Evaluation of Computer Engineering Practicum based-on Virtual Reality Application

I Gde Dharma Nugraha
Computer Engineering Department of Electrical Engineering, Faculty of Engineering, Universitas Indonesia

Kosasih, Dede
Computer Engineering Department of Electrical Engineering, Faculty of Engineering, Universitas Indonesia

https://doi.org/10.5109/4774234

出版情報：Evergreen. 9 (1), pp.156-162, 2022-03. Transdisciplinary Research and Education Center for Green Technologies, Kyushu University
バージョン：

Evaluation of Computer Engineering Practicum based-on Virtual Reality Application

I Gde Dharma Nugraha[1,*], Dede Kosasih[1]
[1]Computer Engineering Department of Electrical Engineering,
Faculty of Engineering, Universitas Indonesia, Jakarta, Indonesia

*Author to whom correspondence should be addressed:
E-mail: i.gde@ui.ac.id

(Received February 11, 2022; Revised March 22, 2022; accepted March 22, 2022).

Abstract: COVID-19 Pandemic had an impact not only on public health but also on general human activities. Various activities had to be done from home, including education. One activity that has been forced to be done in the home is Computer Engineering Practicum. Since the practicum had to be done at home, the student lacks the experience if the practicum is held offline. Therefore, various research has been conducted to improve students' experience while doing their practicum at home. In this study, we explore the possibility of Virtual Reality (VR) technology to set up an online practicum for Computer Engineering. We develop the scenario and the virtual environment to feel the experience to conduct the practicum. We held the survey to gather opinions from the students. The survey result shows that the correlation coefficient value from Kendall's Tau-b correlation test is 0.811. This value means that the student experience during practicum using VR technology is close to the experience in offline practicum.

Keywords: Virtual Reality; Education; Practicum; Covid-19; UI/UX; E-Learning

1. Introduction

Corona Virus Diseases-19 (Covid-19) outbreaks significantly impact human activities. The Government had set up various policies to avoid the spread of the Covid-19. One strict policy is that the students have to learn from home [1,2]. The various education process must be held from home, including the practicum activities.

Various technology has been conducted to support the students who learn from home [3–5]. Learning Management Systems (LMS) had been used to deliver the course material and conduct some evaluations. This tool has influenced various education processes in the education institution [6,7] and has been developed according to the user personality [8]. However, this application is not enough to support the practicum process. The student's experience for the practicum process is not similar between the LMS and the offline process. Therefore, another technology needs to be utilized to improve the student's experience for the practicum process[9].

One technology that is gaining interest nowadays is Virtual Reality (VR) [10,11]. The VR technology provides a virtual environment that is close to the natural environment. This virtual environment can provide the virtual practicum environment for the student to conduct the practicum from home. Then, the students can have experience close to the actual practicum[12].

In this paper, we present our study regarding VR environment setup for computer engineering practicum. We utilized the Oculus device equipped with a headset that displays virtual images and audio. The Oculus is also equipped with a Joystick or Oculus Touch, allowing users to move directly and touch all objects in the virtual environment. We set up a virtual environment with these devices to provide a hands-on experience for the students. To assess the students' experience, we conducted the survey and processed the data using Kendall's Tau-b correlation method.

2. Basic Theory

2.1 Virtual Reality (VR)

VR is an artificial environment comparable or utterly different from the real world. The usage of VR can include entertainment, such as playing games, research, and teaching. VR will typically generate realistic images, sounds, and other stimuli, using a virtual reality headset or multi-project environment to simulate the user's physical presence in the virtual environment. A person with virtual reality equipment can see, walk around, and interact with virtual features or objects throughout the artificial environment[13].

There are various brands and types used by VR technology. The most common device is the smartphone used to project images of the actual environment to the VR. The image produced on the smartphone will be forwarded to a convex lens so that the eye view looks broader and more focused when it is right in front of the eye[14].

