

Design of Body Transformation Experience

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Abstract

Humans can feel an illusory body ownership towards bodies that are different from the real one. It has been well studied how the virtual embodiment can be realized and what can be embodied. However, it is not clear how we feel when our body changes from one body to another. We aimed to provide different experiences of body transformation by varying the transition patterns of avatars. We created five types of avatar transitions. In Flicker process, the body appearance changes instantly from one avatar to another, but with a blank screen in the middle. In Cut process, the body appearance changes instantly without blank. In Smooth process, the avatar's body appearance transforms gradually and smoothly according to a smoothstep function. In Linear process, the avatar's body appearance transforms gradually according to a linear function. In Wave process, the avatar's body appearance transforms like a wave or back and forth according to a mixture of linear function and sinusoidal function. We expect that participants will be the most aware of body transformation in the Wave transition followed by Linear and Smooth transitions. The Flicker and Cut transitions are natural and less noticed by participants.

CCS Concepts

• **Human-centered computing** → **Virtual reality**;

1. Introduction

We can embody various type of virtual bodies that are different from our own bodies such as different ages, different genders, and even invisible bodies [KSM*18]. It has been investigated how the virtual embodiment can be realized and what is critical for inducing the sense of body ownership and agency. As a temporal aspect of embodiment, The length of time required to induce illusory body ownership is investigated. The rubber hand illusion occurs about 18 seconds after the visual-tactile stimulation is applied, occurs faster when the distance between the rubber hand and the real hand is closer, and takes longer the further they are apart [Llo07] [KE17]. In an experiment in which an avatar moves synchronously with a participant, the sense of body ownership occurs within 5 seconds [KBC*20]. However, it has not been investigated how we feel when our body changes from one body to another, or the process of body transformation. This is another temporal aspect of embodiment, rather than the onset time of illusory body ownership. Thus, we focused on the sense of body transformation.

There is a genre of fictional works, in which characters change their physical appearance, size, gender, and abilities, or add various accessories to their bodies in response to some trigger and visual effects (e.g., instantaneous change, gradual increase in size, once naked, or enveloped in light to become invisible). This study aimed to explore the potential for self-experiencing body transformation and the impact of various transformation processes on the sense of body transformation, body ownership, and agency. The research question is how we can design the body transformation experience.

2. Design of body transformation process

We aimed to create different experiences of body transformation for different situations and needs. For example, some users may want to experience an intense sensation of transformation in order to accept a new body and consciously change their attitudes and behaviors, while others may not want to be aware of the transformation. We hypothesized that experiences of body transformation would rely on the types of transition processes utilized. We implemented five types of transition processes that influence the degree of awareness experienced during the transformation, ranging from natural and unconscious experiences to heightened awareness and intensity (Figure 1).

In Flicker process, the body appearance changes instantly from one avatar to another similar to Cut process, but with a blank screen in the middle. This method is inspired by the phenomenon of change blindness [ROC97]. Humans do not detect changes in two alternately changing images with a black or gray screen in the middle. Therefore, this method is expected to be the least noticed by users.

In Cut process, the appearance of the body changes instantly from one avatar to another. We assume that users are less aware of this type of transformation.

In Smooth process, the avatar's body appearance changes gradually and smoothly according to a smoothstep function. Users feel gradual and smooth body transformation.

In Linear process, the appearance of the avatar's body gradually

changes according to a linear function. Users feel the gradual but less smooth transformation of the body.

In Wave process, the avatar's body appearance changes like a wave or back and forth according to a mixture of linear function and sinusoidal function. Users feel a strong sense of body transformation.

3. Methods

Participants wore a head-mounted display (HMD, HTC Vive Pro EYE). Three HTC VIVE Base Stations 2.0 and five VIVE Trackers (2018) were used to track body movements in the real environment and translate them to the avatar's movements in the virtual environment. The trackers were attached with straps to the left and right hands, left and right feet, and the center of the waist. Head position and orientation were obtained from the HMD. The motion of the joints without trackers was estimated by inverse kinematics using Final IK. Unity (2020.3.28f1) was used to realize the virtual environment and control avatars and their appearances.

