Influence of Avatar Realism on Stressful Situation in VR

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Abstract

In this paper we present a study of the impact of avatar realism on user experience and performance in stressful immersive virtual environments. We evaluated a stressful and a stress-free environment with partial avatar embodiment under low (iconic) or high (photo-realistic) visual fidelity conditions. An experiment with forty participants did not reveal any significant differences between both graphical versions. This first result represents an interesting finding since non realistic avatar and environment representations are faster and more economical to produce while requiring less computational resources.

Index Terms: H.5.1 [Information Systems]: Artificial—Augmented and Virtual Realities

1 Introduction

Simulating a realistic appearance, e.g., by achieving a higher degree of photorealism, is both computationally expensive and resource consuming. In the same time, chances are high that this computational effort will just produce a negative impact on the perception and acceptance of virtual humans [5, 1, 8]. Virtual humans which look and behave almost–but not completely–like real persons often appear unintentionally eerie or creepy. This effect is often referred as the *Uncanny Valley* (UV) effect [6]. However, despite its possible implications on development cost and virtual body acceptance, the relationship between realistic human resemblance and the sense of embodiment remains an open question.

2 Experiment

As illustrated by figure 1, participants were immersed in a virtual environment with a Head-mounted display (Oculus DevKit 1), showing a first person perspective of a virtual environment. Navigation and interaction inside this environment was enabled via the Razer Hydra gaming controller (from Sixense Entertainment), a low-cost low-range 6 degree of freedom hands tracking devices including sticks and buttons. Participant were also equipped with a circumaural headphones and two small skin conductance sensors (from eSense) around their fingers.

The task participants had to solve consisted of finding a door key to exit a one-room flat. The key was hidden at different places in the flat, below objects or inside furnitures. Participants were able to freely move objects around as well as opening or closing furnitures. They could grab and release objects using their virtual hands or using a 3D cursor. The virtual room represented a surface equivalent to 150 m^2. It was populated with over 50 interactive or movable objects. The maximum time to fulfill this task was limited to five minutes. In the stressful condition, a fire was ignited 15 seconds after the task started. It then progressively grows and spreads through the room until the five minutes expired, at this point the smoke density is completely obstructing user's vision.

Figure 1: **Participant during an experimental session** Participants wore head-mounted display, circumaural headphones and held in both hands the Razer Hydra's controllers. Galvanic skin response sensors were wrapped to their fingers

We adopted a 2 x 2 x 2 mixed experimental design. The between-subjects factors being a) the graphical representation style, and b) the existence or not of partial embodiment. The within-subject factor was the presence or absence of fire. The first factor, the graphical style, corresponds to the visual realism of the scene. It was divided in two levels: realistic (photo-realistic) versus non-realistic (iconic) representation. Iconic or abstract representation means a lower polygon count and plain colors as materials. The realistic version implies high polygon model and photo-realistic texturing. However, for both the rendering quality remained the same (i.e. same resolution, same light amount and placement as well as shadow quality). The second factor was also separated in two levels: partial avatar embodiment or and no embodiment at all. The embodiment condition consisted in a graphical representation of two arms and hands, replicating user's real hands/arms position and direction. For the non-embodiment condition, the virtual body's parts were replaced with a 3D cursor (represented by a sphere).

The third and last factor consisted of two different levels of threat; either a spreading fire inside the room including smoke and an alarm tone or no fire at all. To avoid sequence effects two different room layouts were created, both of the same base size, but with objects arranged differently. Figure 2 illustrates the different condition combination, as seen from the users point of view.

The following measures were collected in this study:

1. **Presence**: Presence Questionnaire (PQ) from [12] allowed us to evaluate the subjective feeling of immersion.
2. **Game Experience**: A shortened and simplified version of the Game Experience Questionnaire [4] (GEQ) was given to participants after each sphere task round to assess different aspects of their digital game experience
3. **Simulator Sickness**: The results of the simulator sickness questionnaire (SSQ) [2] were solely used to sort out participants.

