Sitting vs. Standing in VR:
Towards a Systematic Classification of Challenges and (Dis)Advantages

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Abstract

With this work, we propose a draft classification of advantages and disadvantages between sitting and standing user interfaces in VR to stimulate discussion and future work.

Classification

The kind of interfaces and physical setups that have been used for Virtual Reality (VR) and computer gaming applications have in the past been often driven not just by the overall goal and functional and non-functional requirements, but also by the availability, quality, and affordability of technology. For example, even though many computer games simulate avatars as walking, running, or doing more elaborate physical maneuvers (from jumping to various sports), the user is in most cases sitting comfortably and operating hand/finger based controllers (although there are notable exceptions, such as many arcade and exergames). How does this affect the believability and overall effectiveness of the user experiences? In which scenarios might it be advantageous (or not) to sit comfortably instead of standing or moving around physically? And for which scenarios would it be beneficial and worth it for the user to stand up or even walk around? While Bellgardt et al. [1] discussed this for different working scenarios, here, we would like to propose a draft of a broader and deeper taxonomy of the pros and cons of seated vs. standing posture during VR usage, to stimulate further discussion and research. In this work, we distinguish between seated and standing user postures in the table below, although the transition is continues (e.g., when using flexible seating or sit/stand stools etc. Note that we use the terms seated vs. standing here to refer to the general posture of the user in terms of being supported by some kind of seat vs. not - i.e., ”standing” here explicitly include walking and other non-seated movements.

Furthermore, when dealing with the advantages and disadvantages of both postures, the degree of embodiment of the interaction interface and paradigm also plays a role and can interact with the pros and cons of the overall posture. For instance, whether or not standing comes with significant safety concerns heavily depends on the level of embodiment, i.e., if the users are either standing stationary, wildly swinging their arms and legs, or even freely walking or running. To account for this, we included the degree of embodiment of the interaction interfaces. Different interactions and corresponding degrees of embodiment can range from using merely fingers/hands to control simulated interactions and (self-)motions (e.g., mouse & keyboard, thumbpads/joysticks, trackpads, and gestures), to more embodied interactions (such as leaning-based interfaces, head-based interactions) to diverse walking-based interactions, as detailed in the below table. Note that the degree of the embodiment is intended to be seen as a continuum, although the below classification had to utilize discrete levels to be visualized in a table. The ratings in the table below indicate the following: (very) advantageous = + (++); neutral = o; and (very) disadvantageous = - (- -). The table points to the advantages and disadvantages of combinations of posture and degree of embodiment, but there might be further important factors as well that go beyond the scope of this extended abstract. For instance, in the case of low-embodied scenarios, there is a large difference between wand-based teleportation and wand-based steering regarding cybersickness, which is not considered here separately.

The classification itself is intended to serve different use-cases: First and foremost, it should provide a broad overview of characteristics to help identify the most suitable posture for a given set of functional and non-functional requirements when designing a new VR experience. Second, it might help to identify open research questions – e.g., does the impact of a mismatch between a real and virtual scenario differ between sitting vs. standing? I.e., may it be easier to imagine/simulate standing when actually sitting than the other way around? Finally, it can help to answer research questions, such as, if it is worthwhile to combine the advantages of a seated or standing posture in hybrid interfaces, which allow for a seamless transition between the postures, or keep the user in an in-between posture, e.g., with a sit-stand stool [2]?

Most importantly, we hope this proposed classification will encourage future discussions and research on this increasingly relevant topic, and help guide the path towards a more extensive systematic classification of the various challenges of sitting vs. standing in VR, as well as the different degrees of embodiment that are possible in VR.

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References

[1] M. Bellgardt, S. Pick, D. Zielasko, T. Vierjahn, B. Weyers, and T. W. Kuhlen. Utilizing Immersive Virtual Reality in Everydaywork. In *Proc. of IEEE VR Workshop on Everyday Virtual Reality*, pages 1–4, 2017.

[2] J. Freiberg. Experience Before Construction: Immersive Virtual Reality Design Tools for Architectural Practice. Master’s thesis, Simon Fraser University, Surrey, BC, Canada, 2015.

[3] A. Kitson, B. E. Riecke, A. M. Hashemian, and C. Neustaedter. NaviChair: Evaluating an Embodied Interface Using a Pointing Task to Navigate Virtual Reality. In *Proc. of ACM SUI*, page 123–126, 2015.

[4] J. J. LaViola Jr, E. Kruijff, R. P. McMahan, D. Bowman, and I. P. Poupyrev. *3D User Interfaces: Theory and Practice*. Addison-Wesley Professional, 2017.

[5] M. Marchal, J. Pettré, and A. Lécuyer. Joyman: A Human-Scale Joystick for Navigating in Virtual Worlds. In *Proc. of IEEE 3DUI*, pages 19–26, 2011.

