Cybersickness

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Overcoming cybersickness remains elusive for VR developers and practitioners. Symptoms such as discomfort, headache, eye strain, and dizziness during and after VR experiences can be associated with cybersickness. Cybersickness is often compared with motion sickness and simulator sickness. However, cybersickness is categorized as a subset of motion sickness as cybersickness is considered a form of visually induced motion sickness (VIMS) (Weech et al., 2019) and shown to be three times more serious than simulator sickness (Stanney et al., 1997).

Keywords: virtual reality ; education ; cybersickness

1. Introduction

Virtual Reality (VR) technologies have been used to solve real-world problems in sectors such as industrial training, military training, medical training, education, commerce, and entertainment (Bailenson, 2018). An advantage of VR is its capacity to provide simulated spaces of content and context which would be difficult or impossible in the real world, resulting in a reduction of costs and risks of operational failure or personnel safety. The first VR system was invented by Morton Heilig in the early 1960's and called Sensorama (Rheingold, 1991). The term Virtual Reality was popularized by Jaron Lanier in the 1980's when a communication system using a Head Mounted Display (HMD) and Data Glove was introduced (Lanier, 2018). Recently, VR technologies have proliferated as HMD's such as the Oculus Rift, HTC Vive, and Windows MR Headsets have arrived on the market. Also, inexpensive HMD's have been manufactured that do not require high-performance computers; examples include the Oculus Quest, Oculus Go and the Nintendo Labo VR Kit. Consequently, previously expensive VR technologies that were only used in well-funded research such as military or medical practices have now become more accessible to education and consumers. Applying VR to a wide target audience such as mainstream education remains challenging at present though as VR is often associated with a health issue that effects each individual quite distinctly. This issue is called VR sickness or, more commonly, cybersickness. Cybersickness can be a critical problem for a user when immersed in VR experiences and much research has been conducted in an attempt to delineate its composition and causes.

2. Challenges

The physiological mechanism of cybersickness is not yet fully understood despite numerous projects and research conducted over an extended period of time (Dennison *et al.,* 2016; Chang *et al.,* 2020). This is mainly due to individual differences being a factor and thus it is challenging to provide a single, all-encompassing model of a generic cybersickness metric even from, as will be demonstrated later, quantitative evaluations of captured physiological data. In addition, cybersickness is a dynamically changing condition which occurs during a VR experience, so it is preferable to pre-emptively detect cybersickness before the user becomes nauseous. Cybersickness has commonly been evaluated using qualitative, subjective surveys such as the Simulator Sickness Questionnaire (SSQ) and conducted usually before and after the VR experience. More recently studies estimating cybersickness using physiological data as objective evidence have been undertaken. However, much of the research and subsequent outcomes require specialized medical knowledge considered beyond the skills of most VR developers, trainers and educators.

To overcome these challenges, a forecastable indicator of cybersickness, termed Onset of Cybersickness (OCS), computed from physiological data, has been proposed and a monitoring method of cybersickness in real-time on a mobile (iOS/ Android) application called Cybatica has been developed (Magaki, 2020). The purpose of the research was to design an accessible, pragmatic metric and mobile iOS/ Android application for non-specialists such as trainers and educators. In the implementation of this research, first, a reliable instrument to capture physiological data was selected; i.e. the Empatica E4. Then, validation of physiological data analysis was tested in an experiment of customized Personal Computer (PC) and VR tasks. An indicator of cybersickness called the Onset of Cybersickness (OCS), determined from the physiological data and associated SSQ data, was proposed. Initial developments have been published (Magaki and

Vallance 2019a; Magaki and Vallance 2019b; Magaki and Vallance, 2020). Thereafter, an Android/ iOS application named Cybatica was designed, programmed and developed to connect with the Empatica E4 device in order to record and visualize the resulting physiological data and subsequent analysis data as a real-time cybersickness monitoring method. An additional experiment of PC and VR tasks was conducted to appraise the proposed OCS metric and test the validity of the Cybatica application. The research illustrated one approach of forecasting cybersickness using physiological data, but the limited data revealed that it is not yet a reliable generic method. Consequently, research monitoring cybersickness in real-time is continuing [1][2][3][4][5][6][7][8][9][10][11].

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