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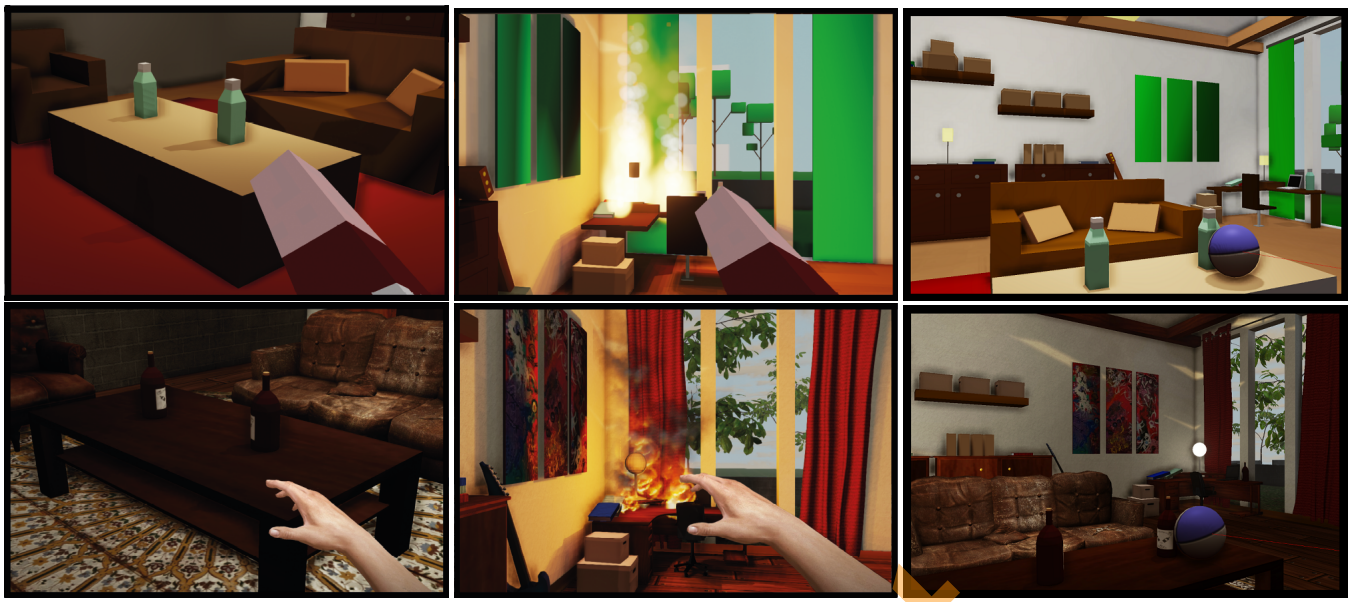

Figure 2: **Avatars from first-person perspective.** Participants saw the virtual avatar's hands from a first person perspective and synchronized with their real hand movement. Each participant experienced both a stressful and stress-free situation with either a realistic or a non-realistic (iconic) environment, or no embodiment at all (represented by a sphere acting as a 3D cursor)

4. **Illusion of Virtual Body Ownership (IVBO)**: A questionnaire based on [11, 9, 3, 7] was used to compare the sense of embodiment for each virtual body representation.

5. **Galvanic Skin Response (GSR)**: The participants level of stress was evaluated using skin conductance measurements.

6. **Situation Rating**: The Situation Rating Scale (SRS) was used to measure the danger participants subjectively experienced.

7. **Task Performance**: The time needed to complete the task and the distance covered during the experimental session.

3 Results & Discussion

In total 40 participants (27 males / 13 females) were involved in the experiment, with an average age 23 years old (SD = 4.88).

Despite a significantly higher sense of danger (SRS) in stressful environment, no significant differences could be found between realistic and non-realistic environments. The task performance, presence, game experience, galvanic skin response and sense of embodiment (IVBO) appeared similar independently of the level of detail given to the environment or avatar representations. However, both versions of partial embodiment led to significantly higher scores in IVBO and presence compared to a simple 3D cursor.

4 Conclusion

Our results suggest that VR simulation of stressful situation are as effective in low or high visual fidelity. To a certain extent, user performance and experience such as the sense of presence, embodiment or danger as well as game experience are not degraded by abstract or iconic visual representations. As suggested by previous study [10], we also noticed that, regardless of graphical fidelity, presence in virtual reality is always higher with avatar embodiment.

Our preliminary findings could be of interest for numerous VR practitioners, researchers and developers, since non realistic avatar representations and abstract environments are more economical to produce, require less computational resources, and do not seem to impact the user experience or performance.

Our next steps is now to confirm further our observations by replicating this experiment with full-body tracking as well as genuine non-human avatars and environments.

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