Chapter 4
Technical Details and Educational Applications for Virtual Reality Technologies

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ABSTRACT

The application of virtual reality (VR) in higher education has drawn attention. Understanding the state of the art for VR technologies helps educators identify appropriate applications and develop a high-quality engaging teaching-learning process. This chapter provides a comprehensive survey of current hardware and software supports on VR. Secondly, important technical metrics in VR technology are considered with comparisons of different VR devices using identified metrics. Third, there is a focus on software tools and an explore of various development frameworks, which facilitate the implementation of VR applications. With this information as a foundation, there is a VR use in higher education. Finally, there is a discussion of VR applications that can be potentially used in education.

INTRODUCTION

Virtual Reality (VR) uses computer technology to create a simulated environment with the user inside an experience. Instead of viewing a screen, users are immersed within and able to interact with virtual worlds (VWs). VR technologies have been developing at unparalleled speed and drawn wide attention. Successful uses flourish in various entertainment areas, including gaming, image processing, computer graphics, online shopping, etc. Lately, VR has been expanding as an advanced technology in areas such as conferencing, tourism, and education. There are three main types of VR used today: non-immersive, semi-immersive, and fully-immersive simulations.

Non-immersive is the lowest immersive and least expensive type of VR. It demands the lowest developed components, which permits users to react with a 3D environment via a stereo display monitor

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or glasses. Typical applications of this type of VR system include three-dimensional (3D) modeling and computer-aided design (CAD) systems (Burdea & Coiffet, 2003).

The semi-immersive VR system is all referred to as a hybrid system (Gadh, 1998) or augmented reality(AR) system. The goal of the semi-immersive VR system is to make the user unaware of their surroundings to the extent that they assume a new identity or interact in new and exciting ways. Some applications of semi-immersive VR are being used in aviation, health care, construction, and education. Oftentimes, experiences include a large concave monitor and a display system; for example, it resembles the big screen experience that can be seen in IMAX theaters and using high-end computer graphics. Another example of a semi-immersive VR experience is the Cave Automatic Virtual Environment (CAVE), where the driving simulator is one of its applications (Barrett, 2012).

The fully immersive VR system provides a maximum level of immersion. This system is a digital technology that enables users to experience real-world artificial environments. It usually includes tracking devices, head-mounted display (HMD), and data gloves. Examples include Oculus Quest, Oculus Rift S, PlayStation VR, Oculus Go, HTC Vive, Valve Index, and Pansonite 3D VR Glasses, etc., which present the users with 3D animations generated by the computer that gives the users the sensation of being part of the virtual environment. Typical user experience includes a virtual walk in a building.

Various terminologies, such as artificial reality (AR), virtual world (VW), virtual learning environment (VLE) and cyberspace, are used in discussions of VR. Overall, interaction is a way to communicate with the system, but unlike the traditional interaction between a human and a computer using a keyboard or mouse, the interaction in VR is performed in a simulated 3-dimensional space. Real time feedback and human engagement are a standard of proficiency in VR systems. The experience of user engagement will be constantly improved, as display and tracking devices become cheaper, more robust and better-designed.

In this chapter, technical metrics in VR technology and metrics of different types of VR devices will be discussed. Secondly, software and various development frameworks, which facilitate the implementation of VR applications, are examined. Third, will be a discussion of the application of VR on education. Lastly, a list of VR applications that can be potentially used for education will be discussed.

BACKGROUND

In 1957, Morton Heilig, a cinematographer, invented the Sensorama (U.S. Patent No. 3,050,870, 1962), a theatre cabinet multimedia device that offered viewers an interactive experience as shown in Figure 1. In 1961, Comeau and Bryan, two Philco Corporation engineers, created the first head-mounted display (HMD) called the Headsight. The display had two video screens, one for each eye, as well as a magnetic tracking device. It was the first motion-tracking device ever created. Headsight was primarily used to move a remote camera allowing a user to look around an environment without physically being there. In 1966, Thomas Furness, a military engineer, developed the first flight simulator for the Air Force. This sparked a lot of interest in VR technology and how it could be used for training purposes (Furness, n.d.). In 1968, Ivan Sutherland, a Harvard professor and computer scientist invented the first VR/AR head-mounted display called 'The Sword of Damocles' (Sutherland, 1965).

As VR has evolved, it has been used in different fields, including: education (Englund et al., 2017), learning and social skills training (Schmidt et al., 2017), military training (Alexander et al., 2017), gaming (Meldrum et al., 2012; Zyda, 2005), architectural design (Song et al., 2017), simulations of surgical