An XR Framework Proposal to Assist Designers in Minimizing Cybersickness

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ABSTRACT

Extended Reality (XR), as a form of human-computer interaction, continues to encounter significant challenges related to user well-being. The frequent discomfort experienced during the use of head-mounted displays (HMDs), commonly referred to as cybersickness, has been the focus of extensive research. This research has led to the development of various techniques aimed at mitigating these adverse effects. However, there remains an absence of a streamlined, automated method to implement these measures effectively. This project seeks to address this gap by providing developers with a tool that facilitates the easy and modular implementation of cybersickness mitigation techniques. Utilizing game engine events as triggers, this prototype allows for the activation and deactivation of these techniques in a seamless manner. We believe this approach will not only simplify the application process for developers but also promote the broader adoption of VR by enhancing user comfort and overall experience.

CCS CONCEPTS

• **Human-centered computing → User studies**.

KEYWORDS

Extended Reality, Virtual Reality, Cybersickness, First-person Shooter Games, Human-computer interaction

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1 INTRODUCTION

Cybersickness (CS) is a term used to describe a range of symptoms that some users experience during or after a extended and virtual reality (VR) sessions [2]. These symptoms include nausea, dizziness, and vertigo. Most VR users experience characteristic symptoms of CS after continuous use for at least ten minutes, posing a significant barrier to expanding VR access and realizing its potential not only as an entertainment platform but also as a tool for medical treatments and military training [9].

Several methods exist to mitigate these symptoms [3]; however, no comprehensive tools are available to simplify the solution to the CS problem. Such a tool would aid VR game designers in applying multiple CS reduction techniques without the need to implement them from scratch or individually seek out third-party solutions.

In this work, we propose a Unity plugin for game development that compiles CS mitigation techniques and facilitates their application through a simplified interface (illustrated in Figure 1).

2 RELATED MITIGATION TECHNIQUES

Numerous techniques exist to mitigate cybersickness (CS) in virtual reality (VR) games, depending on the game's style, user behavior, and user profile data, such as gender and health condition [8]. In this study, we review three techniques: rotational blurring, vignetting, and the virtual nose. Rotational blurring [1] is applied during rapid head or body movements within the virtual environment. It aims to smooth the visual transition perceived by the user, reducing the discrepancy between physical movements and the images presented by the VR device. Vignetting [6] reduces cybersickness by gradually narrowing the field of view (FoV) during certain movements or interactions in the virtual world. By subtly shrinking the FoV, vignetting reduces the amount of peripheral visual information, helping to lessen feelings of CS. The concept of the virtual nose (or static rest-frame) [5] is based on providing a stable reference point within the field of view. This stable point aids in better synchronizing the vestibular and visual systems' motion information, offering a sense of stability even when the rest of the virtual scene is in motion.

These techniques alleviate discomfort by minimizing sensory overload and visual conflicts, particularly in fast-paced games such as first-person shooters (FPS). By reducing abrupt changes in the visual field and peripheral visual information, and by creating a more stable experience, these methods enhance user comfort and reduce the likelihood of CS. This is crucial in high-intensity gaming scenarios, where rapid movements and dynamic interactions are

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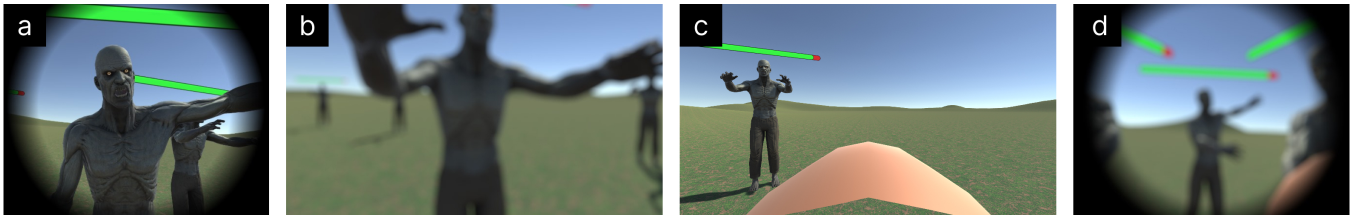

Figure 1: Techniques applied in the first-person shooter Game using our framework: (a) vignetting, (b) rotational blurring, (c) virtual nose, and (d) combination of all three techniques

common, ensuring a more comfortable and immersive experience for the player.

3 MATERIALS AND METHOD

This framework was developed for the Unity game engine using the XR Interaction Toolkit package. It is designed for ease of use, requiring developers to simply drag and drop the plugin prefab under the main camera in the scene. The prefab collects data on the camera's speed, rotation, and acceleration, activating the desired mitigation techniques when these values reach thresholds associated with cybersickness symptoms. Developers can also adjust the acceleration and rotation thresholds as needed.

To demonstrate the framework's effectiveness, we created a first-person shooter (FPS) game prototype, which involves numerous sudden and rapid camera turns that typically trigger CS. In this game, the player shoots zombies that slowly approach from all angles, necessitating fast camera rotations when the player becomes overwhelmed by surrounding enemies.

We implemented three techniques: rotational blurring, vignetting, and the virtual nose. These techniques can be triggered by events customized by game designers using our framework. This proposal enables designers to configure various techniques and triggers, applying diverse effects aimed at mitigating cybersickness in FPS games. This approach allows for a tailored application of mitigation strategies, ensuring the most effective techniques are employed based on specific in-game events and user interactions.

4 CONCLUSION AND FUTURE WORK

We have developed a prototype XR framework for the Unity game engine, which enables developers to efficiently apply various CS reduction techniques through a user-friendly interface. By reducing the implementation workload and saving development time for VR creators, our prototype aims to encourage broader adoption of VR as a media platform by mitigating barriers that affect user well-being.

We intend to test this framework with users, logging their experiences to facilitate further analysis. For future work, we aim to expand the mitigation techniques provided by the framework, adding Foveated Rendering [7] and Dynamic Gaussian Blur [4]. Additionally, we plan to create a racing game demo to better evaluate the framework's effectiveness in dealing with sudden speed changes.

Figure 2: User interaction with the game during the activation of mitigation techniques.

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