

Selfhood: an evolutionary and interactive installation using particle systems to synthesize images and sounds

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Abstract. Aiming to instigate a reflection on the self through a practical and interactive experience, the SELFHOOD installation was conceived. A representation of each participant is created in a form of a cloud of points and a sound drone, suggesting their selves. The dynamics of visitors' movement is sonified in such way that colours and sound textures are fused in a surround quadriphonic system. CromaCrono \approx , the system for immersive improvisation that produces digitally synthesized sounds in real time, is described. This research is anchored in a series of artworks described as interactivity narratives. Philosophical concepts concerning to notions of the Self are presented. We propose that the Presence can be induced by virtual and/or physical sources of stimulation governed by a number of principles that underlie human experience, creativity, and discovery. The methodological point of view is that the notion of Presence indicates that there are essential inputs for the construction of self-referral agents.

Keywords: evolutionary systems, interactivity, multimodal installation, presence, sound synthesis.

1 Introduction

In the development of new music interactive technologies, a mixed reality environment [1] can function as a laboratory to evaluate interactive behaviour [2, 3]. With the advent of new technologies that have emphasized interaction and novel interfaces, alternative forms and modes of interactive media have been realized [4]. These developments raise fundamental questions on the role of the embodiment as well as the environment and interaction in the understanding of the man-machine interplay. In addition, it places emphasis on a more situated and externalist view. Moreover, body's perceptual, cognitive and motor responses have to be reconfigured to the needs and constraints concerning action and perception in these new domains and the interface can now be optimized to its user [5, 6, 7].

In line with these recent developments, we present here the Selfhood installation as an interdisciplinary research framework. Selfhood is an evolutionary and interactive installation in which two particle systems based on Boids [8] are used to synthesize

images and sounds digitally. The sonification of the installation is done by the CromaCrono \approx system that operates with a "Composition Curve" with 10 sections containing 14 parameters. Genetic algorithms were applied in order to control the whole generative engine, also enabling fast transmission and communication peer to peer over the Internet. The economic set of parameters and the small set of compositional operations make possible in real time compositions/improvisations to evolve and share. Local and remote agents can share the generative process of CromaCrono \approx .

Our research is anchored in a multimodal laboratory where we study human cognition and musical creativity supported by digital interfaces, computer graphics, and motion capture. It is an interactive environment with a large 3D screen and a six-channel sound diffusion system. The key points discussed here are: investigation of new paradigms on human cognition mediated by interactive technologies that attempt to describe how the creativity operates [9, 10, 11, 12]; development of new technologies that incorporate interactive techniques based on the integration of multimodal signals [13] and the creation of new art forms based on interactivity narratives, digital music instruments, virtual soundscapes and synthetic visualization [14]. These systems can be evaluated from the perspective of the interaction between agents and devices generating sounds, video, and 3D graphics.

Next section discusses notions of the Self, Presence, virtual reality and interactivity and how behaviour and meaning are affected. Following, the SELFHOOD installation and their technical aspects are described. The last section introduces the development of the interactive sonification. Finally, the conclusions are presented.

2 Theoretical Viewpoint

Many are the attempts of describing the self, Prescott [15, 16] enrolls some of them: I know that I exist; the question is, what is this 'I' that I know? [17] The soul, so far as we can conceive it, is nothing but a system or train of different perceptions [18]. What was I before I came to self-consciousness? ... I did not exist at all, for I was not an I. The I exists only insofar as it is conscious of itself. ... The 'Self' posits itself, and by virtue of this mere self-assertion, it exists [19]. The 'Self' ..., when carefully examined, is found to consist mainly of ... peculiar motions in the head or between the head and throat [20, 21]. The ego continuously constitutes itself as existing [22]. Any fixed categorization of the Self is a big goof [23]. The self which is reflexively referred to is synthesized in that very act of reflexive self-reference [24]. The self ... is a mythical entity. ... It is a philosophical muddle to allow the space which differentiates 'my self' from 'myself' to generate the illusion of a mysterious entity distinct from ... the human being [25]. A self ... is ... an abstraction ..., [a] the centre of narrative gravity [26].

Returning to Descartes [17] what is this 'I' that I know? What constitutes a *self* [27]? All the semiotic signs that compose our knowledge were defined along the time by successive generations so that people could communicate, define concepts, elaborate, construct. There are common, universal signs and concepts; there are others that are specific, differentiated, associated with a culture or a region, p. ex. Is the set of signs associated with the knowledge of each person his/herself? Removing the

signs (concepts, habits, beliefs, strategies, etc.), does the self cease to exist? But if the signs were elaborated through generations, how to define individuality; perhaps the individual combination of signs? How do we modify the others, and are modified by them?

