Comparison of visual techniques for reducing Cybersickness and their impact on the sense of Presence in Virtual Reality

Audric Boullier

Master MTI3D

École Nationale Supérieur des Arts & Métiers Chalon-Sur-Saône, France
audric.boullier@ensame.eu

Alae Boutarhat

Master MTI3D

École Nationale Supérieur des Arts & Métiers Chalon-Sur-Saône, France
alae.boutarhat@ensam.eu

Léo Mans

Master MTI3D

École Nationale Supérieur des Arts & Métiers Chalon-Sur-Saône, France
leo.mans@ensam.eu

Abstract— This study compares three visual techniques: static Reticle, peripheral blur, and dynamic field-of-view reduction, for mitigating cybersickness in VR navigation. We evaluate their efficacy using the Cybersickness in Virtual Reality Questionnaire (CSQ-VR) and their impact on presence with the Presence Questionnaire (PQ) across different environments (indoor / outdoor) and speeds. Results aim to guide context-appropriate technique selection for VR developers.

Keywords — Cybersickness, Motion Blur, FOV Reduction, Visual Guides

I. Introduction

A. Context

A major challenge in Virtual Reality is cybersickness, which disrupts navigation in applications ranging from architectural visualization to flight simulation[9]. Developers have access to several visual comfort techniques[4][6][7].

This study establishes a controlled experiment to directly compare combinations of standard visual techniques, including a horizon line, peripheral blur, and dynamic field-of-view reduction. We evaluate their efficacy in reducing cybersickness and their impact on user presence across varied navigation contexts[1].

The goal is to provide initial, empirical insights into how these common techniques perform under different conditions.

B. State of Art

- **Cybersickness: Causes and Key Factors**

Cybersickness arises from sensory conflict between visual and vestibular systems[1]. Susceptibility is influenced by individual factors like prior gaming experience[8], which reduces symptom severity, and contextual factors, where unconstrained movement and high velocity are key aggravators[1][5]

- **Visual Mitigation Techniques**

Three principal visual approaches have been developed:

- Visual Guides: act as a stable reference, reducing sickness while maintaining presence when well-designed[3][4];
- Dynamic FOV modification subtly restricts peripheral view during movement[7], effectively lowering sickness without degrading presence;
- Motion Blur: enhances presence but reduces sickness effectively only in specific high-mobility contexts[6].

- **Synthesis of Techniques**

The literature reveals distinct performance profiles for each technique. Their comparative characteristics, central to understanding the current research landscape, are summarized in this table:

Technique	Type	Effect on Cibersickness	Impact on Presence
Horizontal Line	Fixed reference line	Moderate reduction	May reduce immersion
Fixed reticule	On-screen fixed point	High reduction	Preserved
Dynamic FOV Reduction[7]	Dynamic occlusion	High reduction	Preserved (if subtle)
Motion Blur (Peripheral)[5]	Dynamic alteration	Significant reduction	Better compromise than FOV

Table 1 — VR visual techniques to reduce Cybersickness

II. Method

We investigated the effectiveness of three visual techniques: a central reticule (R), motion blur (MB), and a field of view reduction (FOVR)[4][6][7]. These techniques aim to mitigate cybersickness by manipulating the peripheral areas of the view or providing a stable visual reference. In our implementation, FOV and R reduce the peripheral field, while MB applies a blur effect based on the camera's

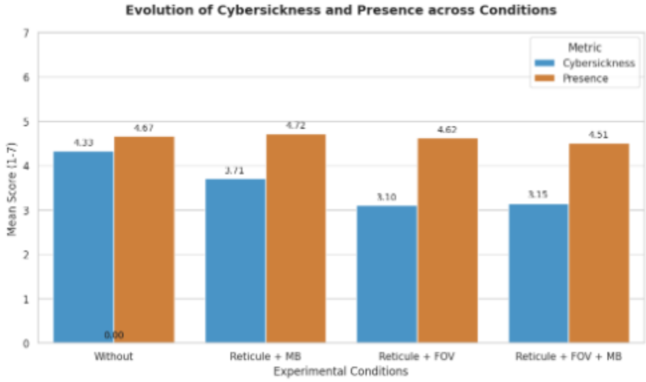
movement intensity. A central reticule is used as a fixed point of reference to stabilize the user's perception during the simulation.
We applied these techniques to a first-person roller coaster simulation developed in Unity. The scene was specifically designed to evoke high levels of optical flow and sensory conflict through rapid accelerations and sharp turns. To measure the impact of these techniques, we focused on two primary metrics: Cybersickness, to assess physical comfort, and Presence, to evaluate immersion. Data were collected via standardized questionnaires administered immediately after each session[1].
The experiment followed a within-subject design with four sequential conditions for each participant: (1) Without (baseline), (2) Reticule + MB[6], (3) Reticule + FOV[7], and (4) Reticule + FOV + MB. This cumulative order allowed us to observe the specific contribution of each technical layer. A total of 9 participants completed the study. Their task was to experience the high-speed roller coaster ride across all four conditions, ensuring a direct comparison of the visual techniques' performance within the same subject

