selected. Press ① to express motion information in numbers or a graph. Motions are tracked in the three directions of x, y and z, each of which represents left and right, forward and backward, and up and down, respectively.

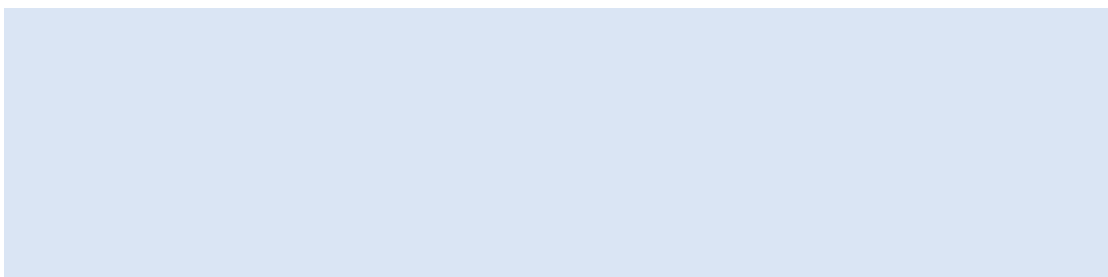


- 3 Select the direction for tracking motions among x, y and z and touch the red button at the bottom to record data. Press the red button again to stop recording. When finished, a graph tracking your smartphone's movements appears as shown on the right.

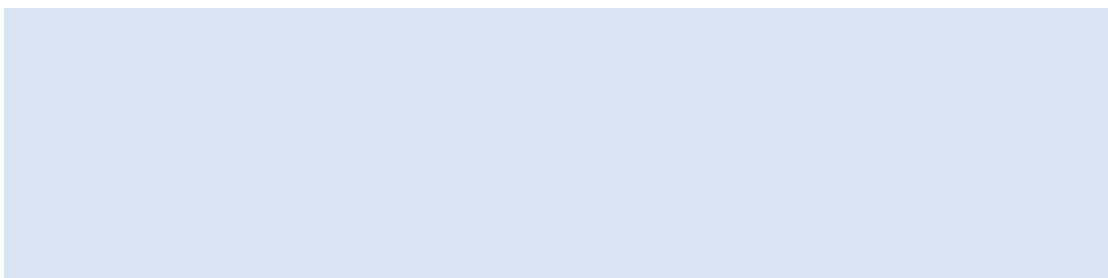


- 4 Attach your smartphone to the VR headset and move around with the recording button of the Science Journal app pressed. Remove your smartphone and stop recording.

- 5 Check how your motions are tracked in a graph. Describe how such a graph could be produced.



- 6 Explain the method of switching images from one to another in accordance with the user's motions in a VR device.



- 7 The app can also track sound and illumination. When finished tracking motions, try tracking other items and check their graphs.



VR experts

With the advent of the era of consumption driven by emotions, companies are focusing their resources on expanding technologies centered on advanced interaction with and tracking of consumers, instead of relying on simple stimulation. VR experts study, develop and apply emotion-centered ICT technologies to allow computers to recognize and appropriately respond to human emotions using wired and wireless sensors and pseudo-random noise. These experts must be equipped with knowledge in human engineering, sensibility engineering and bioengineering. It is projected that the boundaries between reality and VR will be blurred and VR will become a crucial part of everyday life in many sectors in the future. As such, the need for human engineers, UX (HCI) consultants and bioengineers will continue to surge.

What do they do?

- Design and develop a variety of VR hardware such as headsets and input devices
- Develop interfaces that manipulate VR and plans, produces and distributes VR content such as on-site experiences, games and virtual training
- Operate and manage the high-speed Internet connection and content sites that provide the platform for VR

VR-related jobs

Electronic devices	Headset and interface device developer
IT equipment	IT engineer, IT technology developer, telecommunications network operating engineer
Content developer	Developer of content for movies and games

Related majors

VR technologies have continued to evolve to ensure a considerable level of immersion. Still, devices that can instantly display high-resolution images using high-speed

Drama /
cinema

computer
engineering

electrical
engineering

electronic
engineering

telecommunications networks have yet to be developed. Hopefully this can be done at affordable prices. To this end, experts with knowledge in computer engineering, electrical engineering and electronic engineering are needed. Also, much attention will be given to the content offered through such devices. The focus will be placed on technology in the early stages, but in the end, content will become critical as in other service sectors.



Required aptitude

- Rational, analytic and creative thinking skills are required for device development.
- Interest in diverse areas, attention to detail and persistence are required, as is a team spirit.
- An artistic sense is required for content-making, along with a clear understanding of and interest in the latest cameras.



Expert interview

We specialize in computer animation, which is about recreating the motions of different forms of life on a computer screen and programming them to move around as directed by the user.

Two factors are crucial in computer animation research. The first is thorough observation and a clear understanding of reality. In order to create virtual characters that move around like humans, the mechanism, patterns and causal relationship of human motions must be understood and modeled mathematically. If imagination is added, you can end up with an innovative character such as Gollum from Lord of the Rings. Thus, computer animation research can be said to be an area that brings reality and imagination together and realizes the combination on a computer screen. I believe our findings will be widely applied to diverse areas of both reality and VR.



Lee Je-hee / Professor in the Department of Computer Science and Engineering, Seoul National University



DIY VR Glasses



Written by
Min-chul Shin (Singil Middle School teacher)



Product overview

■ Product function

Product function: To help students gain an understanding of the VR realization principle by making DIY VR experience glasses in parallel with the size of their smartphone.

