

QoE Assessment for Virtual Reality Gaming

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Introduction

- The VR gaming industry is expected to grow over the next several years, but VR is yet to be fully embraced by game developers, as well as its target consumer base.
- Finding additional ways to optimize Quality of Experience (QoE) for Virtual Reality games is likely to facilitate technology adoption.
- Quality of Experience for immersive media [1]:
 - „The degree of delight or annoyance of the user of an application or service which involves an immersive media experience. It results from the fulfillment of his or her expectations with respect to the utility and/or enjoyment of the application or service in the light of the user’s personality and current state.”

Description of the research problem

- Higher immersivity comes at the price of increased discomfort (cybersickness, device-related issues, muscle fatigue and pain) and decreased cognitive performance (reaction time).
- **The aim of our research:** building upon existing gaming QoE models and taxonomies (e.g., [2]) by further focusing on VR-specific features.
- **Iterative process:**
 - Developing the initial user testing methodology based on a combination of subjective and objective metrics.
 - User testing and data collection in a laboratory environment.
 - Data analysis and modeling.

Initial testing methodology

- Collecting user ratings for the overall QoE and various aspects of the gaming experience.
- Using subjective (questionnaire) and objective (e.g., heart-rate, electrodermal activity, task performance) measures to track workload, discomfort, and effects on cognitive performance.
- **VR devices:** commercial head-mounted-display-based VR systems with corresponding controllers.
- **Test material:** commercial games belonging to different genres, with simple interaction mechanics such as *slice*, *pick and place*, and *shoot*.

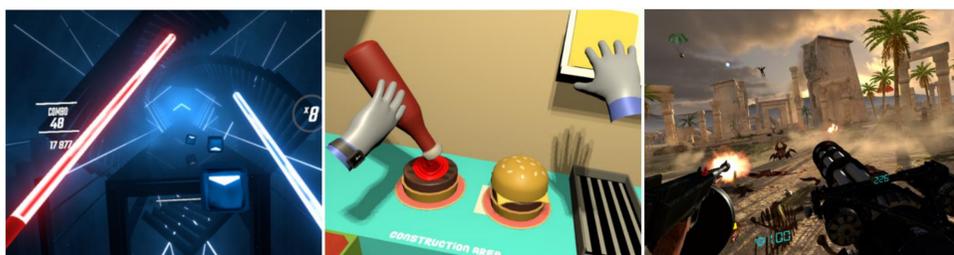


Figure 1. Screenshots of test material: Beat Saber (left), Order Up (middle), Serious Sam VR: The Last Hope (right)



Figure 2. A study participant playing Serious Sam VR: The Last Hope on the HTC Vive Pro system

Selected preliminary results [3]

- VR gaming sessions as short as 20 mins may provoke arm fatigue and pain in a significant number of users.
- Symptoms of physical exertion after physically demanding sessions may be erroneously attributed to cybersickness.
- Reaction time increases after exposure to VR.

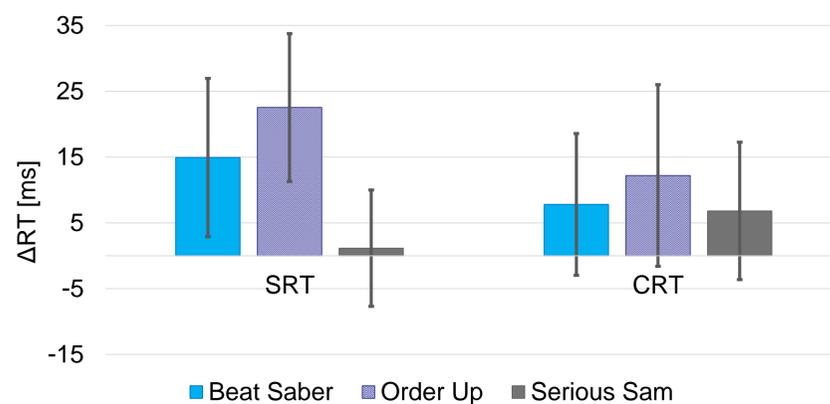


Figure 3. Post-pre differences in simple (SRT) and choice (CRT) reaction time after 20 mins of VR gaming

Future goals

- Providing a more in-depth analysis of the results, especially with regard to human influence factors.
- Replicating the experiment using alternative test material.
- Further focusing on implementation details for presented interaction mechanics.
- Using collected data as input for the development of multidimensional models for VR gaming QoE.

References

- [1] Perkis, Andrew, et al. "QUALINET white paper on definitions of immersive media experience (IMEx)." *arXiv preprint arXiv:2007.07032* (2020).
- [2] Möller, Sebastian, et al. "Gaming taxonomy: An overview of concepts and evaluation methods for computer gaming qoe." *QoMEX 2013*.
- [3] Vlahović, Sara, et al. „The Effect of VR Gaming on Discomfort, Cybersickness, and Reaction Time." *QoMEX 2021*.

Acknowledgement

This work has been fully supported by the Croatian Science Foundation under the project Q-MERSIVE, grant numbers IP-2019-04-9793 and DOK-2020-01-3779.