Embody in Virtual Reality: The Body, Thought, Present, and Felt in the Space of Virtuality

João Martinho Moura, School of Arts, Universidade Católica Portuguesa, Porto, Portugal
https://orcid.org/0000-0003-4004-705X
Né Barros, Balleteatro, ESAP, Instituto de Filosofia, Universidade do Porto, Porto, Portugal
Paulo Ferreira-Lopes, University of Applied Sciences Mainz, Germany

ABSTRACT

Virtual reality (VR) has been a prominent idea for exploring new worlds beyond the physical, and in recent decades, it has evolved in many aspects. The notion of immersion and the sense of presence in VR gained new definitions as technological advances took place. However, even today, we can question whether the degrees of immersion achieved through this technology are profound and felt. A fundamental aspect is the sense of embodiment in the virtual space. To what extent do we feel embodied in virtual environments? In this publication, the authors present works that challenge and question the embodiment sensation in VR, specifically in the artistic aspect. They present initial reflections about embodiment in virtuality and analyze the technologies adopted in creating interactive artworks prepared for galleries and theater stage, questioning the sensations caused by the visual embodiment in virtual reality under the perspective of both the audience and the performer.

KEYWORDS

Embodiment, Media Art, Performance, Virtual Reality

INTRODUCTION

Presence concept is relevant as a mediating variable between experience and induced emotions, and Virtual Reality (VR) is an effective mood induction medium, opening its possible use in different applicative areas ranging from the well-being industry to clinical psychology (Riva et al. 2007). Both affective and immersion content affect the sense of presence, and this sense in the non-emotional environment depends mainly on immersion (Baños et al. 2004). Even if the sense of presence is a central but widely contested concept in VR and has been the subject of significant debate (McRoberts 2018), new advances in technology, combined with human factors research, represent new possibilities to test new explorations. It is often assumed that greater immersive quality levels elicit higher levels of presence, in turn enhancing the effectiveness of a mediated experiences (Cummings and Bailenson 2016). Embodied awareness is physical or emotional and a fusion of experiences that culminate into

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something larger than its parts (Tantia 2020). The sense of agency is provided in virtual reality when the participant’s motion is mapped to the virtual body in real-time or near real-time (Kilteni, Groten, and Slater 2012a). Precisely, what distinguishes VR from other mediums and gives it this status as such is a sense of presence: the feeling of “being there” within the virtual experience produced by the artifact (Steuer 1992). In this sense, this “new” medium can be considered quite distinct from other mediums, such as video. Thus, these devices allow us to consider the hypothesis that mediated perception (with a tool) and non-mediated perception (with a sensory organ) follow similar mechanisms of appropriation (Auvey et al. 2005). Sense of embodiment in VR meaning has also matured with the evolution of interaction devices that transport users to new worlds beyond their physical space, in fields such as medicine (Riva, Wiederhold, and Mantovani 2019) (Alzayat, Hancock, and Nacenta 2019), psychology (Slater et al. 2010), ethics (Slater et al. 2020), science and art (Moura and Kolen’ko 2019), perception (Waterworth and Waterworth 2014), and artistic performance (Moura, Barros, and Ferreira-Lopes 2020a). Mel Slater states that VR is a technology that seems ideally suited to tackle research on induced embodiment, where the sense of agency depends on the synchronicity of visuomotor correlations (Kilteni, Groten, and Slater 2012b). When the stimulus is perceived as directed toward oneself, the brain network that encodes the bodily self and its surrounding space is more strongly synchronized across participants (de Borst et al. 2020). Because VR is able to immerse a user so fully in an experience, providing a range of sensory stimuli, it is an ideal platform for recreating embodied situations, empowering empathy (Wiederhold 2020). For the philosopher Don Ihde, the relations of embodiment occur in a context of use, in which it is possible to perceive the world through the instrument. This technology’s effects are revealed in the alteration of human perception; it must be technically (physically) transparent, integrating with the bodily sensorium (Alves 2009). According to Ihde (2002:xi), the body may have three meanings, which we will try to consider: Body First – in phenomenology, Ihde sensitive body, of a perceived, emotional and moving being-in-the-world; Body Second - is also necessary to consider the experience of the body in the social and cultural sense; and Body Third – technology is a third dimension that crosses the body first and second. Expressing it differently, the first body is the living existential body, the here-now bodily experience, the sense of the body deduced by Husserl as Leib, but much better descriptively developed by Merleau-Ponty as the corps vécu (Pires et al. 2021). The body first is the oriented, active, perceptive being-body, through which we experience the world around us. Experience-as-a-body is a constant of all our experiences (Ihde 2002:69). As important as perceiving, from the body, the surrounding universe, is to notice that this same experience produces self-perception of ourselves as a zero point, coincident with our body perception. As Ihde explains, phenomenologically speaking, the invariant perspective on the world is reflexively pointing out the ways in which this same world ‘points back’ to the null point of each person’s body position. It is relevant to note that Ihde points out the importance of old devices, such as glasses, a hammer (Heidegger), or even long-feathered hats (Meleau-Ponty), productive of the extension of the senses of the body and self-perception. In a way the questions currently posed by virtual reality and intelligent machines will not be very different (Pires et al. 2021).

