VIRTUAL INSTRUMENTALITY : EXPLORING EMBODIMENT IN ARTISTIC INSTALLATIONS

Maria Christou, Olivier Tache, Annie Luciani & Daniel Bartelemy

In this paper we study the question of interaction with digital technologies by exploring the cognitive mechanisms of embodiment in the context of multisensory artistic installations. In order to test our hypothesis we observed visits to an experimental installation, which provides conceptual and technological consistency. Our first observations suggest that these conditions result in a strong embodiment for the proposed interactions.

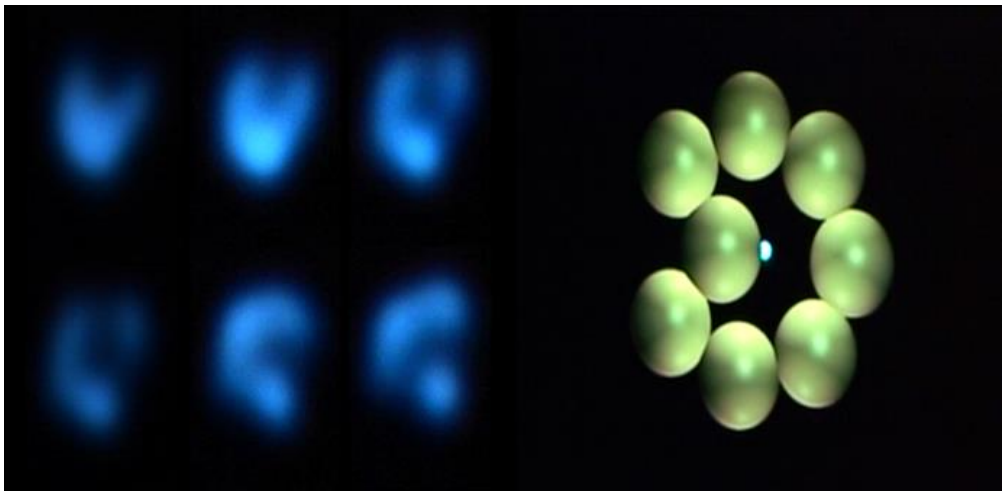

Fig. 1. The two visualisations: On the left a sequence of the "blurry"; and on the right the "ball-like".

Version	1	2	3	4	5	6
Contacts	Hard	Soft	Hard	Soft	Hard	Hard
Visualization	No	No	Blurry	Blurry	Ball-like	Ball-like
Force feedback	Yes	Yes	Yes	Yes	No	Yes

Fig. 2. Upper side: Coordinator and visitor while exploring the installation. Lower side: Summary table of the experimental sessions.

Introduction

Digital technologies for creation free us from physical constraints, but at the same time might lead to the loss of instrumentality, that is the very specific, rich and nearly intimate physical relationship between a human being and an object used to perform actions on the environment. [1] Yet the computer, programmed according to certain rules and linked to the man by the appropriate interface, may offer new forms of instrumentality and be considered as the locus of all instrumentalities. [2] We study the cognitive mechanisms of instrumentality in the context of multisensory art installations, inspired by the hypothesis that conceptual and technological consistency of the composing elements of a multisensory virtual environment is important to the instrumentality of the experience, which should result in a strong embodiment of the proposed interfaces and interactions.

Enacting Digital Matter is an art installation based on the simulation of virtual scenes, addressing the visual, auditory and haptic senses; proposing a form of virtual instrumentality based on physical modeling and force-feedback interfaces. It was presented at the European School of Visual Arts (Poitiers, France) in February 2010. Through this installation, most visitors experienced for the first time a multisensory interaction with physically consistent virtual objects; i.e. simulated objects that behave according to Newton's laws of motion. However, the visitors were presented with sensory paradoxes and unusual situations, such as the possibility to discover an object only by touch, or together with a visual representation apparently conflicting with haptic sensations. Thus, visitors were lead to experience aesthetic and emotional 'shocks' and to question their senses, which is the opportunity to collect essential information about the way our sensory-cognitive system works in an artistic multisensory situation. The installation was designed to capture these unique moments, allowing for further analysis in search of evidences of embodiment.

