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In the clouds

Virtual experience of a matter

DELPRAT, Nathalie [1], LEROUX, Claire [2], FDILI ALOUI, Sarah[3]

[1] Pierre et Marie Curie University, Paris and LIMSI-CNRS, Orsay, France
[2] ESIEA-Paris and ARNUM, Paris, France
[3]IRCAM, Paris and LIMSI-CNRS, Orsay, France
delprat.nathalie@limsi.fr

Abstract—**Interactive simulation is used to virtually experience a matter through an avatar in the form of a cloud (stratus or cumulus). Based on an Optitrack motion capture system and a particle generator, the recently developed CLOUD prototype has shown promising abilities to explore new relationships between rendering, gesture and audio-visual feedback, especially at the limit beyond which the body recognition is lost. Devoted to a multidisciplinary investigation, the prototype will also provide an evolutive tool for an artistic exploration of the imaginary aspects related to an evanescent medium.**

Keywords-component:artscience approach; virtual matter; body-space relationship; audio-visual interactions; imaginary aspects

I. INTRODUCTION

Edmond Couchot's thinking about kinetic art can also deal with artistic experiments in virtual reality, even though the perception area is larger: "to participate is first of all to see, in another way, to see to make a work of art which is not contradictory with a kind of contemplation, as it has too often been said.(…) All these attempts try to merge the observer into various psychological situations where the perception phenomena are used to induce in himself an attitude of perceptive re-creation of the world."[1]. In increasing the observer immersion, virtual reality environments actualize Alberti's perspective: the observer is simultaneously outside and inside the space.

The image, its shape, its texture and rendering have been central in digital art investigations [2]. Thanks to interactive simulation systems in virtual reality, it is now possible to artificially transfer physical characteristics to an image and to interact with it through different sensorial modalities. In this context, the correlation between action and perception is essential to the sensory experience. Whether the user's body is represented by an avatar or not, new cognitive mediations are generated by these unusual conditions [3]. In our project, we propose to focus on interactive images of natural matters. More precisely, the idea is to virtually merge in a matter in such a way that its physical properties have a significant influence on our own body motion. At first, we have investigated the "air" substance in the form of a cloud.

For that purpose, a real-time simulation based on the motion capture of the user's body is performed and a cloud-avatar with variable bodily limits is created. On the basis of a phenomenological approach, two kinds of clouds can be simulated (stratus and cumulus) and various virtual transformations have been tested depending on the matter density and its diffusion rate. Another specific aspect to the project is the investigation of interaction modes which are well-suited to the dynamic behavior of a cloud. In particular, we propose to develop what we have called "contemplactions"(for contemplative interactions). The idea is to reverse the usual process in which action is required to virtually exist. In a diffusive medium, slow movements are more adapted to maintain the cohesion between form and matter. In the same way, the effect of swift gestures needs time to be identified and meaningfully controlled.

This approach is consistent with the description of the "(...) slow imaginary deformation that imagination procures to perceptions", as detailed in Gaston Bachelard's work on literary imagination related to the four fundamental elements [4], starting point of our project. The ability to perceptually experience an imaginary process is one of the most radical changes caused by virtual reality systems [5]. For instance, it is now possible to virtually act in a so-called thought experiment. Thus, the project described in this paper aims to examine the question "what would happen if my body had the density of a cloud?" and endeavours to creatively respond to it, both from the scientific and the artistic viewpoint.

II. CLOUD PROTOTYPE

A. Context

Numerous performance works have based their interactive visuals either on fluid dynamic models, mass and spring models or particle models [6][7]. For instance, Gideon Orbazanekand[1] and Adrien Mondot[2] companies design augmented scenographies with a significant number of mass-spring or particle systems, which behave independently or interactively with the performer's gestures. Most of the time, the user can pass through the virtual matter, interfere with it or disturb it by his own presence. With a cloud-avatar, the interaction is of a different nature, because the user becomes the matter itself. This change in the body density brings out new perspectives on the body-space relationships and participates in the "production of new affects - or better new affective relations - that virtualize contracted habits and rythms of the body" [8]. To explore such a body virtualization, an interactive simulation system (CLOUD) has been developed at LIMSI, in collaboration with Julien Pousse[3] and Quentin Vidal[3]. Its characteristics, briefly described below, have been discussed with the members of the CLOUD workshop[4] in the course of the year 2010.

B. Gesture tracking

Various motion capture systems present specific advantages depending on the context of use and on the developed applications. The most common systems are 2D or 3D infrared cameras such as the Kinect. Three-dimensional systems like Optitrack or Vicon [9] allow for accurate body tracking while motion sensors, such as accelerometers or gyroscopes in WII modules, are well-suited for the tracking of fast movements performed by a specific body part [10]. For the CLOUD prototype, an Optitrack motion capture system composed of twelve circular cameras is used to track the user's motion (Fig. 1). The calibration of the cameras is performed with the help of the Optitrack Arena software. This software locates thirty four markers dispatched on the user's body, creates the user's skeleton in space and sends the marker 3D positions via its communication protocol NatNet.