In a virtual embodiment, at the unconscious level, memories and mental representations may be extended out from the physical body onto technology, blurring the physical and the mediated (Bailey, Bailenson, and Casasanto 2016). VR is more radical by exchanging the normal perceptual environment with a completely virtual one (de Gelder, Katsyi, and de Borst 2018). Of the definitions found in the last decades, VR, generally, can consist of three types of sub-systems: a) virtual environments presented on the screen, b) environments based on multi-projection rooms (CAVE systems), and c) visualization devices placed on the heads of people designated as Head Mounted Displays (HMDs) (Steuer 1992)(Gigante 1993)(Cruz-Neira, Sandin, and DeFanti 1993)(Swanson 2007)(Mazuryk and Gervautz 1999)(Grau 2016). In the 1960s, Morton Heilig (1962) created the Sensorama device, a machine that is one of the earliest known VR technology examples. In the last twenty years, immersive vision devices with sufficient resolution have emerged to visualize generated worlds. We will probably witness a revolution in human interaction with VR technology and the environment in the next decade.
(Shi et al. 2020). However, this technology’s foundations are more than 50 years old, as there are references in 1938 to the term “La réalité virtuelle” by Antonin Artaud in theater contexts (Jamieson 2008). This emerging medium’s impact is now beginning to be felt more in society in general, and, according to Ihde, the ultimate goal of Virtual Reality is to become the perfect simulacrum of full, multisensory bodily action (Ihde 2002:7).

**THE MISSING BODY IN VIRTUAL REALITY**

Current technologies in VR, from different manufacturers, have in common an important aspect: the participant’s body is forgotten. When we use a headset, our eyes transmit to our brains new worlds, but our bodies are usually not represented in this world in fullness, mainly becoming obliterated. Since the first commercial VR headsets appeared, like Oculus Rift, hands’ position can be seen in Virtual Reality, represented by the hand controllers’ position. HTC Vive system, using base stations, achieves a highly accurate representation of the head and hands locations. The LeapMotion system, when attached to VR HMD, reaches a good visualization of fingers inside VR (Wozniak et al. 2016). Oculus recently introduced Hand Tracking technology to its Quest devices, using video cameras built into the headset, providing higher presence and higher realism (Voigt-Antons et al. 2020). Google introduced, in 2019, a new computer vision framework named MediaPipe to better understand hand movements using artificial intelligence and computer vision (Zhang et al. 2020). We can also use many Vive Trackers to locate our bodies’ parts in virtual space (Caserman et al. 2019).