The Installation

Experiencing the virtual scenes, as well as the consequent commentaries of the visitors, were part of the installation, which was more a performance than a material setup. The aesthetic objects considered were not the force-feedback device, the simulated scenes, nor the resulting sounds and images, but the moments of discovery, exploration and expression by the visitor.

The installation consisted of two simulation stations, each one equipped with a screen, a loudspeaker and an Ergon_X force-feedback interface from Ergos Technologies, which allowed visitors to interact with the virtual scenes through hand and arm gestures. Each scene was based on a physical model created and simulated with the CORDIS-ANIMA system. [3] The sensory consistency of the installation was ensured by the fact that a single physical model produced the audio, visual and haptic signals through a synchronous simulation engine. Each station was also equipped with two video cameras and microphones, so that every visit could be recorded in good conditions for further analysis. This equipment was visible and each visitor was asked to give his or her permission to be filmed and recorded. At the entrance of the installation, a monitor screen displayed what was going on inside through one of the installed cameras.

The Model

Each visitor was offered the possibility to explore one or two scenes among the three available ones: “Pebble Box,” “Friction” and “Approach and Retract.” Each scene corresponded to six different versions that were presented successively. For a given scene, the six versions were based on the same physical model but differed by the presence or absence of one of the sensory channels and by the visual representation. For example, a scene could be presented only with visual feedback in one version (no sound nor force feedback) and with all three sensory channels in another one. In the following, the time spent by a visitor on one version will be called a ‘session.’

In this article, we will focus on the Pebble Box scene. [4] The underlying physical model is composed of eight circular masses enclosed in a flat, circular area (see Fig. 1). Using a force-feedback joystick, the visitor directly moves another, smaller mass in the box. Force feedback gives a haptic feeling of the scene: through his or her hands, the visitor can feel the contact between the manipulated masses and the other ones or the border of the box. The interaction between the masses, including the one manipulated by the visitor, is an elastic collision, whose stiffness is high for some versions of the scene and very low for others, giving respectively hard and soft contacts between the masses. Two visualizations were proposed: a 'blurry' one, which gives the impression of a nearly continuous medium, and a 'ball-like' one, which represents the masses and the limits of the box in a clear, non-ambiguous way. The table on the lower side of Fig. 2 summarizes the different parameters of each version. The order of presentation was the same for all visitors, from version 1 to version 6.

The Pebble Box scene did not have audio output. However, the motors of the Ergon_X interface emit sounds – particularly during hard collisions – which some visitors have remarked on and interpreted (see Results).

Methodology

Realism is well known to be a factor of embodiment and immersion, so it could have interfered with the other factors we wanted to observe through the installation; i.e. the consistency of the sensory sensations and the presence of haptic feedback. Consequently, we gave simple and quite abstract visual representations to the scenes. Visual abstractness was also intended to help the evocation process since no straightforward interpretation of the scenes is given. In the same perspective, the experience proposed to the visitors didn't include any scenario, so as to focus them on the interaction with the simulated objects.

As mentioned previously, the installation explicitly included the fact that visitors could express the sensations and feelings elicited by their interaction with the virtual scenes. To stimulate expression, a coordinator accompanied the visitor in order to facilitate his or her reactions, through an open interview addressing; (1) the felt sense of the experience, (2) how it was felt, and (3) what it felt like. The coordinator encouraged the visitors to go beyond superficial descriptions and comments about what they liked or disliked in the situation. He or she helped them talk about their haptic sensations, which is known to be difficult for many people. The scenes were not presented as being a representation of any existing situation: they were only designated through numbers (e.g. “Scene 1”) and the coordinators did not make any suggestions that could lead the visitor to a particular interpretation. As a consequence, the resulting subjective descriptions were expected to access deeper levels of consciousness related to the felt experience, for example through ‘forgotten’ memories or evocative thoughts.

Six visits to the Pebble Box scene have been recorded (see Fig. 2). The visitors were all men, aged from 20 to 55 years old, most of them having an artistic background. We will refer to them with an arbitrary number (e.g. “Visitor 1”), which is not related to the order in which they visited the installation. The visits lasted approximately one hour.

