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Integration Head Mounted Display Device and Hand Motion Gesture Device for Virtual Reality Laboratory

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Abstract. Virtual Reality Laboratory (VR Lab) is an innovation for conventional learning media which show us whole learning process in laboratory. There are many tools and materials are needed by user for doing practical in it, so user could feel new learning atmosphere by using this innovation. Nowadays, technologies more sophisticated than before. So it would carry in education and it will be more effective, efficient. The Supported technologies are needed us for making VR Lab such as head mounted display device and hand motion gesture device. The integration among them will be used us for making this research. Head mounted display device for viewing 3D environment of virtual reality laboratory. Hand motion gesture device for catching user real hand and it will be visualized in virtual reality laboratory. Virtual Reality will show us, if using the newest technologies in learning process it could make more interesting and easy to understand.

1. Introduction

Microsoft Asia News Center in 2016 said 3 top challenges ahead for all educators in the world for facing technology were 53% training, 51% budget and 46% integration of technology with curriculum. So, all educators in the world try hard for using technology maximal in education process. They always make many innovations on learning media with technology. They hope can make a learning media which more interactive, effective, efficient, and also giving new atmosphere in learning process

The most successful media in learning process is media using virtual reality because of much integration among dimension in learning process [1]. A number of developments in media which using visualization (image), audio and video (multimedia) until virtual reality (VR) and Augmented Reality (AR) are increasing time by time. Those are addressed for making a learning process more interactive, effective, and efficient [2]. Virtual reality, a part of multimedia computer will be a trend in learning mode and also a new strategy for learning system [3]. Finally, combination many technologies such as head mounted display device and hand motion gesture device is used for making a learning media with simulation laboratory in it. Concept of virtual reality will be applied to make a media.

In this paper, we create VR physics Lab media which has integration between facilities of laboratory for doing practical with user interaction and using supported technologies, head mounted display device (Oculus Rift DK2) and hand motion gesture device (Leap Motion Controller). VR media is expected increasing a number of innovations in conventional learning media, and also could be described a learning process in laboratory which has many apparatus and material for practical.

2. Previous Work

The number of virtual reality research are increasing time by time. Some of them focus on education. In 2015, VR chemistry lab [4] is a novel 3D about chemistry laborite which using virtual reality technology was created. There were many supported device for VR Chemistry Lab, but only one practical in it, Titration process practical. It's about a neutralization reaction for calculate liquid concentrate. Leap motion controller and Oculus rift DK2 were supported device for VR Lab. Leap motion for recognizing all gesture like turning knob and touching button. Oculus Rift DK2 (like headset) for displaying and allowing user to look in any direction.

A company that dedicated to develop lab simulation [5]. Labster's lab is a media online for teaching about life science like biology, biochemistry, genetics, biotechnology and chemistry. Labster company has many collaborations to apply simulations lab. Labster's lab was designed for universities and colleges. There were many practicals which is doing by user. 3D virtual learning was applied and lab's environment like virtual as usual. It included 3D apparatus, 3D Animation, 3D environment and questionnaire.

3. System Overview

In this section, we explain about VR Lab's system, it can be seen in figure 1. Development of VR Lab used unity 3D [6], for developing game in a cross platform. The supported technologies were head mounted display device (Oculus Rift DK2[8]) and hand motion gesture device (Leap Motion Controller [7]). The input system used leap motion which can recognize hand motion gesture and Oculus Rift DK2 which can track head orientation and position, and the output system used Oculus Rift for displaying 3D virtual reality.