2.1 Presence and Virtual Reality

Recently, the literature suggests that the notion of Presence results from the interplay of both central and peripheral factors and that it should be assessed through a number of convergent measures that include measures of the subjective, physiological and the behavioural state of the user. Body and space refer to vital and interrelated dimensions in the experience of sounds and music. Sounds have an overwhelming impact on feelings of bodily presence and inform us about the space we experience. Even in situations where visual information is artificial or blurred, such as in virtual environments or certain genres of film and computer games, sounds may shape our perceptions and lead to surprising new experiences [28]. In the approach presented here, we propose that the Presence can be induced by virtual and/or physical sources of stimulation governed by a number of principles that underlie human experience, creativity and discovery [12, 9, 29]. Presence has long been a key concept in teleoperation and virtual reality (VR) and has been defined as the “sense of being in a virtual environment” [30]. It is not clear, however, how this “sense” is generated and it is not uncommon to see it explained with the notion of “the suspension of disbelief” coined by in the early 19th century by the poet and philosopher Coleridge. Since the inception of the field in the early 80ies, a large research effort in this area focuses on establishing the constraints governing the emergence of Presence in virtual environments. For example, it has been found that detailed visual scenes are not very important, whereas multi-sensory convergence, own body representations, and active environmental engagement all increase reported Presence. Currently, the research of Presence is facing two fundamental and interrelated questions: a) ontological question whether Presence is a central phenomenon, that is “in the head”, or is peripherally defined by action in the world and b) epistemological question of how Presence can be measured. These two questions are reminiscent of the fundamental challenges the science of psychology was facing at the beginning of the 20th century with the debate between the centralism of continental structuralism and the peripheralism of the functionalism in the United States of America that lead to the rise of behaviourism.

The methodological point of view is that the notion of Presence indicates that there are essential inputs for the construction of *self*-referral agents [13]. Thus, we will deploy methodological efforts focusing on interactive media within mixed reality environment in order to study the constructions of the meaningful relationship between agents and environmental stimuli in a virtual space. The assumption is that the interaction of an organism/agent or group of agents with an immersive space, using various interactive devices, indicates how these processes affect their behaviour and the meaning that is constructed by them. The notion of interaction with which we work goes beyond the textual and analytical dimensions only and it will be linked to several perceptual modalities. In the specific case study on scientific sonification and

visualization, an interactive narrative is seen as a result of emergent processes, more specifically from the interaction with soundscapes, interactive video, animation, and 3D-graphics digitally generated.

3 The SELFHOOD Installation

The new approach to cognition focuses attention on the fact that most real-world thinking occurs in very particular (and often very complex) environments, and exploits the possibility of interaction with and manipulation of external props. It thereby foregrounds the fact that cognition is a highly embodied or situated activity and suggests that thinking beings ought, therefore, be considered first and foremost as acting beings. This shift in focus from Descartes' "thinking thing", and the picture of human being and subjectivity it suggests, to a more Heideggerian approach to being in the world, in which agency and interactive coping occupy centre stage, is an extremely important development, the implications of which are only just beginning to be comprehended [31].

In the SELFHOOD installation (Figure 1), a vision system identifies the body of the visitors and creates a visual representation of each one, suggesting their selves.

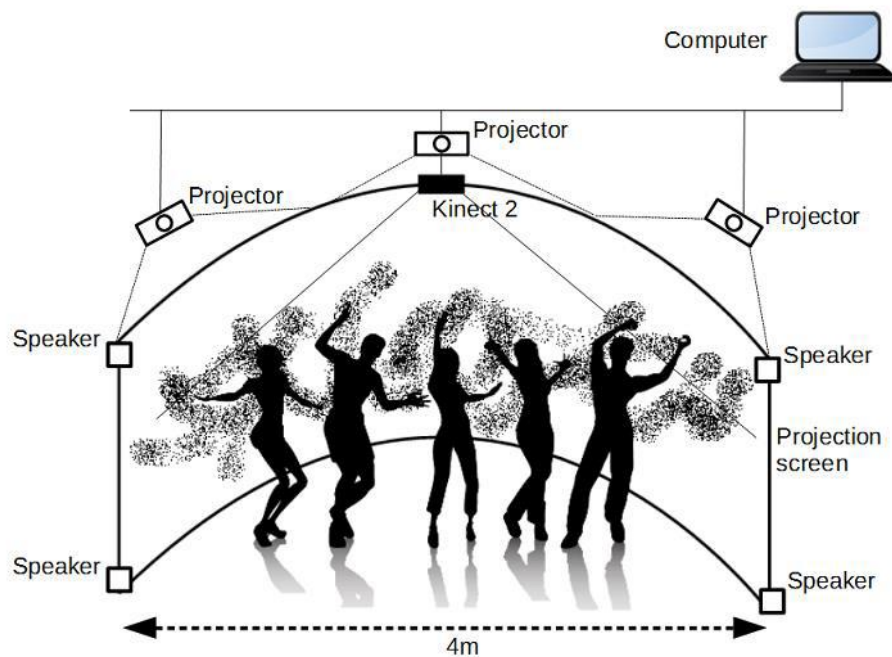


Fig. 1. Shows the layout of the SELFHOOD installation. Three projectors, a Kinect2 sensor, a computer, and loudspeakers were used in the first setup.