Results

We focus here on three main observations that suggest the connection between consistent sensory signals and embodiment, or, in other words, what we call virtual instrumentality. Instrumentality in the virtual world is the result of an embodied interaction, which enables the human capabilities to incorporate the new situation. The instrument becomes an extension of the hand, and can be used fluidly and intuitively to explore the given possibilities of the virtual world. In the Pebble Box scene, the instrument considered is a hybrid system constituted of the force-feedback device (real-world part) and the simulated mass that is connected to it (virtual part). The structure of the process towards instrumentality is here explored in three constituents:

EMBODIED MEMORIES

In order to explain the newly felt sensations, visitors were suggested to employ a strategy of transposing them to another experience, felt in the past. The experiences they chose in order to describe their sensations were characterized by a strong embodied quality. They were about sensations from their daily routine, or deep-anchored senses of their past. These felt memories came to explain the actual haptic situation.

Here is how Visitor 1 describes his sensations when exploring the scene in the first session (no visualization, hard contacts):

The images that come to my mind are situations where, sometimes, I wake up in the morning, on my bedside table, there is a glass of tea, my glasses, stacked books, the alarm clock, handkerchief packs, and things like that, and I try to catch my glasses to check what time it is and so I grope around saying to myself ‘I’m going to try not to knock anything over...' and then suddenly you put your eyes at your fingertips.

During the first session too, Visitor 2 explains that the haptic sensation he experiences is actually familiar and he can remember it from another situation: “I know from experience, I’ve done this before, I can remember that sensation... when I was riding a bike, the friction of the brake on the front wheel.”

SPATIAL REPRESENTATIONS THROUGH HAPTIC FEEDBACK

The sensation of a space, opening up at the haptic sense, has been described during most sessions and by most visitors. For example, during the first session, even though there is no visualization, Visitor 3 said:

I think there are still constraints, that is to say... places, places... For example I have the impression that I feel a kind of ball, a kind of place where I am below. [...] I’m navigating around a space, into a space [...]

there are empty places, there are full and empty spaces... Well, I really see it as a plane, [A/N: a flat surface] it's on a plane.

The description of the virtual space gained in subtleness during the third session, when a visualization of the scene, the blurry one, is given for the first time. It became instantly clear for all participants that the image was the graphic representation of the virtual space they had explored haptically. Visitor 3 declared: "Yes, this is the graphical representation of this space!"

Visitor 3, recognized the image as a graphical representation while continuing to manipulate the haptic device. The connection between gesture and graphics came as the result of doing. An image coming as a verification of the haptic sense has also been discussed in the paper of David Prytherch and Bob Jerrard. [5]

In addition to that, Visitor 2 describes how he was able to refine the characteristics of this space: "I think there are several stages with the joystick. All around, well... there is nothing acting. Then, there is a resistance appearing around, when moving towards the center of the joystick, there is a resistance that comes in."

Visitor 3 also described with more details the virtual space: "It's as if there was a ... a circular constraint, in the center, a ring, and I can go either outside or inside it. Now I'm in the inner ring, and if I force a bit I move to the outer ring."

During the fourth session (blurry visualization, soft objects), visitors talked about sensing a curved space, a feeling that can be due to the succession of repulsion and contraction forces. Here is what Visitor 4 said: "I have a space which is rather curved. A haptic space."

During the sixth session (ball-like visualization, rigid objects), all of the participants talked about how the virtual space they felt before was finally revealed to them. They were able to identify the haptic sensations they experienced during the previous sessions and felt the connection between the mental representation of the space they had constructed and the visual space presented to them during this final session. Visitor 3 expresses this connection between the visual and haptic channels in a particularly strong manner: "There, this is what I wanted from the start!"

This quotation suggests that the mental representation of the scene elicited by the haptic channel was strong enough to call for a specific visualization, which corresponds to the ball-like one. Notice also how most of the visitors use first person expressions to describe the sensations. This point is really important to us because it indicates clearly an effective implication and immersion into the virtual scene. It seems that visitors were projecting themselves in the scene through the instrument instead of considering it as an intermediate between them: the instrument was, at least partially, incorporated. This tendency was probably reinforced by the fact that they didn't clearly see what they where actually manipulating until the fifth session.

All these remarks indicate that it is possible to create a strong representation of the virtual space with haptic sensations as the main input. However, during the second (no visualization, soft contacts) and fifth (ball-like visualization, hard contacts, no haptic feedback) sessions, it is really remarkable that none of the visitors talked about space. On the contrary, when strong force feedback was there, the feeling of touching the space was present, and even augmented by visual representations of the scene.