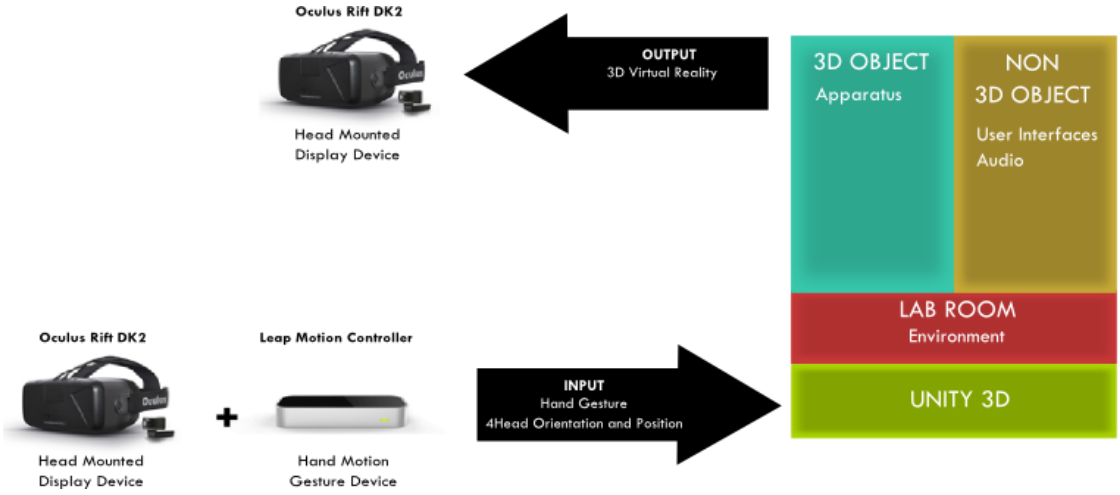


Figure 1. System Overview of Virtual Reality Laboratory

3.1. Head mounted display device

3.1.1. Oculus rift DK2. Head mounted display device lets user seeing and moving free in virtual world (Virtual reality technology). This device can be seen in figure 2. The technology's name is oculus rift DK2. Development of Oculus are classified by 2 categories, Development Kit 1 (DK1) and Development Kit 2 (DK2) [4].

Figure 2. Oculus Rift DK2
(Source: http://fahs_techteam.blog)

3.1.2. Oculus rift DK2 as head mounted display device. Oculus Rift displays our virtual reality on user's eyes directly include 3D Laboratory and it's all apparatus and material. So, it be seen so realistic. Actually, not only handle display output for user. Oculus rift also get user's head movement and positions. All information is caught by 3 sensors, gyroscope, accelerometer and magnetometer. They run Oculus Rift's functions such as head tracking and positional tracking. Head tracking is a condition for recognizing all user's head movement such as turning head to the right or left/ up or down. Positional tracking is a condition for oculus rift analyzing object for near/far position.

3.2. Hand motion gesture device

3.2.1. Leap motion controller. Hand motion gesture device can be seen in figure 3 is a device with sensor technology for catching physic data of human's hand movement such as pointing, grabbing etc.

Figure 3. Leap Motion Controller
(Source : http://apps.leapmotion.com)

Leap motion controller has 2 cameras IR (infrared) monochromatic and 3 LEDs IR. All human's hand movement will be caught in device's area. Function of 3 LEDs, produce infrared light then 2 cameras IR will be produced a grayscale image until 300 fps. Those data are sent to the computer with USB cable.

3.2.2. Leap motion controller as hand motion gesture device. Leap Motion controller can detect human's hand movement with skeletal tracking method. Skeletal tracking is method for reading information about hand position and human's finger. Leap motion controller's signal will collide with hand and finger, and then signal will be received by computer for determining coordinate user's hand and finger. So, Leap motion controller can recognize all gesture (given and declared first) for interaction with VR Lab.

3.3. Scenario

We had a scenario for VR Lab. First, user choose one practical. There was more than one practical in it. After that, user should take all apparatus for doing practical. User did practical with needed apparatus. And then, user did all steps practical. In the end of practical, user had to answer the quiz. All quiz was used for making sure if user understand about theory of practical. See figure 4

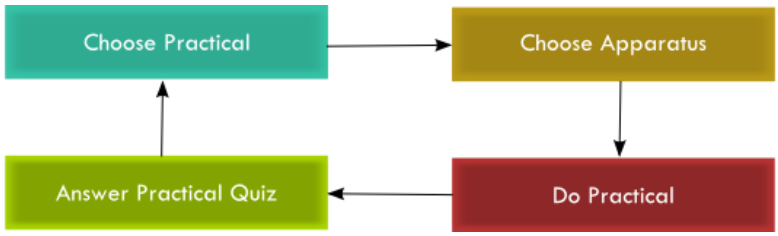


Figure 4. Scenario Virtual Reality Laboratory

4. Implementation

4.1. Integration head mounted display device (oculus rift DK2) and hand motion gesture device (leap motion controller)

Integration 2 devices with different function could be integrated with some engine. There were many engines for developing and making integration both devices. This research integrated head mounted display device and hand motion gesture device not only in software but also in hardware. The result of integration device (hardware) can be seen in figure 5. Leap motion controller was attached to Oculus Rift DK2 with universal VR Dev Mount. This was a place for putting Leap motion controller.