Two types of avatars were prepared for avatars before and after the transformation. The pre-transformation avatar has a lifelike form that mimics a human, promoting a strong sense of body ownership. In contrast, the post-transformation avatar features anime-inspired design and blue skin, decreasing the the sense of body ownership. The utilization of these highly dissimilar avatars effectively compares distinct transformation processes. Five types of transitions were used as described in the previous section. Regardless of the transformation method, the transformation took place over a period of 10 s. In Flicker transition, the gray blank screen (0.2-1s) was inserted in the middle of Cut transition. In Cut transition, the avatar changed immediately in the middle of the transformation period. In Smooth, Linear, and Wave transitions, we modulated transparency (alpha channel) of two avatars according to the smoothstep, the linear, and the mixture of a linear and sinusoidal functions, respectively (Figure 1(left)).

4. Experience

Participants can experience all five body transformations in this demonstration. We expect them to be most aware of the Wave transition, followed by the Linear and Smooth transitions. The Cut and Flicker transitions are natural and less noticed by participants when they are focused on other tasks.

In a preliminary study, a comparison was made between the Cut, Linear, and Smooth transitions using 28 participants. We found that the linear transition resulted in the highest sense of body transformation, followed by the smooth transition. The Cut transition produced the lowest sense of body transformation. Based on these findings, our demonstration implements body transformations that are more conscious (Wave) and less aware (Flicker).

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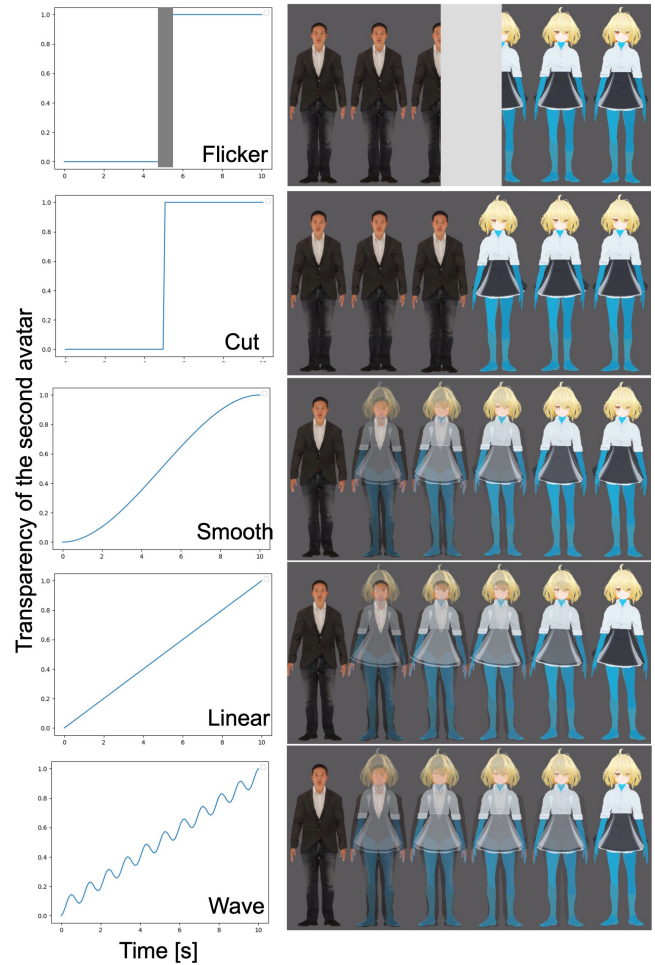


Figure 1: Functions (Left) and schematics (Right) of five avatar transitions. From top to bottom: Flicker, Cut, Smooth, Linear, and Wave transitions.

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