2.2 Non-Immersive Virtual Reality

Non-Immersive virtual reality is one type of virtual reality technology generated from a computer but still allows the user to remain alert and control the physical environment. This technology has been widely used in everyday life. This non-immersive virtual reality system is found on computers or video game consoles, displays, and other input devices such as keyboards, mice, and controllers[15].

2.3 Semi-Immersive Virtual Reality

Semi Immersive virtual reality provides a virtual environment that provides a different perception of reality. This technology allows users to stay connected to the surrounding environment when users focus on digital images. Semi-immersive technology supports realism using 3D graphics, otherwise known as vertical depth of reality. The more detailed graphics of this type of VR give the user a more immersive feel. They are often used for education or training and rely on high-resolution screens, powerful computers, projectors, or loud simulators that partially replicate the available design functionality of actual-world mechanisms[16].

2.4 Fully-Immersive Virtual Reality

The fully immersive simulation provides the user with the experience close to the actual situation and is equipped with sight and sound. Users need the right VR glasses or Head Mount Display (HMD) to feel the best experience and interact with fully immersive virtual reality. Meanwhile, Headsets on WR require high-resolution content that is equipped with a wide field so that it can see the natural environment. This display is usually split between the user's eyes to create a stereoscopic 3D effect and is combined with input tracking to create an immersive and believable experience. This fully immersive VR type is usually used for games and other entertainment purposes according to user needs. However, the use of this technology continues to increase not only in the entertainment sector but also in the education and employment sectors[17].

2.5 Oculus Rift

The Oculus Rift is a Google Ski-Masked Shaped virtual reality-based device that connects to a computer or smartphone. The Oculus Rift is a headset that provides users with a visual image to feel they are in a virtual world. In one set, the oculus rift consists of goggles shaped like ski goggles that display a screen with two adjacent images for each of the right and left eyes. A combination of lenses above the screen allows zoom-in and zoom-out features to form a stereoscopic three-dimensional image. There is a sensor that adjusts the image by following the user's movements. In some versions of the Oculus Rift, the device is supported with external position tracking, which helps track the user's movements more accurately and provides a more realistic virtual image[14].

With sensors consisting of a gyroscope, accelerometer, and magnetometer, the oculus rift provides a better experience than other virtual reality devices. Oculus rift is designed to solve problems that exist in VR, namely motion sickness and dizziness after using the device[18].

2.6 Augmented Reality

Augmented Reality (AR) is a variation of VR where virtual objects interact with the natural environment. In operation, AR requires a combination of virtual and real objects in a natural environment, running interactively with real-time and with virtual objects. In other words, this technology must be registered validly directly proportional to the virtual world with the real world. In contrast to VR, which creates a virtual environment that provides a user experience, AR refers to merging virtual objects into an accurate three-dimensional scale[19].

2.7 Unity

Unity is a software or application used to develop 3D video games, architectural visualization, Real-Time 3D animation, and interactive media installations. Unity can be run on most modern operating systems, and games produced from Unity can be run on computers, Android smartphones, Wii, iPhone, iPad, Playstation, and X-Box 360. In addition, Unity can produce games on a browser on Mac. and Windows by using the web player plugin[20].

Unity has several main sections, including Game Objects, Projects, Scenes, Components, Prefabs, and Assets. As one of the solutions provided by the makers, Unity offers an asset server that can be used on all scripts and game assets that can support projects consisting of various gigabytes files and thousands of multi-megabyte files. This feature allows Unity users to store metadata that can be run in various graphical versions. Unity has two types of licenses, namely Unity Personal and Unity Pro. Unity Pro is equipped with built-in features such as post-processing effects and rendering effects.