Figure 5. The result of integration device

4.1.1. Unity 3D. Integration both device (software) in this research use unity 3D engine. Unity 3D engine is produced by Unity Technologies, 2005. Unity engine is used for developing games or simulation (2D or 3D) for PC, mobile, console and websites. So, Unity's target platforms are PC (windows, macOS, Linux), mobile (android, blackberry, tizen, iOS, windows phone), console (Playstation, Nintendo, Wii, Xbox) and websites (Facebook). Integration those devices can be helped with Leap Motion Package v2.3.1, Leap motion IR camera object attached to the camera Oculus Rift DK2 Object. Therefore, our hand model can be displayed in VR Lab.

4.2. Virtual reality laboratory

4.2.1. Modularization concept. Modularizations Concept was applied to VR Lab. Three practical are provided in it, so user can select one of them. Not only practical selection, modularization concept was also applied on apparatus and material selection. First meaning, user can select only apparatus which they are needed in practical, then user do their chosen practical. Second meaning, user can select all apparatus, then they do their chosen practical but they only use apparatus which are needed in practical. Third meaning, user can select many apparatus and select all apparatus which are needed in practical, they can do practical but if they don't select all apparatus which are needed in practical, they can't do practical and have to select all needed apparatus

4.2.2. Asset virtual reality lab. VR is a simulation of real object into virtual object. All objects in virtual world was called Asset. Asset in VR Lab contain 3d and non 3d objects. 3D objects such as environment, apparatus and non 3d objects such as UI and Audio. See figure 6

(a) (b) (c)

Figure 6. Asset virtual reality lab: (a) environment (b) apparatus (c) UI

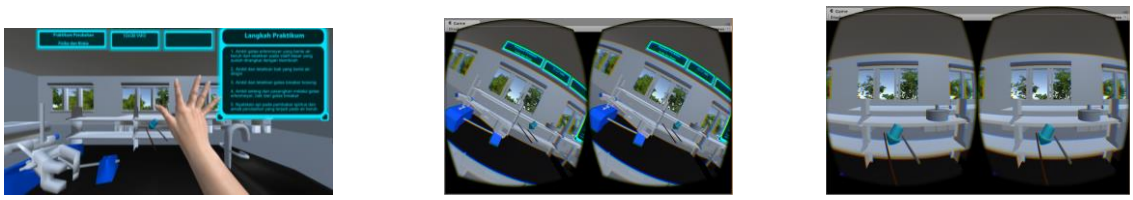
4.3. User experiences

We gave more new experiences for user after using VR Lab. First, user's gesture and user's movement. User's gesture is all hand gesture for interacting with VR Lab. There are 5 gestures, grab, drag, put, touch, and swipe, it can be seen in figure 7.

All gestures have different functions. Grab, drag and put gesture for grabbing / moving object for one position to other positions. Touch gesture for touching 3D or UI (non 3D) and swipe gesture for moving one scene to other scene.

User's movement are classified into 2 types. Head movement and body movement. Head movement, user can move their head freely and see around VR Lab. User can turn their head to the left/right and up/down. So, they can see 360^{O}. Body movement is movement of body's user to walk around such as go/back forward or turn left/right. So, user can walk from one position to other position.

All gesture and movement are applied for giving new experiences for user and making this research more immersive.



(a) (b) (c)

Figure 7. User Experiences: (a) gesture (b) head movement (c) body movement

5. Experiment

In this section, we did experiment about VR Lab. This was tested by junior and senior high school students. There were 30 students and teacher try VR lab. See figure 8.

Figure 8. Trying VR Lab

They tried all steps in this VR Lab and were guided by us. After they did all steps, they were given a questionnaire and could give us a feedback about VR Lab. We tested our VR Lab use PC's specification and specification software, it can be seen table 1 and 2.

Table 1. Specification PC

	iMac
Processor	3.2 GHz Intel Core i5
Memory	8 GB 1600 MHz DDR3
Graphics	NVIDIA GeForce GTX 675MX 1024MB
System Type	64-Bit
System Operation	OS Sierra

Table 2. Specification Software

Engine	Unity 5.3.3.1f
SDK Leap Motion	v2.3.1
SDK Oculus	0.5.0.1 Beta

For collecting feedback from user, we give them a questionnaire. There were 7 questions in this questionnaire, about their knowledge about VR, quality of VR and their impression after trying this VR.

50 % user know about VR but 57% never try VR So they never how feel playing VR is. Then 67% user said Quality of VR Lab Graphics was so fantastic, 55% Quality of VR Lab Sounds was enough for giving the atmosphere of lab and 54% explanation of practical's theory could be understanding enough clearly by them. Then, after trying VR Lab, 67% said if doing practical in VR Lab was more immerse than conventional Lab, and the last 97% said this research need more development such as more practical or etc. See figure 9.

