International Journal of Integrated Research & Innovative Statistical Insights (IJIRISI)
Volume: 01, Issue: 01, July 2026
ISSN: xxxxx - xxxx
DOI: xyz

Cybersickness in Digital Environment

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ABSTRACT:

Cybersickness, also known as virtual reality sickness or digital motion sickness, is a significant challenge in today's digital and immersive world. This paper explores the causes, symptoms, and impact of cybersickness on users in virtual environments. Research suggests that mismatches between vestibular, proprioceptive, and visual signals contribute to cybersickness, leading to symptoms such as nausea, disorientation, and fatigue. Various mitigation strategies, including design improvements, user education, and gradual exposure to virtual environments, are discussed. A multidisciplinary approach involving psychology, neuroscience, human-computer interaction, and medical research is essential to understanding cybersickness and developing effective mitigation strategies. The ethical and sustainable development of immersive technologies requires prioritizing user comfort, safety, and well-being. Collaboration among researchers, developers, and users is crucial for creating engaging and enjoyable digital experiences while minimizing the risk of cybersickness.

Keywords: *Cybersickness, Virtual Reality Sickness, Digital Motion Sickness, Virtual Environments, Immersive Technologies, Screen Sickness*

INTRODUCTION:

Our daily lives are now completely shaped by technology, which has changed the way we work, live, and engage with the outside world. Technology encompasses a wide range of inventions made possible by human ingenuity, from basic instruments to sophisticated systems. It is the practical application of scientific knowledge that results in the development of instruments, apparatus, and systems, facilitating work, enhancing our understanding, and connecting us in unprecedented ways.

Innovations across diverse sectors such as biotechnology, robotics, artificial intelligence, information technology, medicine, and more have characterized the evolution of technology. These developments have revolutionized not only industries and economies but also communication, information access, and problem-solving techniques.

The rapid pace of technological advancement has ushered in an era of continuous change, presenting challenges for organizations, societies, and individuals to adapt and seize new opportunities. While technology brings benefits

such as improved connectivity and information availability, it also raises concerns about privacy, ethical issues, and its impact on employment.

Now utilising head-mounted displays, virtual reality (VR) is a rapidly emerging trend in gaming, education, entertainment, the military, and health applications. While virtual reality offers engaging experiences(1). Additionally, automation and artificial intelligence may replace certain jobs, leading to increased unemployment in specific industries and potentially exacerbating social discontent and economic inequality(2). Digital addiction, resulting from constant connectivity through smartphones and other devices, poses risks to mental health and overall well-being(3). The manufacturing, use, and disposal of electronic devices contribute to environmental contamination, with effects such as energy consumption, e-waste, and the extraction of rare minerals for technology components(4). While technology has facilitated greater connectivity, it can also contribute to social isolation as individuals interact more with screens than with each other (5). Extended usage of digital devices has been linked to health problems such as musculoskeletal disorders, sleep disturbances, eye strain, and a sedentary lifestyle that exacerbates physical health issues(6).

What is Cybersickness?

Cybersickness has emerged as an unpleasant side effect of virtual reality immersion. Initially reported when head-mounted 3D displays were introduced in 1968, cybersickness did not receive much attention at that time. However, with the recent growth of the virtual reality (VR) industry, there has been a surge in related research. While cybersickness is sometimes confused with motion sickness experienced while watching movies or playing video games, it specifically refers to a disorientation caused by a shift into a visually distinct space, such as virtual reality or augmented reality. Symptoms often occur in specific situations(7)

Extended use of digital devices can induce feelings of nausea, headaches, and disorientation known as cybersickness. This phenomenon arises from a discrepancy between the perceptions of the inner ear and the motion perceived by the eyes. Confusion between the senses can occur when the inner ear detects motion while the eyes remain fixed on a single spot. Cybersickness is associated with both simulator sickness and classical motion sickness, with up to 80% of first-time users of VR headgear experiencing this multiphasic, polysymptomatic illness (8). The discrepancy between visual and vestibular signals, particularly in highly realistic visual graphics, is a key factor contributing to cybersickness.

Causes

Cybersickness can be triggered by various activities such as playing video games, using virtual reality headsets, and prolonged computer use. It often arises from sensory disparities, particularly those between optic flow and proprioceptive/vestibular cues. The exact cause of cybersickness remains unclear, but it is believed to stem from a mismatch between sensory signals that convey information about the body's orientation and motion. For instance, in many virtual reality applications, optic flow creates the illusion of motion, leading users to perceive movement at a specific speed and direction. However, their proprioceptive and vestibular organs do not detect actual self-motion because the users themselves are not physically moving. This discrepancy in sensory input, where visual cues suggest motion while other sensory cues indicate immobility, can lead to sensory inconsistencies and ultimately cybersickness(9).