We used OSC (Open Sound Control) protocol to transmit in real-time the position information from Optitrack to a gesture analysis MaxMSP patch and a gesture synthesis C++/OpenGL program. The graphical feedback has been performed using the OpenGL library and an open source particle generator (SPARK), which provides a realistic rendering of fire, rain or smoke. This particle generator has been adapted to simulate a cloud-like matter by adding cloud transmitters.

Figure 1. CLOUD system installation.

C. Cloud simulation

Natural phenomena modeling, such as clouds, remains a complex task in computer graphics as well as in fluid mechanics [11][12]. In the CLOUD project, visual appearance and physical relevance have the same level of importance. For the pilot studies, an intermediate approach has been chosen. Indeed, a particle generator system, which is the simplest way to obtain realistic rendering of clouds, has been coupled with an elementary analysis of the cloud physical characteristics. Hence, two pre-set kinds of cloud have been developed. They provide the real-time rendering of a virtual cumulus (compact cloud) and a stratus (dispersed cloud) (Fig.2). The MaxMSP patch maps in real time the gesture data for the rendering parameters. This mapping is called the gesture control and allows for an interaction between the user's gesture and the cloud feedback. Additionally, the life time of each transmitter, the size and color of the particles can be changed in the general flow or modified for one transmitter only. The activation or deactivation of each transmitter is also proposed via the MaxMSP interface, providing partial changes in the avatar appearance.

III. VIRTUAL EXPERIMENTS

Although still under development, the CLOUD system has already allowed us to test different virtual modifications of the user's body. We present here the main findings of this study, starting from transformations in which the body is clearly discernable to highly dispersed representations where the loss of bodily references is significant (videos are available on [13]).

A. Excited cumulus

For the cumulus-like simulation, the particle life time and size are chosen such that the resulting avatar always appears in the form of several small clouds, linked to the user's body (cf. Fig.2).

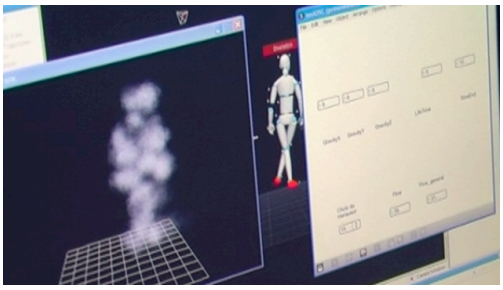

Figure 2. User body skeleton and cloud-avatar (cumulus).

[1] http://www.frieder-weiss.de/works/all/Mortal-Engine.php
[2] http://www.adrienm.net/
[3] student-engineer ESIEA
[4] http://vida.limsi.fr, Projets, NUAGE

Depending on the particle density distribution, the compactness of the cloud can be changed and the action-reaction delay is controlled through the value of the particle flow emission. Among the tested renderings, we have more particularly experimented what we have called the "excited cumulus" (Fig.3). It represents a middle state between highly evanescent matter with high reactivity and very dense matter with strong inertness. In this case, the usual relationship between movement and space is not fundamentally modified but the user can play with his new bodily density and adjust his gestures in agreement with the fluidity of the simulated matter.

Additionally, gravity effects in each space direction can be selected via the MaxMSP interface, giving a smoke rendering when they are applied to the vertical velocity component or a wind effect on x and y axes (see Fig.4). For the latter case, the particle dispersion provides a simple way to fill the space with the evanescent matter according to the user's movement. A wind-like sound can be added to the simulation and combined to these effects. Its control is performed with the user's hands. The sound intensity depends on the position of the left hand (up and down). Its frequency is related to the distance of the right hand from a reference point located at the scene center (from low to high frequencies). As expected, the addition of the audio modality partly changes the experimentation, reinforcing the sensation of dispersion and lightness.

B. *Stratus contemplaction*

In the previous simulation, body recognition becomes more difficult when some transmitters are deactivated or when an interactive zoom effect is applied to the image. Indeed, it is possible to artificially change the vision scale according to the user's distance from the screen. The automatic adaptation allows the user to experience the matter in a different way, losing his usual references between body and space. The same effect has been tested with the stratus-like cloud, which represents a highly dispersed continuous medium. In this case, the matter smoothes out the form and slow movements are required to interact with the image. Moreover, when the particle time life is long, the user is constrained to remain immobile in order to recover his avatar in its original form (Fig.5).

