DEVELOPMENT OF INTERACTIVE OBJECTS USING UNITY 3D FOR OCULUS RIFT WITH MOTION SENSOR

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In dedication to my beloved family, friends and most of all, my supervisor Dr. Fajar bin Abdul Manap for his generous guidance, patience and never ending support throughout the project.

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ABSTRACT

With the advance of technology, 3D visualization is no longer unachievable. In order to achieve 3D visualization, computer that supports high graphical quality is already sufficed. However, for one to be fully immersed to experience 3D visualization has become a breakthrough in virtual reality system with the emerging of Oculus Rift. Virtual reality technology has been classified as emerging technology that is relatively fast growing with prominent impact and ambiguity. The potential of virtual reality technology is still currently being explored to fully utilized it to aid in many industries that is not only limited to gaming field since Oculus Rift is first being introduced as a headset that provides immersive gaming experience. Virtual reality technology is being applied in education field to bring school books to life, reducing training cost for medical surgery practices for medical students and enabling designer to explore own design through immersive 3D modeling. Thus, this project aimed to exploit the Oculus Rift combining with Leap Motion sensor to provide immersive interactive virtual environment that is suitable for the application in education field. Virtual Reality Keyboard-Dictionary and "LEGO" mode is developed by using Unity3D integrated with Oculus Rift and Leap Motion sensor to effectively enhance learning process with knowledge being delivered in a whole new interactive virtual environment where the command is being controlled using hand gesture. With suitable methods used and algorithms designed, a fully interactive virtual environment that implemented virtual hand controlled system is the outcome of the project.

ABSTRAK

Pada era yang modernisasi ini, visualisasi 3D dapat dicapaikan dengan kecanggihan dan kemajuan teknologi. Kecapaian visualisasi 3D adalah melalui kegunaan komputer yang menyokong fungi untuk memaparkan grapik yang berkualiti tinggi. Dengan pengenalan dan kemunculan alat teknologi visualisasi yang bernama Oculus Rift, alat tersebut telah menjadi satu kerjayaan dalam teknologi realiti maya yang mampu memberi peluang seseorang untuk mengalami visualisasi 3D secara mendalam di satu persekitaran maya yang dicipta dengan kegunaan komputer. Teknologi realiti maya ialah satu teknologi yang dikategorikan sebagai teknologi kemunculan baru yang berkembang secara pesat dan mampu memberi impak serta sumbangan yang besar kepada pelbagai jenis industri. Di sampingan itu, pelbagai pengajian telah dibuat untuk mengembangkan potensi teknologi reality maya ini untuk penggunaan dalam bidang yang lain dan bukannya terbatas kepada bidang permainan komputer sahaja. Teknologi realiti maya sedang dikaji oleh pakar-pakar untuk diaplikasikan dalam bidang pendidikan supaya memberi suatu persekitaran pembelajaran yang berinteraksi, mengurangkan kos latihan pembedahan perubatan dan membolehkan pereka untuk meneroka reka bentuk sendiri melalui pemodelan imersif 3D. Oleh itu, perlaksaan projek ini adalah bertujuan untuk mengeksploitasi kegunaan Oculus Rift dan pengesan gerakan Leap Motion untuk mempertingkatkan proses pembelajaran melalui penyampaian ilmu pengetahuan secara interaktif di dalam satu persekitaran ciptaan imersif maya. Semua aktiviti dalam persekitaran ciptaan maya tersebut dapat dilakukan atau dikawal dengan kegunaan sistem isyarat tangan maya. Dengan penggunaan kaedah dan penerekaan algorithma yang bersesuaian, persekitaran maya yang berinteraktif yang dikawal dengan sistem isyarat tangan maya dapat dihasilkan.

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CHAPTER I

INTRODUCTION

1.1 Project Introduction

Virtual reality or known in short, VR has become more and more advanced as we have progressed through various stages of technological development. Higher capacity circuits allow for the amazing size shrinkage. As a result VR hardware that once spanned the whole room can now fit in the size of a hand. Despite the fact that its current, primary application seems to be immersive gaming, the Oculus Rift has a bright future in other arenas. The chief among these, without a speck of doubt, is education. Oculus Rift will make explaining scientific ideas and terminologies easy by providing visuals inside the Rift. Education can be fun and informative at the same time. Thus, this project's aim is to create a virtual environment that makes learning effective and interactive at the same time which then generated the idea of creating a virtual keyboard that can spawn objects based on the word that is being typed by the user. The objects created through typing of a word can be interacted by user through hand gestures like grabbing and throwing.