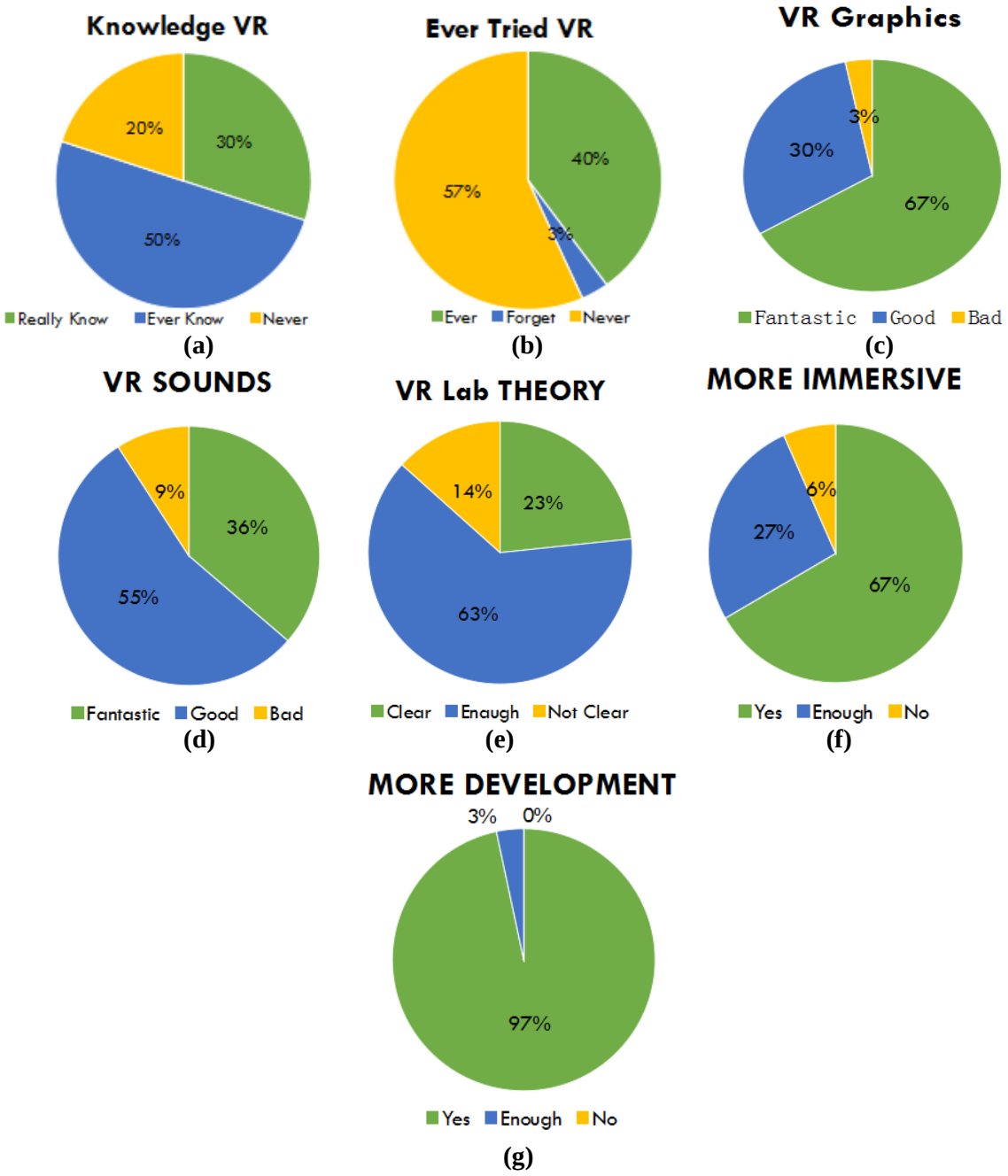


Figure 9. The Result of Questionnaire: (a) Knowledge VR (b) Ever Tried VR (c) VR Graphics (d) VR Sounds (e) Understanding VR Lab's theory (f) VR Experiences (g) VR Next Development

6. Conclusion

We developed another VR Lab that focus on physics subject and this research targets were students of junior and senior high school. The result of this research was we succeed to make a new media using VR technology which has fantastic graphics, good sounds, and more immersive. So, all students felt more interesting and easy to understand when using this media in learning process.

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