2.8 Oculus Integration

Oculus integration is an essential VR feature, component, script, and plugin for developing Oculus apps in Unity. It includes several essential SDKs to assist with advanced rendering, social and community building, sample frames, audio, and avatar development—VR, Audio Manager, Avatar, Platform, Framework, Spatializer, and several other things. The Oculus incorporates advanced renderer, social, platform, audio, and avatar development capabilities for Oculus VR devices and some Open VR supported devices[21]. This incorporation includes the following features:

- Audio Manager. It contains scripts to manage all

your application's audio and sound effects.
- Avatar contains the scripts and prefabs needed to add an Oculus Avatar to a program or application.
- LipSync is a collection of plugins and scripts that can synchronize avatar lip movements with spoken voice.
- The platform includes all functionality of the Oculus Platform Solution to applications.
- Sample Framework is a folder containing the main principles of Integration
- Spatializer contains scripts and plugins to add a sound source and make it sound like it is coming from a specific direction.
- VoiceMod, plugins, and script set to modify incoming audio signals.

2.9 XR Interaction Toolkit

XR Interaction Toolkit is a component-based interaction system that has been provided by Unity to simplify VR performance and creation. This toolkit provides a framework for 3D interaction and UI to be accessed through Unity. The core of this system is a collection of interactor and interactable components and an Interaction manager that links the two types of components[22].

2.10 Human-Computer Interaction

Human-Computer Interaction (HCI) is increasingly focused on the efficiency and effectiveness of use beneficial to end-users. The development and manufacture of software, hardware, and applications are based on human behavior. The current development of HCI can also lead to VR and AR, which provide new experiences for interaction. The interaction formed from virtual reality technology presents a different experience because users can interact with objects virtually and do not exist naturally or physically.

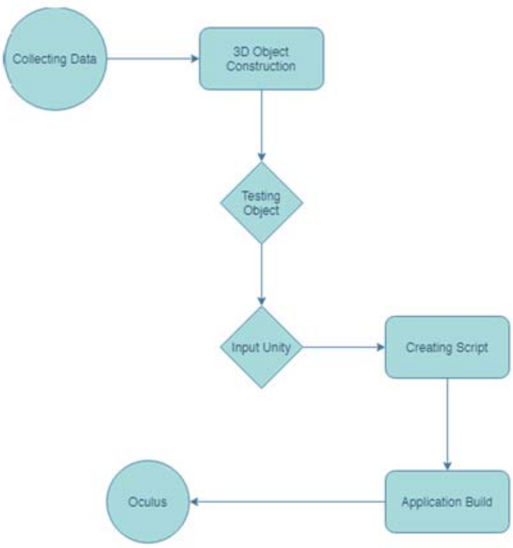

Fig. 1: Flowchart Design

The application of virtual reality technology can be applied in education, which is expected to help students further develop their talents by interacting directly with the VR using existing methods virtually. By utilizing virtual reality technology, interactions that previously could not be done due to certain things that require students to stay active at home can be done using virtual reality[23].

3. System Design

3.1 General Description

In the application of virtual reality-based practical simulations, the application uses a headset such as the Oculus Rift. Its manufacture uses Unity, in which many features will make the environment or object interact with its users. The creation of objects and environments in the simulation is carried out based on natural conditions and environments.

In the process illustrated in Figure 1, making applications for VR begins with the data collection process. The data collected is in the form of what activities are in the simulation, what objects must be included in the actual environment, and some other data that will support creating an environment as similar as possible and as natural as possible.

3.2 System Specification

The research was conducted by designing a system that uses a set of software. The main software used in designing this system is Unity 2019.4.28f1. Unity as the main software is run using the researcher's laptop device and is used to develop a VR simulation system. Additional software was used to support the implementation of the simulation design in Blender. While the hardware or hardware used is the Oculus Rift. The specifications used in software and hardware are shown in Tables 1 and 2[18].