The Oculus Rift is known best for its popularity among gaming industry. However, with its advanced technology, it will be wastage to be applied only in immersive gaming. The founder of current famous social website that is currently being used worldwide, Mark Zuckerberg stated that he is going to make Oculus a platform for many other experiences. For years, virtual reality technology has been developed and

explored by many experts in order to make breakthrough in this marvelous technology besides being bounded in gaming areas. Thus, many scientists and engineers have started to apply VR in many different fields and it is proven that VR technology can be beneficial to the society apart from providing an immersive gaming experience for gamer.

The Leap Motion gesture controller will exploits a Virtual Reality device, Oculus Rift to deliver a wholly unique experience on augmented reality computing. The user is expected to be able to interact with objects or hovering menu interfaces such as buttons or application in VR which displayed in front of the eyes while wearing the Oculus Rift. The headset enables the user focused on a task or interacts with the virtual reality surrounding by using bare hand instead of controlling any joystick. Accuracy of interaction inside VR is expected to increase further as The Leap Motion sensor has been used to replace the joystick as controller. The project is focusing on getting the hand gesture using Leap Motion sensor as input to control the objects or hovering menu inside virtual reality which can be seen using Oculus Rift that replace non immersive system in virtual reality.

1.2 Objectives

The development of interactive objects using Unity 3D with Oculus Rift and Motion sensor aimed to achieve three objectives that provide the main idea on guiding the project towards succession. The three objectives are stated as below.

1. To develop interactive objects for Oculus Rift integrated with motion sensor which is the Leap Motion.
2. To design graphical user interface (GUI) and hand gestures for object interaction in virtual reality.
3. To develop virtual hand control system that is suitable to be implemented in education institute for more effective and interactive learning.

1.3 Problem Statement

Nowadays, it is hard to visualize things just based on imagination alone. Some may face problem when it comes to imaginary stuff. Students are most likely facing difficulties in imagining the reaction of molecules or trying to visualize how the heart pumps blood throughout the human body system. Furthermore, architect also will face problem in explaining his design to the client with bare words and only pictures drew in 3 dimensional (3D). With the advance of technology, 3D visualization is no longer unachievable. It provides the convenience of visualizing objects and even environment with the help of computers. With the computer technology now, visualizing the designs before construction or either provides immersive learning experience for students to learn inside virtual worlds can be done with ease and the aid of software. The project is aimed to provide a different perspective view and create a more convenient solution for the interactions inside the virtual reality. In education field, virtual reality can have a great impact to enhance the effectiveness of studies by providing a virtual environment for conveying information that can effectively capture attentions. Thus at last, learning can be fun, motivating and interactive at the same time.

1.4 Scope of Project

The scope of this project includes doing research on past projects in this field of interest and designing of user interface which can be separate into two parts which one part involved with software and another is hardware. The project includes the creation of interface for user to interact with objects inside a 3D virtual reality by using Oculus Rift and Leap Motion sensor for a more precise controlling. The project only involved the use of software to create and develop graphical user interface (GUI) which is known as Unity 3D program. The programming languages involved that used to build the interface is C# programming language. The project is limited to only the creation of simple object interaction inside a virtual world containing a virtual keyboard for user to interact with. Objects can be spawned by user based on the word typed using the virtual keyboard. The objects spawned can be interacted by user through hand gestures but only limited to grabbing and viewing it in a view of 360 degree. The library has limited vocabulary of words and objects. The library is currently limited to only 10 simple words. Another part

of the project is known as the “LEGO” mode. The “LEGO” mode allows user to create or build desired 3D objects using own creativity from stack of cubes. However, the “LEGO” mode is only limited to creating 3D objects by combining cubes but not other shapes. The “LEGO” mode can only be reset once a user made mistake or for the rebuilding purpose. The combining function of the cubes is activated once one cube touches another cube. The separation function of the 3D object is currently unavailable in this project.

As for hardware part, there is no involvement of constructing, designing or building own circuits as mainly the project is software based. The project’s hardware part involved the implementation of hardware such as Oculus Rift and Leap motion sensor for displaying VR world to user and the sensor enable user to interact with objects or GUI inside. The project involved the establishment of communication between both hardware with the use of Leap Motion SDK and Oculus Rift Runtime software so that the object seen inside VR can be interacted by user through the help of Leap Motion sensor.