There are multiple approaches to the problem of representing, within a digital computer, information concerning and related to the movement of the human body, being the target of many questions for many decades (Badler and Smoliar 1979). All those technologies are pushing the future of virtual reality interactions. The need for its rapid commercialization reinforced essential innovations such as 6DOF through cameras using inside-out tracking, bringing headset costs to impossible values of five years ago. Most digital representation techniques in motion rely on point mapping, motion tracking suits, or computer vision techniques to detect the body’s main points in action. Even if motion capture (MoCap) systems are valuable tools to generate realistic trajectory profiles for human-mimicking (Schlagenhauf, Sreeram, and Singhose 2018), those are mere points in space and time, then adapted into avatar rigging systems.

Virtual Reality is here and now, more accessible than ever. This new generation of devices lets us enter new worlds, and terms like *immersion* are commonly used to describe the feeling they can offer. Nevertheless ... is it really immersion? We all generally agree; however, we can always question to what extent. Basic experiences in current VR do not let us see our own body, and this difficulty leads us to write this publication. Is the representation of the participant relevant for an immersive experience to be more complete? Do *users as owners of avatars* represent indeed embodied sensations?

For example, in a current social application called VRChat, used by thousands of participants today, we find that bodies are represented by vectorized avatars (Gaylor and Joudrey 2017) whose position and rotation are obtained from three points: two hand controllers and one headset. Yes, we know the experience is in VR, and therefore it is more immersive, but we can minimally compare this feeling with the experience of looking at a screen in Second Life, more than a decade ago. The visual logic is the same. Only the point of view is changed. Experiences like Second Life are, in fact, revolutionary and are part of our cybernetic path, having been extensively studied in research in the last decades (Kaplan and Haenlein 2009) (Boulos, Hetherington, and Wheeler 2007) (Hawridge 2009). However, in this essay, we will focus on the issue of corporeal representation. Human flesh is essential in the human condition, and the Masahiro Mori (2012) Uncanny Valley effect is still present in most computer and interactive experiences nowadays (Lugrin et al. 2018). Mori’s original essay on uncanny valley implied that near-human virtual characters would inevitably elicit negative affective reactions characterized by eeriness and aversion (de Gelder et al. 2018). Above all, well-designed virtual characters visually consist of points and joints internally rigging 3D object parts
when mapped are turned into body representations. These mappings are sometimes not enough to describe the richness of detail in the subtle or even artistic movement.

If we take photorealistic advanced approaches, scanned avatars appear to be more human-like and stimulated higher body ownership of the artificial. Yes, but users as avatar owners concept is subjectively speculative, and questions still arise about how or if realistic human-like appearances of avatars really contribute to the psychophysical effects known from VR experiences (Latoschik et al. 2017). Interaction designers often strive to create more-realistic and natural interactions for VR applications, but moderate levels of interaction fidelity can result in the worst user performances, already referred to as the uncanny valley of VR (McMahan, Lai, and Pal 2016). Even if we have well modeled and textured rigged 3d avatars, those configure a partial sense of ownership (Lugrin, Latt, and Latoschik 2015), and mere presence sometimes is not enough (Kane et al. 2012).

The following question seems too simple, but it focuses on a very transversal point when creating virtual reality experiences, where the participant’s body is usually transferred to an entity that he will own. But ... can we be more embodied in the virtual space?

Philosopher Don Ihde gave a presentation in Media Lab Prado at the 6th International Conference On The Philosophy of Computer Games: The Nature of Player Experience, in Madrid, in 2012 (Ihde 2012). In his speech, Ihde explained the game experience’s embodiment process and talked about multistability between image, movement, and the participant. Ihde incorporates Merleau Ponty’s notion of the perceived world as the foundation of all Reality, referring to multistability in the interaction (Komelsen 1991). It was an exciting presentation, specially targeted to a media art audience, and many questions about how the embodiment process occurs arose. He mentioned that gaming experiences using characters controlled by players are not entirely corporeal. Multistability is to analyze the conditions under which this or that stability can be experienced as given, as the invariability of being a human body – and not having a human body, but being a human body (Albrechtslund and Ihde 2003).