Table 1. Specification Oculus Rift

OS	Windows: Vista, 7, 8, 10 MacOS: 10.6+ Direct3D10 or OpenGL 3 Linux: Ubuntu 12.04 LTS
Chipset	ARM CortexM3 Micro-controller
Display Technology	OLED
Pixels Per Inch (PPI)	441
Head Tracking	Yes
Positional Tracking	Yes
Video Output	DisplayPort 1.2
Sensors	Gyroscope,Accelerometer, Magnetometer
Inputs	HDMI 1.4b, USB, IR Camera Sync Jack
Stereoscopic 3D capable	Yes
Display Resolution	960 x 1080 (1.13:1) [1920x 1080]
Camera Videos	1.1 MP (1408x792)
Refresh Rate	75 Hz, 72 Hz, 60 Hz
Price	Rp 7.000.000

Table 2. Specification Computer

Computer Name	DESKTOP-2SKJM1P
OS	Windows 10 Pro 64-bit
Processor	Intel(R) Core(TM) i5-7400 CPU @ 3.50GHz (4 CPUs)
GPU	GTX 1660 Ti
Dedicated Video Memory	6 GB
Shared System Memory	4032 MB
RAM	16 GB
Storage	240 GB SSD + 500 GB HDD

3.3 The Scenario of Practicum using VR

The VR environment can be entered when the students open the application on the computer and use the Oculus headset to see the virtual environment and use the Oculus Touch as a controller to interact with the VR objects. The objects in this scenario are the computer components such as motherboard, CPU, memory, hard disk, etc. In the VR environment, the student has to arrange the computer components so that the computer can run properly. If the student makes a mistake in placing the components correctly, the computer can not run properly, and the student can push the restart button on the menu. If the position of components is in the correct position, the student can turn on the computer. Figure 2 illustrates the scenario of the practicum using VR.

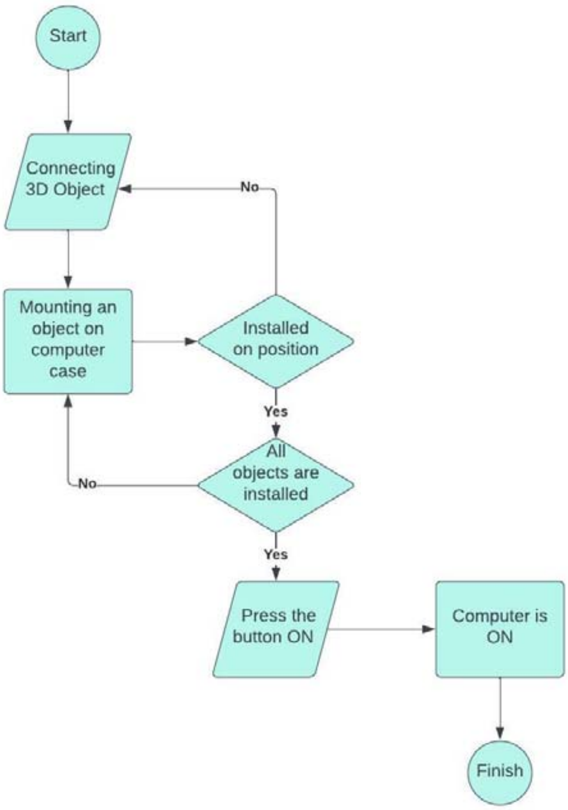

Fig. 2: Scenario Flowchart of Practicum based on VR

3.4 VR Creation

In this study, we utilized Blender software to create the 3D Objects related to the Computer components. We create 3D objects that appear close to the actual components. After creating the 3D objects, we use the Unity application to create the VR environment and design the interaction between the student and the components. Figure 3 shows the 3D creation of the whole computer. Figure 4 shows the 3D creation of the computer components.

