Body ownership of virtual avatars: an affordance approach of telepresence

1. Introduction

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Abstract: Interaction with and graphical representation of avatars in virtual environments is an increasing trend of our cyber-society. However, there is a lack of knowledge about how the human being deals with these computational beings. Projects in the field of *telepresence* seek to understand the human ability to achieve a *distal attribution* of him/herself, also known as *ownership* [1]. A large majority of these studies are only based on questionnaires [2, 3, 4, 5]. Here, the objective is to use a less subjective measure to evaluate the phenomenological embodiment of the individual into the avatar. In practice, the presence is gauged by an *affordance* marker, which is the ratio between an environmental dimension and a body dimension (*π factor*) [6, 7, 8]. The project will consist in modelling avatars with a different morphology and recording the variation of the *π value,* when a participant has to steering the avatar through variable width apertures. The virtual character is controlled through the Kinect natural user interface.

2. Objectives

The goal of this project is to carry out different experiments to evaluate the user body's ownership of diverse virtual avatars. Three main experiments are planned to analyse the effect of the avatar morphology and dynamic on the *telepresence* phenomena.

- *Experiment 1:*

  The princeps experiment aims at making a comparison between the *π value* in a virtual environment and the π value recorded in natural conditions [6].

- *Experiment 2:*

  The purpose is to manipulate the avatar dimensions, such as a small avatar can be controlled by a large person and vice versa, in order to study the weight of the human/avatar matching on virtual body ownership.

- *Experiment 3:*

The objective of the last experiment is to evaluate whether or not a natural user interface enhances the *presence* feeling. To do that, a condition in which the avatar articulations are controlled by the Kinect is compared to a condition in which the NUI only controls the gravity centre of the 3D character (the rest of the movement is artificially loaded). Therefore, the influence of the avatar dynamics is tested here.

3. State of the arte

The concept of *presence,* defined in the field of virtual reality, resembles the concept of *ownership* in certain aspects. The sensation of "being there", in place of the avatar that represents the individual in the virtual world is one example. For Minsky [9] the term *"telepresence"* describes the operator's sensation to be physically present in the space where s/he acts via the machine. Sheridan [10] proposes to distinguish between *virtual presence* for virtual reality and *telepresence* for remote control situations. It seems that this separation is not useful in neuroscience [4]. In fact, the central question is the mental representation of one's human body. Subjects in virtual reality situations say they were mentally more "situated" in the virtual world than in the physical world [3]. Loomis [1] distinguishes between the phenomenal body and the physical body to explain the *distal attribution* of an avatar to her/himself in the virtual world. According to this author, in this singular situation, there are three entities. The first one is the objective entity, which is the physical body of the individual. The second is the virtual body, represented by the user body inside the virtual environment (the avatar). The last entity is the *body schema* or mental representation the user has of her/his own body. When the individual interacts with a mediated world, her/his *body schema* can be deteriorated by swapping between virtual body and physical body [2]. So far, the main psychophysical measurements of ownership have only been carried out in the context of teleoperation [7, 8]. The purpose of the present project is to take advantage of the virtual environment plasticity to complete a systematic analysis of the body ownership of an avatar by using an objective mean of evaluation based on the *affordance* methodology [11].

4. Technical description

- Modelling/implementation of the experimental stimulus will be carried out with Blender and Unity 3D game engines.

- The human user will interact with the avatar through Kinect [10] cameras, which can provide both classical 2D color images and a high-quality depth map.

- Computers and a video projector will be used to display the experimental trials.

- The project requires a quite large room which has the possibility of video projections on a screen or white walls (typically a class room).

5. Work plan

5.1. Week 1

- Modelling the experimental environment:

    * 3D world (ground, apertures...),

    * Avatars with different morphologies (Point-Light Walker vs. Stick Man vs. Mannequin) and dynamics (movement kinematics).

- Protocol setup for the princeps experiment.

5.2. Week 2

- Experiments on voluntary participants.

- Data analysis.

- Presentation of the first results.

5.3. Week 3

- Continuation of the experiment 1, in order to accumulate enough subjects for a statistical analysis.

- New avatars modelling and protocol setup for the second and third experiment.

5.4. Week 4

- Tests on participants in the experiment 2.

- Tests on participants in the experiment 3.

- Conclusions and perspectives.

6. Profile of team

Yves Rybarczyk holds a PhD degree in Robotics and Human-Machine Interaction, from the University of Evry (France). His research focuses on i) the telepresence and ownership phenomena, and ii) the modelling of sensorimotor couplings and their implementation in artificial systems. This research is mainly applied to enhance the link between human user and neuromimetic agents.
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Tiago Cardoso holds a PhD degree in Electrotechnical Engineering, from the New University of Lisbon (Portugal). An important part of his research focuses on the Natural User Interfaces and their application in the framework of assistive technologies, such as the sign language learning.
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Tiago Coelho holds a MSc degree in Electrotechnical Engineering, from the New University of Lisbon (Portugal). He works, under the supervision of Prof. Yves Rybarczyk, on 3D agents modelling and human-avatar interactions with the aim of enhancing the telepresence in virtual worlds.

Other people needed. This is a highly interdisciplinary project. We also need the following profiles:

- A computer scientist with good programming skills (C# or Javascript or Python). He will work on system integration and game programming.

- A graphic designer with knowledge in graphics computing software (Blender or Maya or 3ds Max), game engines (e.g., Unity 3D) and some programming skills. He will work on the 3D modelling of the virtual characters and environment.

- A psychologist to set up pertinent scenario details, interesting psychological tests and data analysis.

- Any interested people are welcome both from engineering and humanities.

7. References

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