Interactive art is a prominent field to explore this kind of embodied (dis)continuity because artists have the propensity to risk and fail, gracefully incorporating this experience in their work. According to Né Barros, the notion of post-phenomenology launched and discussed by Ihde, as a variational and multistable theory, seems to refer to the ontological domain of the notion of performance itself: the movement of performance is incomplete, multifaceted, calls for an opening of meaning and when considered its form as an art object, it forces itself into a state of suspension with the real. Performance (in the broadest sense) results from a phenomenological reduction practice because, by reinventing a new reality, it carries with it the search for a new position in what it has been involved in (Barros 2019:43). There are still gaps and discontinuities between abstract concepts of the body, embodiment experiences, and the dynamic interactions with the flux of which these are enculturated expressions (Hayles 2002).

Specifically, in digital dance, as a mediator of the virtual environment, the body is the system’s first sign operator, and we consider this area a field of great exploration regarding HCI and embodied sensations in virtuality, as much like interaction, performance is about doing (Nitsche 2013). The integration of VR and interactive technology in dance performances leads to new insights and experiments with choreographic methods that may ultimately take dance in a new direction (Cisneros et al. 2019). One of the most stimulating and challenging issues in the arts is the debate over its materiality. This issue is even more pressing for those arts who live within the limits of their physical existence, namely, the performing arts (Barros 2019:27). The micro, minimal dimension of a given action acquires a determining function in the performative object’s narrative construction (Moura et al. 2020a). Not surprisingly, we see performance studies represented on panels on video games, as tracks in digital art conferences, and in showcases at computer conferences such as CHI or SIGGRAPH (Nitsche 2013). Virtual reality/performance work tends to engage actively with open forms of audience participation and interaction, site-specific responses to space (whether virtual or actual), and the possibilities inherent in discontinuous, gaming, interactive, and user/participant-led time frames (DeLahunta 2002).
In our long interaction tests and dance/performance experiences, we tried multiple forms of body capture, representation, and projection, using RGB Firewire cameras in the 2000s, and since then, infrared lighting on stage, motion tracking systems, multiple stereo, and depth cameras like the Kinect or RealSense. We managed to project bodies and gestures through the virtual space and time, at the theater stage and galleries (Moura et al. 2008, 2011, 2014; Moura, Barros, and Ferreira-Lopes 2019; Moura, Canibal, and Guimarães 2013; Moura and Kolen’ko 2019), concluding there is such important information between our body’s many parts that point marking systems cannot catch. In recent exhibitions, we opted to explore the raw volumetric data from depth sensors with virtual reality in the theater to achieve a better physicality, sensed both from the performers and the audience.

WORKS

In this publication, we present two pieces that use VR, and to which we assign other sensors trying to better represent the participant’s body in motion, overcoming the avatar feeling we mentioned in the previous sections. Introduced in 2018, VV is an artistic installation designed for an art gallery that explores virtual spatiality involving it with the participant’s body. Next, the performance piece UNA, planed in 2018 and presented in 2020, is a work in total immersion, where the audience (one spectator at a time) witnesses a body in movement, expanding. In the following two sections, we will analyze the two pieces.

VV (2018)

In 2018 we started an experience of body teleportation to the urban space in the City of Braga. It took place as an exhibition at the gnration gallery, framed in UNESCO’s Braga Media Arts program. The piece, called VV, used VR technology so that participants could navigate the city, taking as a starting point one room inside the art gallery. One of the problems we came up with was the limitation that the current VR interfaces do not present the user’s entire body in the immersed environment. This piece alluded to extra bodily experiences in confrontation with the urban space, using VR technology and participant’s movement capturing. The room was 6 x 10 m, was well-positioned at the entrance to the gallery, and was chosen because it was a closed space with little natural light (Figure 1). Only one person could enter at a time so that the experience was as private as possible. There was only one HTC Vive Pro VR helmet in the room, whose connection cable was connected to the ceiling, nothing more.