1.5 Brief Introduction of Methodology

The project started by doing related research about the past projects. Secondary data will be reviewed initially through websites such as IEEE, Science Direct and articles or journals across the internet. As for the designing part, the project uses Unity 3D software to design the interface for Oculus Rift which combined with Leap Motion sensor. C# programming language will be the main programming languages used to create the graphical user interface (GUI). The project will be divided into a few stages where the first stage involves the establishment of communication between Oculus Rift and Leap Motion Sensor. Two softwares are needed to make the connection possible. Both of the devices are connected to computer through USB. Upon succeeding, user’s hand will be able to be seen inside virtual reality environment as virtual hand. The Leap motion sensor will act as a motion sensor to detect the hand gesture of user and all hand gesture perform in reality will be shown inside VR with the use of Oculus Rift.

As for the second stage of project, Unity 3D software will be used to design a simple object for user to interact. The virtual hand of user can now started to grab, throw or hold the object inside VR. C# programming language is used to make the interaction possible. For third stage of the project, Unity 3D software will be exploited further to create GUI such as hovering menu that appears through specific hand gestures, Virtual Reality Keyboard-Dictionary that spawned object based on the word typed and "LEGO" mode for 3D object building using cubes. Coding is used to allow those interfaces created to perform task after received touch interaction by user which is similar to touchscreen of a smartphone. Lastly, troubleshooting of the program will be done to ensure there is no bug found and the GUI designed can perform accordingly.

1.6 Report Structure

This project's thesis describe in details about the project by separating it into five chapters where each chapter will be discussing different information regarding the project.

For the first chapter, the purpose is to give a brief introduction about the project and what will be done throughout the project. Elements such as project overview, objective, problem statement, scope of project and brief discussing of methodology used will be outlined in this chapter.

Second chapter will focus on the literature review where past researches that had been done will be discussed. All related researches done by researchers related to Oculus Rift and Leap motion sensor will be summarized and compared to get a clear idea on the reason of this project is conducted.

Chapter III will discuss in details the methodology used in this project. This chapter is aimed to provide detailed information on how the project is conducted and the approaches used to obtain the desired result.

Result and discussion will be portrayed in Chapter IV. All results gained after conducting the project will be shown in this chapter and the analysis of result will be written to discuss the findings.

Lastly, in Chapter V will summarize the project done to come out with a conclusion on whether the objective of this project has been successfully achieved or not. This chapter also provides the suggestion or opinion for future development of project.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

In this chapter, all past researches that had been done by other researchers regarding or similar to the project's title will be studied and discussed. The discussion will include the method of conduction, result obtained, the advantages and disadvantages of their approaches while conducting their research. Comparisons are done as well to improve the current project and all approaches used in the past are studied as well.

2.2 Oculus Rift and Leap Motion Sensor

The Oculus Rift is a head-mounted virtual reality device which is developed by Oculus VR. The display of the Oculus Rift is made of OLED or also known as organic light-emitting diode with resolution of 1080x1200 per eye and a 90Hz refresh rate. The Oculus Rift has a custom sensor board that consist 3 main components of STMicroelectronics 32F103C8 ARM Cortex-M3 microcontroller, Invensense MPU-6000 (gyroscope + accelerometer) and Honeywell HMC5983 magnetometer. In addition, Oculus Rift is said to offer advantages over traditional HMDs. Oculus Rift provides Field of Vision (FoV) of approximately 110 degree diagonal and inbuilt rate sensors register that changes in angular head orientation in three dimensions with latencies better than 50ms [1]. The Oculus Rift has built in headphones with 3D audio effect and rotational and positional tracking. In the paper [2], the author was able to make conclusion stating that the use of Oculus Rift was promising especially in a small

enclosed spaces where space is limited based on the data collected in his study. The author had obtained result proven that Oculus Rift offered a portable and practical solution to examine vector and support multisensory integration.

In this project, the version of Oculus Rift used is known as DK2 shown in Figure 2.1 which was release in mid of 2014 where DK1 shown in Figure 2.2 was released in late 2012. DK2 has improvements over DK1 which includes lower persistence OLED display, higher refresh rate, positional tracking, a detachable cable and omission of the need for the external control box. The headset uses external camera to tracks infrared dots located on the front surface of the headset for motion tracking.

Figure 2.1 Oculus Rift (DK1).

Figure 2.2 Oculus Rift (DK2).

Leap Motion Sensor is a small motion sensor that is able to detect hand and fingers motions as input. It is developed by Leap Motion, Inc. which is an American