III. Results and Discussion

The statistical analysis reveals that while the global impact on cybersickness showed a strong trend ($p = 0.09$), specific technical combinations yielded significant improvements. Specifically, both FOV and Reticule ($p = 0.048$) and Motion Blur -FOV-Reticule ($p = 0.043$) successfully reduced sickness levels compared to the baseline. This confirms that restricting the peripheral field of view, especially when combined with motion blur, effectively mitigates the sensory conflict triggered by the roller coaster's rapid movements.
Regarding Presence, the scores remained remarkably stable across all four conditions ($p = 0.98$), with means consistently around 4.6/7. This lack of significance is a positive outcome, as it proves that our visual techniques do not degrade the immersive quality of the experience. Furthermore, the Pearson correlation ($r = 0.09$, $p = 0.56$) shows no link between discomfort and immersion, suggesting they are independent factors in this scenario.
In conclusion, Exp-FOV-R emerges as the optimal solution. It achieved the lowest sickness score (3.10) while maintaining a high level of presence, providing a clear answer to our research objective: it is possible to significantly enhance user comfort without sacrificing the core VR experience.

IV. Conclusion

We investigated the effectiveness of three visual techniques to mitigate Cybersickness and maintain Presence in VR: reticule, motion blur, and field of view (FOV) reduction. Our results demonstrate that these techniques can be efficient for this reduction, and, among the tested combinations, the Exp-FOV-R configuration (FOV reduction paired with a reticule) appears to offer the best balance by significantly improving user comfort.
Even though the levels of experienced sickness decreased, the roller coaster simulation represented a rather extreme scenario with high optical flow. Therefore, future work will explore the applicability of these techniques to more common VR environments. Additionally, we intend to investigate how the intensity of these visual modifications influences the perceived sense of immersion over longer exposure times.



V. References

[1] Davis S, Nesbitt K, Nalivaiko E. A systematic review of cybersickness. In: Proceedings of the 2014 Conference on Interactive Entertainment [Internet]. Newcastle NSW Australia: ACM; 2014 [cité 12 janv 2026]. p. 1-9. Disponible sur: https://dl.acm.org/doi/10.1145/2677758.2677780

[2] Is&t/spie electronic imaging [Internet]. Disponible sur: http://hdl.handle.net/10985/7954

[3] Lin JJW, Abi-Rached H, Kim DH, Parker DE, Furness TA. A “natural” independent visual background reduced simulator sickness. Proceedings of the Human Factors and Ergonomics Society Annual Meeting [Internet]. sept 2002 [cité 12 janv 2026];46(26):2124-8. Disponible sur: https://journals.sagepub.com/doi/10.1177/154193120204602605

[4] Seok KH, Kim Y, Son W, Kim YS. Using visual guides to reduce virtual reality sickness in first-person shooter games: correlation analysis. JMIR Serious Games [Internet]. 15 juill 2021 [cité 12 janv 2026];9(3):e18020. Disponible sur: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8323020/

[5] Zhang YS, Ou LC. Effects of simulated bobbing and step sounds on cybersickness and presence in virtual reality. Displays [Internet]. 1 janv 2026 [cité 7 déc 2025];91:103202. Disponible sur: https://www.sciencedirect.com/science/article/pii/S0141938225002392

[6] Lin YX, Venkatakrishnan R, Venkatakrishnan R, Ebrahimi E, Lin WC, Babu SV. How the presence and size of static peripheral blur affects cybersickness in virtual reality. ACM Trans Appl Percept [Internet]. 31 oct 2020 [cité 12 janv 2026];17(4):1-18. Disponible sur: https://dl.acm.org/doi/10.1145/3419984

[7] Fernandes AS, Feiner SK. Combating VR sickness through subtle dynamic field-of-view modification. In: 2016 IEEE Symposium on 3D User Interfaces (3DUI) [Internet]. 2016 [cité 12 janv 2026]. p.

201-10. Disponible sur: https://ieeexplore.ieee.org/document/7460053
[8] CHIRA 2018 [Internet]. 2018. Disponible sur: http://hdl.handle.net/10985/13975
[9] Hasibuan CF, Hartono B, Wijayanto T. Effect of prior gaming experience on cybersickness symptoms in a virtual reality environment. Virtual Reality & Intelligent Hardware [Internet]. 1 oct 2025 [cité 12 janv 2026];7(5):468-82. Disponible sur: https://www.sciencedirect.com/science/article/pii/S2096579625000440

j