Since the Self is still something misunderstood, a cloud of points and a sound drone with grains were first used to represent it. Different colours are assigned to

different clouds, which are displayed on a curved screen, following the movement of their owners. Depending on the spatial distance between visitors, they influence each other: a set of points from a visitor's cloud is displayed with the colour of the cloud of his/her neighbour. The closer people are the greater the influence, the greater the number of coloured dots with the other person's "self-representation". Figure 1 shows the layout of the SELFHOOD installation. Three projectors, a Kinect2 sensor, a computer and loudspeakers were used in the first setup. The dynamics of visitors' movement in front of the installation is sonified in such way that colours and sound textures are fused in a surround quadriphonic system. Therefore, not only the uniqueness of each one is represented as well as how they actuate in themselves. A video showing people playing at the SELFHOOD installation can be seen at [32].

3.1 The Particle System

In order to create a representation of the visitors, three main components were applied: 1) a physical sensor capable of tracking the visitor's body, 2) a programming environment/language focused on visual effects and 3) a screen. The first component is the Microsoft Kinect v2 sensor, which utilizes a set of two sensors (a coloured camera and an infrared sensor) to track up to 6 bodies (at 30 Hz) from 0,5 to 4,5 meters away. Each body is represented as a set of 25 joints with real space coordinates relative to the sensor's position and a colour ID. This ID is used to differentiate one body from another. The sensor data can be acquired through the Microsoft API or through distributed libraries. The KinectPV2 library was used to allow the communication between the Processing environment and the Kinect v2 sensor. With this library, it is possible to detect the bodies and their joints. It is also possible to get the visual input from the coloured camera and the infrared sensor. The second component is the Processing graphic programming environment and the third one consist of a three hall immersive display with (5760 x 1080) pixels of resolution

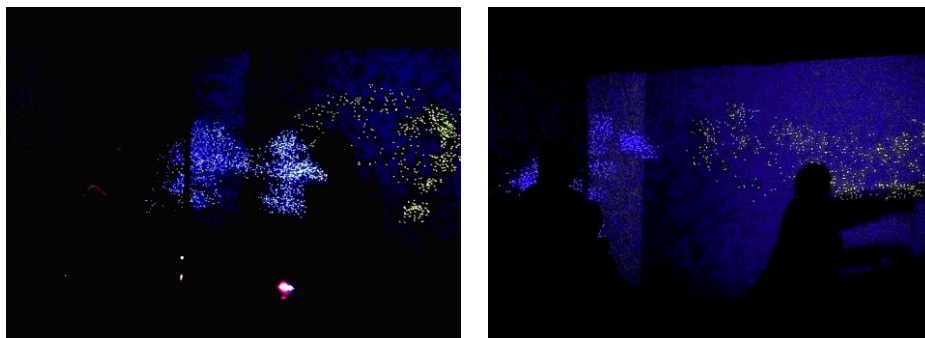


Fig. 2. Visitors are experimenting the SELFHOOD installation. A performance video demonstration can be found in the following link: <https://youtu.be/9F-s3Cafhc4> [33].

By using these tools, the SELFHOOD environment creates a representation of its users in a form of a set of particles systems. Each body contains 25 particles emitters located in each one of its joints. These emitters create coloured particles that match

the colour of the ID of their bodies. Figure 2 shows the representation of the selves through particle systems.

The particles are created with a random initial velocity at a random direction that is affected by a gravitational force present in the simulation. Depending on the distances between bodies, their self-representations interfere with each other by sharing and acquiring particles of different colours. The closer the participants are, the more particles they share; the particles of each self-representation have different colours.

After the creation of the participant's representation, it is displayed on a screen. To improve the immersion of the user, three projectors were used to display the particles bodies on projection screens. These screens were aligned in a "coliseum" arrangement in order to fill the whole field of view of the human eye. The screen was also big enough to create a "mirror" effect of the users' bodies, improving, even more, the user immersion.

4 Interactive Sonification

Complementary, our research is anchored in a series of artworks described as interactivity narratives and supported by digital music instruments, virtual soundscapes and synthetic visualization [34, 35, 36, 37, 38, 39, 1, 40]. We also have studied how virtual spaces, furnished with interactive soundscapes, digitally generated sounds and 3D animations, and interactive video clips contribute in understanding creativity [41].

The sonification of SELFHOOD was implemented with a system for immersive improvisation that produces synthesized sounds in real time, called CromaCrono \approx [42]. Departing from observations on the way sensory processes are integrated with the environment, CromaCrono \approx paradigm exploits the interaction of space and time from the human agent perspective.

