The Impact of Virtual Reality on Motion Sickness Incidents: Causes, Roles, and Prevention Strategies

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Abstract

Background: Technology is increasingly developing, over time the virtual reality (VR) industry is increasingly in demand. VR is a three-dimensional object that displays the real world. With this sophistication, VR actually provides discomfort for its users, namely Motion Sickness. Motion Sickness is a change in dynamic movement in the virtual world that causes discomfort to its users. **Method**: The method used in this paper is the literature review method. **Purpose:** the purpose of this paper is to determine the impact of Virtual Reality on Motion Sickness incidents. **Discussion:** The results of the literature review show that there are causes of VR Sickness, namely hardware, content, and human factors. VR Sickness can be prevented through pharmacological and non-pharmacological means. **Conclusion:** Virtual Reality is one of the causes of Motion Sickness incidents.

Keywords: Virtual Reality, Motion Sickness, VR Sickness, motion sickness, Treatment of Motion Sickness

Introduction

Technology is growing, over time the virtual reality (VR) industry is increasingly in demand. This makes VR technology incorporated into several fields such as movies, games, and education. Virtual reality technology is a system of visualization tools, which includes special virtual environment devices (CAVE systems, augmented reality systems, HMD helmets, spherical displays), as well as simpler devices such as 3D widescreen projection screens, 3D theaters, and virtual reality glasses. Even in the early stages, this technology was used to develop various skills (especially in training the spatial abilities of pilots and astronauts. With the sophistication of the technology, negative symptoms arise that can disturb its users. These symptoms are similar to those of motion sickness. The main symptoms of motion sickness are eyestrain, disorientation, and nausea.[1] These uncomfortable feelings may hinder future VR experiences, so Motion Sickness is considered an urgent problem to be solved.

The negative symptoms mentioned above were initially attributed to technical flaws in the virtual reality technology itself. However, it has been shown that improved technical characteristics (higher video resolution, and more accurate tracking and optical systems) lead to improved symptoms e.g., the latency of their occurrence is significantly reduced. The negative symptom complex that appears in the virtual environment was originally attributed to motion sickness, which occurs in the natural environment in people traveling by ship or plane. It is suspected that motion sickness arises due to a conflict between sensory signals from the vestibule and visual systems.[16] For example, a person standing in the cabin of a ship sees a stationary cabin environment (not sensing body movement through visual signals), while he or she senses body movement through vestibule signals. However, later, to describe the feeling of discomfort arising from interaction with virtual reality systems, a new term was proposed, reflecting a new symptom that could be compared to symptoms caused by commonly used devices such as centrifuges. In addition, many observers noted that they had a strong impression of having moved their bodies during interaction with the virtual environment, even though objectively their bodies remained still.[16]

To address these issues in the use of virtual reality devices, it is necessary to assess their impact, and identify individual characteristics. In addition, eye movement characteristics are also considered as an objective measure of a person's behavior during the observation of virtual events. Oculomotor activity has long been studied in the context of explaining simulator sickness. It is proposed that proprioceptive signals of the eye muscles are one of the reasons for the vection illusion where a person has a moving virtual environment and a stationary observer. Eye movements are considered an indicator of vestibule dysfunction that causes the appearance of the vection illusion.[13] In addition, it is suggested that the vestibule-ocular reflex plays an important role in the appearance of illusory movements of the observer in the virtual environment. Many researchers have conducted user experiments using VR to investigate the causes of adverse symptoms.[20] Based on the experimental results, some studies have provided guidelines for alleviating VR sickness. The review of the research results varies. This article explores more about how VR impacts the incidence of Motion Sickness.

Methods

This article uses the literature review method because it analyzes several literature sources in the form of journals. The keywords used in the literature search are Virtual Reality; Motion Sickness; Treatment of Motion Sickness; Motion Sickness; Motion Sickness; Impact of Virtual Reality, VR Sickness.

Discussion

Motion Sickness is often referred to as cybersickness which is a physical discomfort disorder of users who are still left in the virtual world. Motion Sickness is a change in dynamic movement in the virtual world that causes discomfort to its users because it gives symptoms of nausea, dizziness, and cold sweat like motion sickness.[7] Furthermore, the process of motion sickness is that users feel that they are making dynamic movements in Virtual Reality (VR), even though in the real world users do not experience dynamic changes. this makes users feel dizzy and nauseous.

VR itself is a three-dimensional object that displays the real world.[7] How to enter the virtual world is easy, users only need to use a headset that looks like big glasses so that users feel reality in the virtual world of images, sounds, and other sensations. Historically, VR was used for professional settings, but with the development of VR technology it is utilized in the entertainment and education industries. The main goal of VR is to provide an accurate and believable replication of real experiences. However, surely technology besides providing benefits also has risks or negative effects for its users because they feel discomfort when using VR. One form of user discomfort in VR is Motion Sickness.

Motion Sickness refers to the normal universal physiological response to the perception of unusual movement, whether real or apparent. The most dramatic form of Motion Sickness is seasickness, other forms are air sickness, car sickness and train sickness.

Space sickness is a specific form of motion sickness that occurs in micro-gravity conditions. Recent interest in motion sickness is associated with the increasing use of simulation technology. In particular, motion sickness is common in systems that present optical depictions of inertial motion such as flying or driving simulators and virtual environment systems (cybersickness).[17] The development of motion sickness symptoms follows a regular sequence that varies with the intensity of the stimulus and the individual's susceptibility. The initial symptom is usually discomfort around the upper abdomen, which is followed by nausea and increased malaise. Simultaneously, per-oral and facial pallor appears, accompanied by cold sweat. With rapid worsening of symptoms, there may be changes in salivation, body warmth, dizziness, vomiting, and repeated vomiting. Lethargy, fatigue and drowsiness may persist for hours after the movement stimulus ends.