Presenting Manifestation

The symptoms of cybersickness are comparable in intensity to those of motion sickness(10). They are highly uncomfortable and can significantly disrupt the immersive VR experience (11). Cybersickness encompasses a range of negative symptoms, including disorientation, apathy, fatigue, dizziness, headache, increased salivation, dry mouth, difficulty focusing, eye strain, vomiting, stomach awareness, pallor, sweating, and postural instability(8).

Susceptibility:

Women are often considered more susceptible to cybersickness than men, while older individuals tend to experience more severe symptoms and have a higher risk of developing the condition. Although not conclusively proven, factors such as the menstrual cycle, gender differences in postural stability, and variations in viewing angles contribute to this gender-based susceptibility. Additionally, exposure to virtual reality has been reported to exacerbate light-headedness in individuals who already experience motion sickness. This suggests that virtual reality experiences can amplify pre-existing sensitivity to motion-related discomfort(7).

Physiology role and effects:

Cybersickness induces physiological changes in the central nervous system, autonomic nervous system, and gastrointestinal tract. A study examining these changes found that during virtual reality exposure, there was an increase in fingertip body temperature while gastric tachyarrhythmia increased on the electrogastrogram. Skin conductance, respiratory sinus arrhythmia, and relative delta power (T3, F3) in the EEG also increased. Conversely, heart rate, relative beta power (T3, F3), and the maximum amplitude of the photo plethysmogram decreased(12).

Parameters such as heart rate, respiratory rate, eye blink rate, gastric tachycardia, and respiratory-induced sinus arrhythmia were found to be positively correlated with cybersickness symptoms(7). Studies conducted on roller coasters with virtual reality utilized transcranial Doppler ultrasonography and near-infrared spectroscopy to investigate cerebral blood flow abnormalities associated with cybersickness. One study measured blood flow to the brain immediately after the ride, revealing notable alterations. Overall cerebral perfusion declined, but there were increases in specific cortical regions. The amount of oxidized haemoglobin in the parietal-temporal region increased significantly in subjects experiencing motion sickness, correlating with the severity of their nausea(13). Due to these physiological effects, air force bases have implemented policies prohibiting pilots from operating aircraft within 24 hours of simulator training and from operating vehicles immediately after participating in virtual reality experiences(14).

Measures took to overcome:

To alleviate cybersickness, a Cybersickness Relief Virtual Environment (CRVE) provides feedback through messages advising users to decrease navigation speed and temporarily narrow their field of vision(15). Limiting total screen time, taking regular breaks, adjusting screen positioning for optimal lighting and anti-glare filters, and staying hydrated can all help prevent cybersickness.

When experiencing cybersickness symptoms, stepping away from electronic devices, taking breaks, walking, resting the eyes, and drinking water can be beneficial. Over-the-counter drugs may also be used to alleviate symptoms. Behavioural therapy, accommodations, and medication are primary treatments for motion sickness. Behavioural techniques such as focusing on distant horizons, avoiding alcohol, and maintaining steady postures can lessen symptoms. Adaptation therapy can help reduce symptoms with repeated exposure, but not everyone responds to it. In severe cases, anticholinergic medication, such as scopolamine and dextroamphetamine, can be effective, although caution is advised due to potential dependence. H1 receptor antagonists like dimenhydrinate and 5-HT3 receptor antagonists are also potent medications for cybersickness(7).

To prevent motion sickness in virtual environments, game developers should control player movement, provide visual cues and references, assist in maintaining steady postures, optimize task difficulty, incorporate high-quality graphics and sound, and minimize visual fatigue through time controls and high-quality head-mounted displays with clear user interfaces(16).

Conclusion

Cybersickness, also known as virtual reality sickness or digital motion sickness, presents a significant and evolving challenge in our increasingly digital and immersive world. Understanding and addressing cybersickness is

crucial for the well-being of users as technology evolves and virtual experiences become more prevalent. While ongoing research continues to explore the precise mechanisms of cybersickness, it is evident that discrepancies between vestibular, proprioceptive, and visual signals contribute to its onset.

Efforts to mitigate cybersickness involve continuous advancements in design, software, and hardware by developers and researchers. Educating users and gradually exposing them to virtual environments can also reduce vulnerability to cybersickness. A multidisciplinary approach encompassing psychology, neuroscience, human-computer interaction, and medical research will play a pivotal role in enhancing our understanding of cybersickness and devising effective mitigation strategies in the dynamic realm of digital experiences.

Ultimately, addressing cybersickness is both a human-centred and technological challenge. Prioritizing user comfort, safety, and well-being is paramount in the ethical and sustainable development of immersive technologies that enhance our lives without compromising our health. Collaboration among researchers, developers, and users is essential to cultivating a welcoming and enjoyable digital environment for all.

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