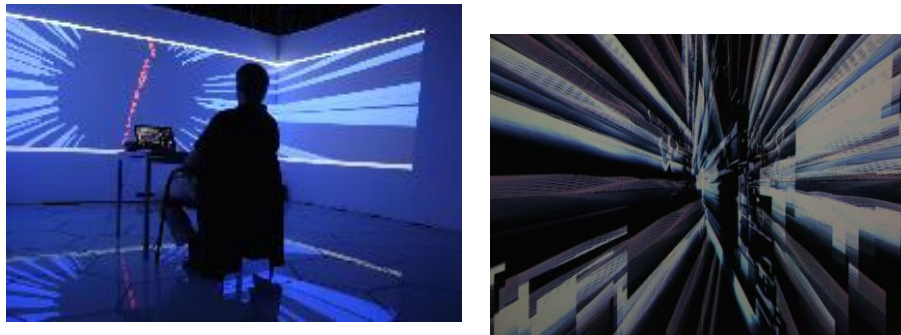


Fig. 3. Presents the visual display of CromaCrono \approx (on the left) and a visual pattern generated by the system (on the right). A demonstration video can be found at [43]: <https://vimeo.com/145326063>

In CromaCrono \approx , simple geometric shapes and computer-synthesized sounds support an audio-visual textural architecture (Figure 3). The Boids [44, 34] are used to

control several parallel processes generating sounds and animating graphics in real time. Therefore, Boids trajectories are used to control the display of hundreds of primitive geometric shapes that vary in shape, colour, speed, and dispersion in space. All these variations produce the audio-visual texture which is coupled with generative rules for controlling sounds and interactions with local and remote agents.

Sounds are generated in real time by four different standard synthesis methods: Additive Synthesis, FM Synthesis, Waveshaping, and Karplus-Strong Algorithm [45]. A granular synthesis engine post-process is applied to the initial synthesized signal according to the spatial projection of two colour-voices: the bluish and reddish ones. In order to emphasize the visual discrimination of two independent interwoven textures, the opposition in the colour spectrum defined these starting colors. Therefore, the whole system works as a unified generative process (see Figure 6).

Economic set of parameters and the small set of compositional operations make possible to evolve and share in real time compositions/improvisations via the Internet. Local and remote agents can share the generative process of CromaCrono \approx . Sound and images are synthesized in local machines while agents exchange parameters that produce a "texture of times". These features, still to be explored in the SELFHOOD installation, raise questions such as: how do close people influence/are affected by us? And who affects the most, the geographically close people or the people with whom we are connected?

The shapes in the complex visual textures (see Figure 4) are associated to sound synthesis engines: spheres to additive synthesis, squared frames to FM, planes to Waveshaping and triangular frames to Karplus-Strong.

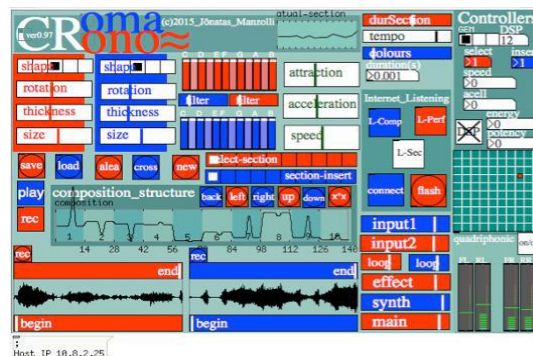


Fig. 4. GUI of CromaCrono \approx showing all the integrated control parameters of the system (top), and in detail the “Composition Curve” and the buttons to apply genetic and structural operations over the curve. A remote user can also "press" the buttons using a mirror control in a location via a VPN connection.

5 Conclusions

Recently, we verify a shift from Descartes' "thinking thing" and the image of human being and subjectivity suggests, with an inner self, to an interactive approach to being

in the world, where agency and interactive confrontation occupy the centre of the stage. In order to instigate a reflection on the self through a practical and interactive experience, the SELFHOOD installation was conceived wherein a representation of each participant is created in a form of a set of particle systems, in different colours. Different participants interact with each other by their distances, sharing particles. The closer they are, the more particles they share.

The sonification of SELFHOOD was implemented with a system for immersive improvisation that produces digitally synthesized sounds in real time, called CromaCrono. It expands the notion of texture, from physical and tactile sensations to the cloud of events that are perceived surrounding the subject. Then, the texture is conceived as a mass with a density of interwoven processes, which increases as much the processes are interconnected.

The approach presented here reinforces that Presence can be induced by virtual and/or physical sources of stimulation governed by a number of principles that underlie human experience, creativity, and discovery. This research is anchored in a series of artworks described as interactivity narratives and supported by digital music instruments, virtual soundscapes, and synthetic visualization.

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