Although simple, the piece’s configuration involved depth sensors positioned in the gallery room (Figure 2). When the participant wears the helmet, his body is represented in the virtual world in a perspective and accurate real scale. Depth cameras were positioned in the ceiling to better cover the body from the top, and in the first weeks of the exhibition, the body was partially covered once we used just one camera. Three weeks after, we added a second camera to cover the full body. When
using two cameras, their positions were calibrated in the 3d space. Both VR and depth camera systems were connected to the same computer, and in this way, we obtained low latency. Custom software was created to plot the depth body in VV, and this was not achieved through the standard techniques of tracking body parts, but from the point-cloud sensor signal itself, and the illusion that we establish a mental connection with our digital self is significantly greater than in traditional motion tracking techniques used in cinema to create avatars (Menache, 2000). This visual connection, and consequent sensory appropriation, happens and is accentuated during four minutes, enough time for the participant’s mental state to cross the boundary from the physicality to the immateriality of virtual space. The final count of this time involved preliminary testing with 10 participants (students related to VR and gamming) and the general public (the first 50 participants of the exhibition) during the first week of the piece’s exhibition, which was on display for a considerable period: four months (Figure 1). An assistant was always present in all the individual experiences. Through her, one question was asked to the participants after the experience: “did you feel your body present in the experience?”. In our opinion, the participant’s embodiment in the artifact would be a critical aspect so that possible disembodiment could be felt after the fourth minute. Experiences conducted by Mel Slater (2014) showed that the brain is apparently able to drive attitudes and behavior of individuals according to their level of body ownership with respect to the type virtual body in which they are embodied. In Slater research, 3D avatar models were used.

In VV, we used the participants’ self-physical properties to represent their bodies, presenting pointclouds and lines. All the hardware equipment was hidden in the ceiling of the room. The depth sensor was positioned to capture a room’s fixed area, represented in a circle drawn on the floor. In this area, we have matched the entire depth captured in the real to the virtual image presented in the HMD (Figure 3). The scale adjustment was precise, so that taller or shorter people could see their bodies correctly adjusted (Figure 4).

A set of instructions is provided to the participant in the first minute. When looking around, the participants realize that they are still in the same space, this time virtual. For security reasons, participants are asked not to leave the circle where they are. If this happens, the participant is prompted to remove the helmet. Some people might experience motion sickness, nausea or disorientation, blurred vision, or other discomforts when experiencing VR, so we put a warning that if someone feels any of these symptoms, they should remove the helmet or ask the assistant for help.

During the first few minutes, participants get used to the experience of seeing their own body, and some abstract objects with spatial audio appear in front of them that they can touch, even hear. Audio associated with the city is also presented through spatial sound. The street is on the left side,
so the participants hear people, cars, and buses passing by on that side. Soft music starts to grow. This phase is one of habituation, of bodily connection with the digital image. After the fourth minute, the image representing the participant’s body initiates a process of ‘freezing’, and this phenomenon creates the desired sensation of the author that will cause the detachment of its physical body. A virtual camera, which projects binocular images on each participant’s retina, begins to move smoothly from the gallery room, overcomes the physical barriers of the walls, elevates the participant to a reality and a mental state of lightness and fluidity, something shamanic that transcends human barriers (Eagar 2004). At this moment, looking back, the participants visualize the body that they left behind (their body), in a suspended state, in the gallery room, and his mind begins to move slowly (Figure 5).

Figure 3. Participant perspective in Virtual Reality. Picture: João Martinho Moura.

Figure 4. A young participant experiencing VV. Picture: gnration gallery.

