Indicating Stamina Loss in Video Games using Weight–Changing Controllers

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　　Indicating Stamina Loss in Video Games using Weight–Changing Controllers
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Background

Integrating haptic stimuli into VR systems is a promising area of study. A system capable of simulating weight can improve immersion and enjoyment in gaming appications as well as elevate training applications by providing more dimensions of feedback, i.e. in tool use [1].

Last year, Kalus et al. developed PumpVR, a prototype system using liquids to dynamically shift weight into two controllers. In their initial study, two demo applications were implemented, which demonstrated higher immersion, improved game experience as well as a significant improvement in body ownership illusion (BOI) for the users of PumpVR [2].

A frequent balancing mechanic in video games is the use of a ‚stamina bar', which limit the player by only allowing them to use certain abilities for a set amount of time (or number of uses). Usually, actions like sprinting, climbing or attacks are bound to a cooldown to increase difficulty and to prevent players from spamming these abilities to complete levels or tasks faster than intended [3].

The amount of stamina remaining and cooldowns are often communicated visually, typically by bars filling up or emptying. Especially in VR games, which allow and encourage players to be physically active, this seems unintuitive. Since Kalus et al. demonstrated that their system can be used to manipulate perceived fitness, liquid mass transfer could also be used to simulate exhaustion or a loss of stamina.

Goal of the Thesis

The goal of this work is validating whether dynamic weight change can be used to communicate stamina loss. Therefore, a climbing game for PumpVR will be implemented in Unity, which requires players to scale a wall using both controllers. Reaching for and gripping the next hold consumes stamina. While holding onto the wall, the exhaustion level remains the same, and at certain safety points, the stamina loss is reset. If the player loses all stamina, their character can no longer grip and falls off the wall.

Before the study can be conducted, the PumpVR prototype will be validated for this application by measuring how consistent the liquid level is in both controllers throughout their whole volume without emptying them in-between levels.

The application will then be tested twice (within-subjects), once with a stamina bar as a visual HUD element, and once with stamina loss represented by filling the PumpVR controllers. To answer the research question, the subjects' immersion and game experience will be recorded and compared using questionnaires for both trials. The time to complete the level and the number of required grips can be used as quantitative metrics.

Tasks

- Familiarization with literature and research on weight perception in VR
- Evaluating PumpVR for application-specific fill levels
- Developing a climbing game in Unity
- Integration with PumpVR
- Designing, conducting and analyzing a study to compare both means of communication

Required Skills

- Arduino Programming
- Game Development using Unity
- Designing and conducting scientific studies

Sources

[1] Lim, W. N., Yap, K. M., Lee, Y., Wee, C., & Yen, C. C. (2021). A Systematic Review of Weight Perception in Virtual Reality: Techniques, Challenges, and Road Ahead. *IEEE Access*, *9*, 163253-163283.

[2] Kalus A., Kocur, M., Klein, J., Mayer, M. & Henze, N. (2023). PumpVR: Rendering the Weight of Objects and Avatars through Liquid Mass Transfer in Virtual Reality. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (CHI '23), April 23– 28, 2023, Hamburg, Germany.* ACM, New York, NY, USA, 13 pages. https://doi.org/10.1145/3544548.3581172

[3] Giant Bomb Concept Wiki. (n.d.). *Stamina Bar (concept)*. Giant Bomb. Retrieved March 15, 2023, from https://www.giantbomb.com/stamina-bar/3015-3569/#:~:text=A stamina bar means a,increasingly sophisticated in this regard.

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