The investigation of the cognitive limit beyond which the connection with the avatar is lost has to be better characterized, both from the scientific and the artistic side. Yet, we have already noted that contrary to most usual action-reaction processes, the virtual experience of a matter requires slow-moving gestures and a particular attention in order to better follow and control the avatar behavior (Fig.6). This leads to experience different states - between perception and imagination - in the form of an "intermediate" imaginary state, which is specific to the virtual dimension. This kind of contemplative interaction, that we have named "contemplaction", is an illustration of the image adjustment to imagination (and not only to perception) defined by the philosopher Lambert Wiesing in order to characterize the new imagination faculty induced by virtual images [5].

C. *Cloudy gesture*

Within the Cloud project, a specific application has been prototyped where a dancer can generate a cloud and interacts with it. The MaxMSP interface receives the markers positions and processes the gesture analysis by computing gesture descriptors related to dance movement characteristics. These descriptors are meant to be mapped to the virtual cloud input parameters. We conceived a gesture control strategy that maps gesture descriptors to specific cloud parameters. For example, the quantity of motion is mapped with the gravity of the cloud.

Figure 3. Excited cumulus.

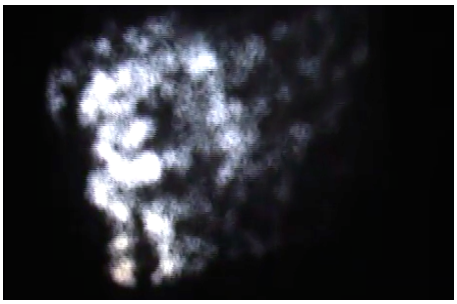

Figure 4. Wind effect (cumulus).

Figure 5. Stratus (without movement).

Figure 6. Stratus contemplaction.

When the dancer moves in one direction with sufficient energy, the cloud has more weight according to this direction (Fig.7). The quantity of motion being the amount of detected motion in time, it is perceived in dance as the energy of the performer movement. Other descriptors such as the extension of the body can be mapped to the cloud density and color [14].

IV. Artistic Experiences – Toward "The Awake Sleeper"

Cloud is an intercultural symbol of contemplation, of the wandering spirit but also of the imaginary world which shapes itself into its evanescent patterns. This out of time inspiration source for artists addresses technical challenges, which were particularly explored by some romantic and impressionist artists such as William Turner, John Constable or Eugène Boudin. More recently, Florent Trochel attempted to tame them [15]. Thus, he turns the situation around by throwing clouds on the ground. Going through them, people generate or erase them according to their directions, which are indicated by a path of pressure sensors. During the day, the installation is almost unnoticeable due to the surrounding light and the density of the motion swiftness. At night-fall, it reveals itself when the motions slow down and the clouds in the sky disappear in the darkness. As Abraham Moles said: "The point in a work of art is to transcend by the wealth, the individual ability to perceive."[16].

In the CLOUD project, we are mainly interested by the matter and we try to perceive it in its specificity. Fifteen years ago yet, the artist Char Davies explored this direction in her piece of virtual reality *Osmose: subterranean Earth* [17]. On one hand, she wanted to enlarge the perception of visitors *(*« I spent a lot of time walking in the midst of nature, and while I walked, I always tried to feel enveloped by what was around me. This is the reason why I quit painting to move into this new medium, because one can feel totally engulfed by this space."[18]). On the other hand, she made people live a new journey experience. Two kinds of interface allowed this experience: a head-mounted display and a motion tracking vest that goes along with the motions of breathing. Its breadth leads the observers into images and created worlds by the artist. In CLOUD, the world is not closed, there is no narration; only maybe a way to lead the observer -step by step- into the blurred and abstract world of his cloud-avatar.

Figure 7. Cloud generation related to the dancer motion.

V. Conclusion

The CLOUD project addresses various issues which require a multidisciplinary approach to be investigated. From a cognitive viewpoint, some specific correlations between matter characteristics and user's action have been pointed out thanks to the proposed simulation. For instance, the adjustment of the gesture speed in relation to the matter density has been clearly observed. The existing mapping strategies for interaction allow for a perceivable dialogue between the user's gestures and the cloud feedback, even when the body limits are indiscernible. Thus, it is possible to create a perceptual ambiguity based on an in-between state : the awareness of presence through the cloud response and the sensation of disembodiment through its dispersion.

With CLOUD, the usual relationship between imagination and perception is fundamentally modified. The image does no longer represent a mediation between them. It permits to experiment in an imaginary space, which artificially possesses its own material quality and may resist our will. This obviously leads us to bring into question the perception of our own image and the implication of our body hybridization with images. This aspect as well as the influence of the cloud-avatar characteristics on the user's behavior are worthy of further consideration.

Presently, the prototype will be enriched by new audio and visual interactions and different cloud modelings will be tested. Once developed, the CLOUD system will be a useful tool for an artistic exploration of the spatialized sound influence on the user's gesture and on the perception of visual rendering. Sounds and music, colour light sources, particles sources, gravity and density will be custom-designed enough to multiply artistic works.

The virtual experience of a matter does not express an unconscious escape from reality but is essentially an ontological experience that the "awake sleeper" would not have denied [19].

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