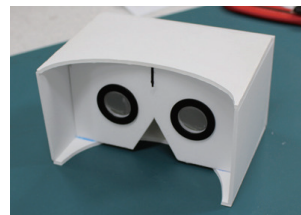
■ How it works

Students experience VR through the interaction between the convex lenses of VR glasses and focal length using the VR experience app downloaded on the smartphone. A variety of app options is offered. Students can experience VR by moving around in all directions.

■ Product picture

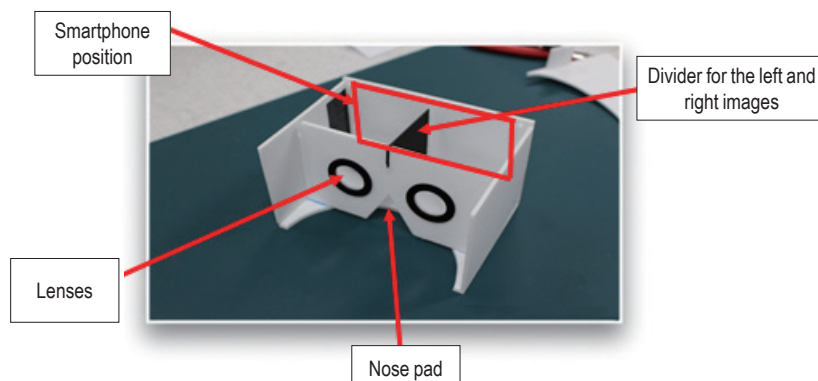


Cardboard VR glasses (from Google)



Styrofoam board VR glasses

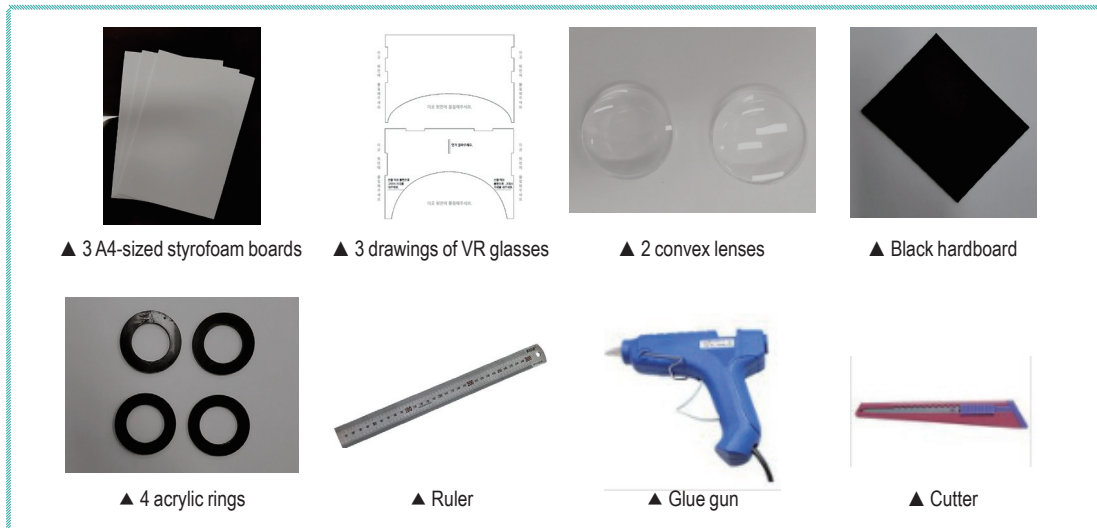
■ Product structure



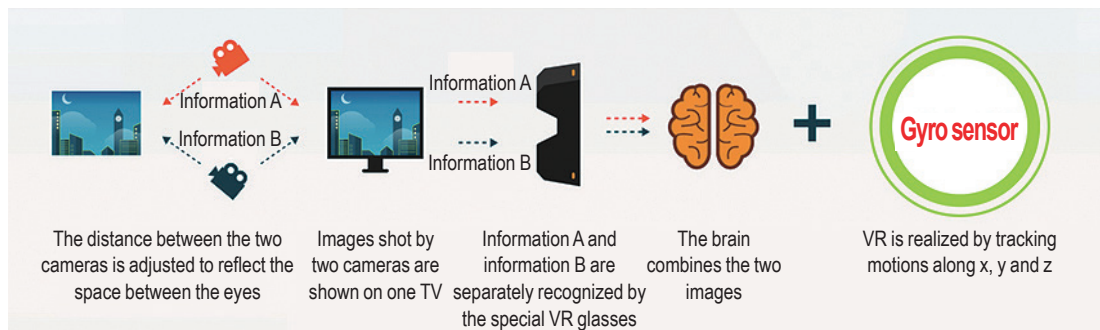


Production overview

- **Production time** : About 1 hour
- **Needed materials and tools**



- **Key production principles** : VR realization principle



- **What requires attention in production**

- ① Design your VR glasses in parallel with the size of your smartphone.
- ② Download an app for VR experience in advance (some are large in size).
- ③ Use the cutter very cautiously.

- **Required knowledge and functions**

- ① VR realization principle
- ② Ways to experience VR with VR glasses
- ③ Characteristics of each material and how to use tools

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- ❶ Artificial Intelligence
- ❷ Driverless Vehicles
- ❸ IoT(Internet of Things)
- ❹ **Virtual Reality**
- ❺ CRISPR
- ❻ Space Launch Vehicles
- ❼ Natural Disasters
- ❽ Smart Medicine
- ❾ Game Engines
- ❿ Sports Statistics

SW Education Module Textbook ❹ Virtual Reality

Truer than True Virtual Reality

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