Figure 5. Body detachment in VV after the fourth minute. Picture: João Martinho Moura.
We can conceptualize this detachment as a displacement, an awake dream, in which the same happens due to the mental connection initially established. At this moment, the participant experiences moments of confrontation with the city and its heritage in slow movements. His body was left behind. The gallery walls become translucent, and there is a movement towards the exploration of space, the same physical space that the participant used to enter the gallery. In this dimension, the participant has now the power of teleportation, a new dimension in sensory experience perception, reminding the notion of space by Foucault, fundamental in the exercise of power (Foucault 1984).

For this phenomenon to occur, the author did many experiments to represent the physical space in three dimensions, capturing ground and aerial images and combining different perspectives using photogrammetry (Moura & Kolen’ko, 2019). The technique arose from previous experiences in the areas of distant macro space, in artistic collaborations that the author maintained with ESA, the European Space Agency, between 2013 and 2016, in the space exploration of Comet 67P/Churyumov–Gerasimenko, at the time located more than 500 million kilometers from Earth (Moura, 2016); and in micro and nano space (Figure 6), in artistic collaborations with INL - International Iberian Nanotechnology Laboratory (Moura and Kolen’ko 2019) (Moura, Llobet, et al. 2019). Pointclouds are an efficient way to represent physical space, being in the nano, regular, or macro scale, especially in VR, due to its particular spatial distributions, enhancing the three-dimensional perception of space when we move.

These techniques map the space and create virtual representations of the real at positioned points (Figure 7), agglomerates pigments that confer the desired volumetry and are well perceived by the participant.

Figure 6. a) (left) Spatial representation. Generated reconstruction calculated by SEM microscopy observations in the INL cleanroom, representing nanoparticle foam to produce clean hydrogen energy. Approximate scale: 10μm. Source: João Martinho Moura / INL. b) (right) ‘Comet 67p: an unexpected topological space’, João Martinho Moura, 2016. ‘View Rosetta’s comet’ João Martinho Moura et al. Comet data: ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA.

Figure 7. Tests on creating depth capture tool in a garden (top); in a fountain in Largo do Paço in Braga (bottom). Picture: João Martinho Moura, 2015.
The result is an abstract city that appears transcendent, in translucent layers, sometimes not always visible or conscientious at the first visual impression. In cities, buildings accumulate over the centuries, and the actual overlap of the buildings, whether cultural or urban, prevents these impossible views of the urban landscape. This visual isolation confines a singular perception of the existing one from perspectives that would be impossible to experience physically. In this way, the gallery itself becomes a dispositif, a building as aparatus (Leach 2019). The following images represent the author’s view when demonstrating the piece, immersed in VR (Figure 8). When combining the self with the surrounding known space, we effectively add a new Reality layer to the digital body, thus making it more corporeal, playing with spatial memory in our favor. The fact that we draw the participant and the surrounding space in the same graphic way allows coherence in the teleportation and out-of-body experience. This way, the participants’ idea they leave their body happens, experiencing the city space through their visual and auditory receptors and in impossible movements. This journey ends where it started. The virtual camera returns slowly to the body it initially left (Figure 9).

From the first 50 participants, direct questions regarding the feeling of presence, more than 90 percent felt genuinely embodied by the experience and deeply connected to the piece’s audiovisual apparatus. Some participants experienced nausea or disorientation and gave up in the first few minutes. Those symptoms are typical and common when compared to desktop or projection display systems (Sharples et al. 2008).

This displacement, along with the confrontation with our digital body, and the following detachment, arouse sensations of a realistic digital embodiment and sense of presence far beyond the techniques that we currently find in recent virtual reality equipment. The fact that we provide improved self-appropriation mechanisms during the initial four minutes leads the participant to connect intimately with the felt environment. When we deactivate this mechanism, the sensation is the loss of physicality, not being total because there are other factors that we sustain, such as the city scenario, and that stabilizes the participant, keeping him connected only with his mind.