[6] T. Nguyen-Vo, B. E. Riecke, W. Stuerzlinger, D.-M. Pham, and E. Kruijff. NaviBoard and NaviChair: Limited Translation Combined with Full Rotation for Efficient Virtual Locomotion. *IEEE TVCG*, 2019.

[7] S. Razzaque, Z. Kohn, and M. C. Whitton. Redirected Walking. *EG Eurographics*, 9:105–106, 2001.

[8] J. N. Templeman, P. S. Denbrook, and L. E. Sibert. Virtual Locomotion: Walking in Place Through Virtual Environments. *Presence*, 8(6):598–617, 1999.

[9] L. Terziman, M. Marchal, M. Emily, F. Multon, B. Arnaldi, and A. Lécuyer. Shake-Your-Head: Revisiting Walking-In-Place for Desktop Virtual Reality. In *Proc. of ACM VRST*, pages 27–34, 01 2010.

[10] J. Wang and R. W. Lindeman. Silver Surfer: A System to Compare Isometric and Elastic Board Interfaces for Locomotion in VR. In *Proc. of IEEE 3DUI*, pages 121–122, 2011.

[11] Z. Yan, R. W. Lindeman, and A. Dey. Let your fingers do the walking: A unified approach for efficient short-, medium-, and long-distance travel in vr. In *Proc. of IEEE 3DUI*, pages 27–30, 2016.

[12] D. Zielasko, S. Horn, S. Freitag, B. Weyers, and T. W. Kuhlen. Evaluation of Hands-Free HMD-Based Navigation Techniques for Immersive Data Analysis. In *Proc. of IEEE 3DUI*, pages 113–119, 2016.

[13] D. Zielasko, B. Weyers, and T. W. Kuhlen. A Non-Stationary Office Desk Substitution for Desk-Based and HMD-Projected Virtual Reality. In *Proc. of IEEE VR Workshop on Immersive Sickness Prevention*, 2019.

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posture	sitting		standing		
degree of embodiment	**low** (finger/hand-based)	**high** (including vestibular cues)	**low** (finger/hand-based)	**high** (including vestibular cues)	**walking**
typical locomotion interfaces	none, controller/ pointing-based steering [4], finger WIP [11]	leaning-based: ChairIO, NaviChair [3]; seated WIP [12], accelerator pedal [12], shake your head [9], desk travel [13]	none, controller/ pointing-based steering [4], wand-based teleportation	Joyman [5], WIP [8], NaviBoard [6], shake your head [9], Silver Surfer [10]	free-space walking, redirected walking [7], treadmill walking
comfort (long-term)	++ long-term usability, less exhausting	++ long-term usability, less exhausting	− − standing without embodiment can be very exhausting over time	− standing for a purpose might be more convenient than without	o strong purpose for standing but also more exhausting than sitting
cybersickness	+ sitting generates less sickness, however highly depends on the chosen travel technique (steering − vs teleportation ++)	++ more embodied interfaces generate less sickness	o standing has no pros or cons regarding sickness, however highly depends on the chosen travel technique (steering − − vs teleportation +)	+ more embodied interfaces generate less sickness	++
enhancement, engagement, movement abilities	− typically lower and more passive	o even more improved when allowing for 360° rotations	o	+ movement abilities: crouching, jumping, turning, crawling, etc.	++
safety	++ reduced chance of falling, injury, bumping into objects	+ less save with more body movement	+	− less save with more body movement	− − increased safety concerns: falling, colliding with real-world obstacles, getting entangled in cables, running into walls
realism	− very restrictive in the scenarios that match	+ can map more	− very restrictive in the scenarios that match	+ can map more	++ strong but only for walking scenarios
technical complexity (tracking)	++ small tracking space, very defined tracking scenario	+ small tracking space potential overlap/occlusions	++ small tracking space, very defined tracking scenario	o small tracking space, interaction devices should be untethered	− − requires large tracking space, interaction devices should be untethered
locomotion range, useable space	++ independent of size of physical room	++ independent of size of physical room	++ independent of size of physical room	++ independent of size of physical room	− depending on and limited by size of physical room
locomotion precision	+ joystick and co. often allow for precise movements; supported	− leaning and co. often are reported to be less precise	o joystick and co. often allow for very precise movements; unsupported	− leaning and co. often are reported to be less precise	++ natural
interaction precision	+ many interactions benefit from support	+ many interactions benefit from support	o environmental as well as body support is harder to implement	− mainly unsupported mid air interactions	− mainly unsupported mid air interactions
inclusiveness, accessibility	+ suitable for most people, including wheelchair-bound	+ more embodied interfaces may be more or less inclusive, depending on the disability	−	−	−
multi-user interaction (co-located)	− little benefit over remote interaction	− little benefit over remote interaction	− little benefit over remote interaction	+ limited physical interaction with collaborators possible	++ physical interaction with collaborators possible; might rise safety issues
metabolic energy consumption	− − / ++ is very low; can be a pro or con	− / +	− / +	o	− − / ++ is high; can be an pro or con