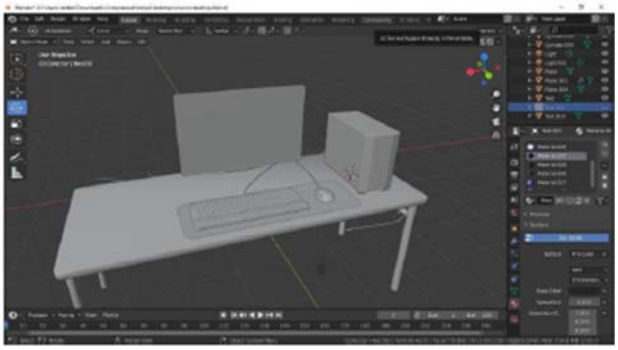

Fig. 3: The Computer object designed in the Blender Software

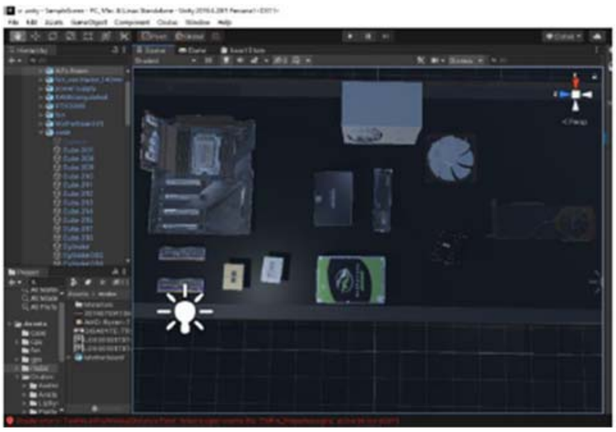

Fig. 4: 3D object creation for the Computer Components

Fig. 5: The student uses the Oculus device

4. Experiment and Analysis

4.1 VR Implementation

We experiment by asking the student to use the Oculus Rift VR headset, hold the Oculus Touch and run the executable file created by the Unity software. The student can see the VR environment through the Oculus Rift and interact with them using the Oculus Touch. Figure 5 shows the setup of the devices on the student.

The student can see and interact with the computer components in the VR environment. The student uses the Oculus Touch to interact with the components and place them correctly. Figure 6 shows the appearance of the computer components.

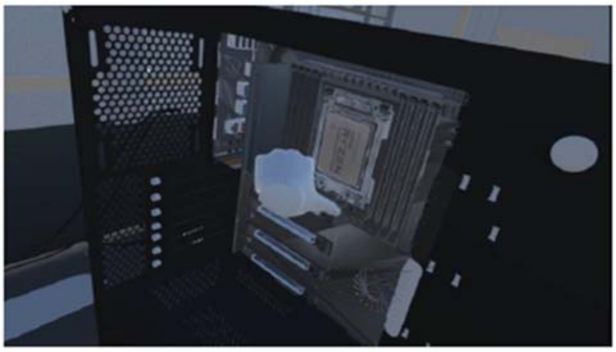

Fig. 6: Computer Components in the VR Environment

In this simulation, if the student successfully places the components in the right place, a new ON button will appear. The student can press the ON button to turn on the computer. The practicum is finished when the computer is turn on properly. Figure 7 shows the moment when the computer is on.

Fig. 7: Computer On when the components are installed properly

One of the features of this VR application is the restart menu. This menu is placed on the OVR Camera Rig, which allows the student to access this menu anywhere. This menu can be used to rerun the application after finishing or restart the application when the student makes a mistake. Figure 8 shows the position of the restart button.

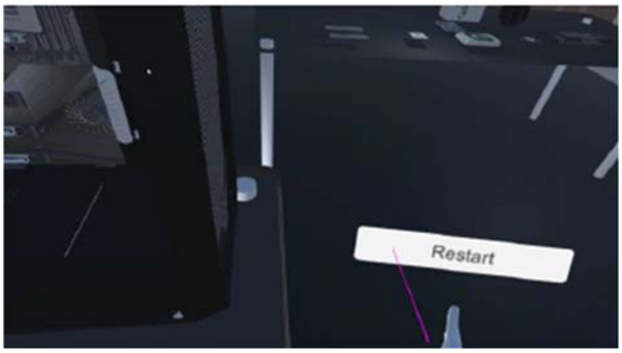

Fig. 8: The position of the Restart menu

4.2 User Feedback Analysis Method

To evaluate the experience of the VR application, we asked the 20 participants to use the application and fill the survey. The simulation is conducted in the lab environment so that the students will have the same experience. From the collected survey data, we use the Kendall Tau Correlation Test to analyze the data. This method is intended to determine if the VR-based application can meet students' expectations. The survey is conducted using the facility provided by the Universitas Indonesia, namely, survey.ui.ac.id website[24)].