THE MACHINE EMBODIES AN INDEPENDENT LIVING AGENT

The haptic device of the installation takes on a life of its own, it becomes an autonomous entity, with its own will and personality. The visitors interpret its feedback and reaction as well as the mechanic sounds, as a dialog between them and the machine. They ascribed mystic ways to its performance.

“She [A/N: the machine] doesn’t want me to reach the central position.”

“When I pivot, I feel that it kind of stands up to me.”

“I like the sound of the machine... you know... its way of conversing too [...] I don’t know if it’s a dialog... Well yes it is, it’s a dialog [...] if we say that this is a reactive entity, maybe a living entity, I don’t know, it’s… this movement to make it feel good, or bad... according to its reaction.”

We observed differences in the degree people experienced it in different situations. On one hand, in the first session, the machine’s reaction was perceived as stubbornness, as a resistance to the visitor’s intention to manipulate it.

On the other hand, in the third situation, visitors softened their expression and tended to interpret the machine’s reaction more as a way of communication between them and the image, an agent who reacts to their gestures. In both cases the haptic feedback was the same, what changed is that in the first situation the only sensory feedback came from the haptic device, and in the second there was an image which reacted correspondingly to their gestures. So, a second sensory feedback cue helps in the understanding of the interaction. People were no longer confronting the machine, but rather cooperating with it.

“Anytime I move, it’s full of tiny different sounds, as if it was a language.” (Visitor 2)

“Actually, it’s a response to the gesture I make.” (Visitor 2, talking about what happens on the screen)

“Without the image, well it’s true that I feel something but, there, on the screen, I’m conscious that there is something facing me.” (Visitor 6)

“What is curious is that, suddenly, I feel like there is someone else who wasn’t there [...] Until now, I had the feeling that I was in a kind of dialog and now... now we are three.” (Visitor 1)

Finally, in the forth session (blurry visualization, soft contacts), the feeling of being in a dialog persists but this time the entity is considered less reactive:

“I think it was given some anesthetic.” (Visitor 3)

Conclusions

Our method has proved to be a valuable way to collect rich information about the visitors’ experience, providing insights into the sensory-cognitive process. We identified three dimensions that characterize creative interaction with the virtual scene depending on the degree of multisensoriality. Enactive situa-

tions awake embodied memories in order to create the adequate conditions to translate the virtual experience to an embodied one. Developing haptic feedback enables spatial representations of the virtual world and subsequently helps in building a better coupling of action-interaction, a necessary condition for creative interaction. Finally, the that fact to recognize the machine as an equal co-player by attributing it agency couldn't conclude better our hypothesis for creative instrumentality in virtual artistic environments.

References and Notes:

All quotations in the paper were translated from French by the authors.

ACKNOWLEDGMENTS

This works has been supported by French National Agency of Research (ANR-08-CREA-031).

CREDITS OF ENACTING DIGITAL MATTER

Artistic production: A. Luciani, J-L. Florens
Interaction and simulation engineering: J-L. Florens, A. Luciani, C. Cadoz, J. Castet Software engineering: N. Castagné

REFERENCES

1. *Annie Luciani et al., "Exemplary Enactive Tasks and Associated Technological Bottlenecks," (paper presented at the 2nd Enactive Workshop, Montreal, 2006).*
2. *Claude Cadoz, "Musique, Geste, Technologie," in Les Nouveaux Gestes de la Musique, eds. Hugues Genevois and Raphaël de Vivo, 47-92 (Marseille: Éditions Parenthèses, 1999).*
3. *Claude Cadoz et al., "CORDIS-ANIMA: A Modeling and Simulation System for Sound and Image Synthesis - The General Formalism," in Computer Music Journal 17, no. 1 (1993): 19-29.*
4. *Maxime Houot et al., "Perception of Multiple Moving Objects Through Multisensory-Haptic Interaction: Is Haptic So Evident for Physical Object Perception?" in Proceedings of the 3rd International Conference on Enactive Interfaces, Montpellier, November 2006, 154-155.*
5. *David Prytherch and Bob Jerrard, "Haptics, the Secret Senses; the Covert Nature of the Haptic Senses in Creative Tacit Skills," in Proceedings of EuroHaptics 2003, Dublin, 2003, 384-396.*