With the advent of VR systems, Motion Sickness has been observed as a common side effect of using such systems. As VR has become a cheaper and widespread technology, Motion Sickness caused by VR systems has become one of the relevant issues. Therefore, in recent decades, many studies have been conducted to reduce the effects of Motion Sickness in VR. Research shows that many factors are considered responsible for causing Motion Sickness in VR systems. Recent research has uncovered many factors associated with Motion Sickness caused by VR systems. These factors include but are not limited to: gender differences, type of virtual environment, VR experience, graphic properties, virtual environment lighting, and motion sickness experience. In addition, the impact of Motion Sickness with the association of the above-mentioned factors on human physiological factors such as heart rate, blood pressure, and sugar level is also reported.[22] In order to measure the impact of Motion Sickness on human physical factors under various virtual environment conditions, it is important to understand the association of various factors with Motion Sickness caused by VR.

According to Chang, et all.[1] there are several causes of VR Sickness, namely hardware, content, and human factors. The first cause is hardware.[1] Hardware is an important factor that determines the quality of VR. In early studies of VR sickness, symptoms were often ascribed to poor hardware performance, and it was thought that user discomfort would decrease as VR technology matured.[17] The most frequently studied topic is display-related factors as display devices deliver VR content. In addition, certain features of the technology can also cause Motion Sickness.

The second cause is content. VR content is an important factor that determines the level of VR fidelity as well as VR sickness. As developers have tried to implement higher VR fidelity, content details have become more complicated. Advances in hardware systems make it possible to create realistic virtual scenes. However, these efforts do not always result in a better user experience. Users report more severe VR sickness as motion becomes faster.[2,10, 11] The results showed that the severity of nausea and vection increased as the speed increased from 3 m/s to 10 m/s. However, the positive correlation between speed and VR sickness disappeared if the speed exceeded 10 m/s. Users reported the highest discomfort at 10 m/s and maintained (or slightly decreased) the level of VR sickness up to 60 m/s. The authors claim that the level of illusory self-motion determines participants' discomfort. That is, the range of scene speed that causes stronger vection can be attributed to the cause of VR sickness. If the VR scene speed is too fast, then users may not experience discomfort due to the weak feeling of presence. In addition, the oscillation frequency or amplitude that causes adverse effects on users has been widely investigated. [4, 5, 18]

The last cause is the human factor. It is often observed that the severity of VR sickness differs among users, even though users experience the same VR content through the same device. Such characteristics are based on age, gender, and Motion Sickness susceptibility.

Motion Sickness can be diagnosed based on manifestations during motion exposure after ruling out other pathological disorders. Heart rate variability and electrogastrogram (EGG) are useful for assessing cardiac sympathovagal interaction and gastric motility during Motion Sickness. HRV indices may be affected by inter-subject variation movement patterns, subject, self-adjustment, vomiting process, and stress response. It is important to quantify the severity of Motion Sickness and identify objective physiological parameters of Motion Sickness, in order to follow up the habituation process and examination of the efficacy of therapeutic measures. A wide variety of Motion Sickness questionnaires have been used to assess Motion Sickness susceptibility. Based on research conducted by Koca and Bayindir.[8], the Coriolis Motion Sickness Susceptibility Index Test requires subjects to move their heads in a pitch and roll position while sitting upright in a chair that rotates around the Earth's vertical axis.[8] The visual vestibular interaction test is based on the observation that visual fixation during low-frequency movements triggers the disease. Seated subjects read lines of letters from a luminous matrix attached to the chair while rotating in darkness in a low- frequency sinusoidal pattern. The percentage of errors in letter identification was highly correlated with airsickness susceptibility. All of these tests are highly provocative and this condition is a disadvantage of these tests. Increased salivation is one of the commonly reported early signs of Motion Sickness. Contrary to the reported increase in salivation, in laboratory trials, a decrease in salivation rate was found to be associated with the severity of motion sickness and seasickness. Increased protein and sodium concentrations correlated with the severity of Motion Sickness. Electrode activity was also found to be sensitive for prediction of individual Motion Sickness susceptibility diagnosis.

Various pharmacological and non-pharmacological preventive measures have been proposed to prevent Motion Sickness or for active treatment when signs and symptoms already appear.[19] In pharmacological prevention, prescription drugs are used. While non-pharmacological prevention in the form of reducing sensory input, accelerating the multi sensory adaptation process, preventing factors that can worsen nausea, avoiding smoking, distraction strategies, and increasing psychological factors that allow subjects to cope with their condition can be useful for improving Motion Sickness. Reducing sensory input can be helped by lying down, closing eyes, sleeping and avoiding stimuli. In addition, users should stay well hydrated as dehydration can worsen the symptoms of Motion Sickness. Patients should stay hydrated by drinking water and limiting alcoholic and caffeinated drinks. Then, avoiding smoking can reduce susceptibility to Motion Sickness. On distraction strategies, controlled breathing, listening to music or using aromatherapy fragrances, such as mint or lavender, may also help.

Conclusion

Motion Sickness has become a high-priority topic in the virtual reality industry. Despite various attempts, there are mixed results on how to alleviate user discomfort. The three main causes of Motion Sickness are hardware, content, and human factors. Meanwhile, there are two prevention strategies, namely pharmacology and non-pharmacology.

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