The Likert scale is used to determine the score in the questionnaire. The Likert scale is used to measure attitudes, opinions, and perceptions of a person or group about social phenomena, which in this case, the phenomenon being measured is the respondent's experience in using a virtual space that has been designed in[25)]. Respondents were asked to answer and complete the questions or statements on the questionnaire made by the researcher referring to the parameters determined by the researcher.

In this study, the Likert scale used was five scales based on Hertanto's theory [18], where a questionnaire using a Likert scale with five scales accommodates answers than respondents who were neutral or hesitant[26)]. Compared with the four-scale Likert scale, respondents who are doubtful or neutral about the statement submitted will have difficulty determining and have implications for the significance of the questionnaire results. In addition, when compared to a 7-point or 13-point Likert scale, the 5-point Likert scale makes it easy for respondents to distinguish and understand the information from each point. The answer parameters used in each scale point are: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree.

4.3 Analysis Result

Based on the results of the questionnaire recapitulation, obtained as many as 20 respondent data from the target of 20 data. The survey target consisted of 14 respondents majoring in computer engineering and six respondents from electrical engineering. Based on the actual data from the questionnaire, the actual number of respondents has met the number of target respondents with the background of the respondent's majors following research needs. We use the SPSS software to analyze the data.

Table 3. Data Correlation Test Results using SPSS

Correlations

			Practicum Problems	VR-based Practicum Implementation
Kendall's tau_b	Practicum Problems	Correlation Coefficient	1.000	.811*
		Sig. (2-tailed)	.	.049
		N	20	20
	VR-based Practicum Implementation	Correlation Coefficient	.811*	1.000
		Sig. (2-tailed)	.049	.
		N	20	20

The result of the processed data can be shown in table 3. Based on the results of Kendall's tau-b correlation test output using SPSS data processing software, the data significance value or Sig is obtained. (2-tailed) on the variable resulting from the questionnaire is 0.049. In this analysis, variables can be stated to have a relationship if the value of Sig. (2-tailed) < 0.05. Meanwhile, if the value of Sig. (2-tailed) > 0.05, then the relationship between variables is not significant or has no relationship with each other. So it can be concluded that there is a significant or real relationship between the variables of Practical Constraints and VR-based Practical Applications.

After knowing the existence of a relationship between variables, Kendall's Tau-b correlation test can determine the level of closeness of the relationship by looking at the correlation coefficient between variables. In the correlation test results obtained, the correlation coefficient value between variables is 0.811*. This value is included in the coefficient value interval of 0.76 – 0.99, which means that the relationship between variables is very close. Meanwhile, the asterisk (*) indicates the significance of the relationship formed with a significant number of 0.005.

The correlation coefficient value of 0.811 proves a positive or unidirectional relationship that can be interpreted as increasing the effectiveness of practicum activities through VR-based applications that previously experienced problems due to the pandemic.

5. Conclusion

In this study, we study the usage of VR technology to conduct the computer engineering practicum. We have succeeded in developing a VR application and can be used by the students. The developed VR application can help students improve their skills when conducting the practicum based on the VR application. In the correlation test results obtained, the coefficient value between the Practicum Constraints and VR-based Practical Applications is 0.811, which means that the relationship between variables is very close. Hence the experience gained by the student in the VR application is close to the actual practicum.

Acknowledgments

This work has been supported by Hibah Riset Kompetitif (PUTI Q1 2020) Research Grant 2020 from Universitas Indonesia No. NKB-1409/UN2.RST/HKP.05.00/2020.

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