**UNA (2020)**

We move now, from the space gallery to the performance stage. In the presentations and rehearsals of previous work: NUVE (Moura et al. 2011), in 2010, and CO: LATERAI, between 2016 and 2019

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**Figure 8.** a) Participant’s perspective of the gallery in VV (2018); b) Flying over the city of Braga (“Braga, snapshots in virtual reality”, an image presented at Artech 2019). João Martinho Moura.

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**Figure 9.** The participant in VV, having his digital body back (2018). Picture: João Martinho Moura.
(Moura, Barros, et al. 2019), We presented the body in motion, expanded, between graphic abstractions, and a close relationship between image and movement. In CO:LATERAL several presentations were made in different countries, using projections on a transparent screen, placed between the public and the audience (Figure 10). Its research was presented at the ISEA 2019 conference in South Korea, where we deepened concepts concerning the volumetric body in performance at the stage, and we asked ourselves what if we could see that volumetric body in total immersion in Virtual Reality?

This question was a *leitmotiv* for creating our last work, UNA, planed at Balleteatro in 2018, as a trial in total immersion, and firstly presented in 2020 (Figure 11). In NUVE, performed by Né Barros in 2010, the relationship between the choreographic body and its artificial double was explored, in the space-time, projected, and extended in an intimate relationship with the virtual. In CO:LATERAL, the immaterial space expanded, the image became closer to the public, and between the moving body and the audience, transparent, mixed, embodied realities were presented. UNA was a continuation of this immateriality, this time, in total immersion, where the audience (one spectator at a time) witnesses the body in movement, again, expanding. Ten years after NUVE, one goes back to testing, to the laboratory, transforming and questioning the performative and embodied space, where the spectator


is one, is not in the audience, but in the center, in a space that does not exist, and where different understandings of the performative body are reflected. In a previous publication, the artistic concept of UNA is explored in detail (Moura, Barros, and Ferreira-Lopes 2020b). In this text, we will focus on the procedures we had to develop and evolve the piece.

The UNA performance was announced as a Virtual Reality trial in an experiment that lasted less than 10 minutes per participant. In this way, the spectator enters the Coliseu do Porto, stays in a waiting room, an antechamber, waiting for his/her turn. When called, the participant moved into the middle of a selected room, being received by an assistant, who explained that the performance would take place in total immersion and aided in placing the equipment. In this room, choreographer and performer Né Barros is positioned laterally, serene, and calm. Silence is total. There is no big audience, only one spectator and one performer, and a room assistant. Headphones with noise cancellation are also correctly placed in the participant’s head. During the first minute, the participants see a virtual space, and after, they are gently elevated to a virtual height of about 1km. This elevation is accompanied by wind. We placed a fan on stage pointed to the participant, triggered at the elevation moment. This physical sensation caused chills in the participant’s skin when they felt taken to immaterial space. Indeed, this small element, a simple fan, significantly contributed to the sensorial experience.

Né Barros approaches the capture area and places herself in the fetal position (Figure 12). Its body shape begins to appear slowly (Fig 13). All movements happen steadily as the participant has the freedom to look everywhere and may not be in the performer’s frontal position. To solve this situation, auditory sound ambiances in spatial sound help the participant better orient himself, as audio can be paramount in defining the immersion level in virtual reality.

Figure 12. UNA (2019). Né Barros performing in virtual reality. Balletoatro, Porto.

Né Barros gently approaches the participant and begins to gesture. The participant realizes there is a body nearby. In this scenario, there is no traditional physical barrier between the stage and the audience, as in previous works. The notion of performative space is challenged.

The participants can also move in an area of 3 square meters. Furthermore, they can approach a few centimeters from the performer or even incorporate her, depending on their position in space. The artist hugs the participants, touching them virtually, positioning herself in front of the depth sensor (Figure 14).

Né Barros, positioned herself laterally to the participant, held out her hand. The headset’s virtual camera moves smoothly to a side position to capture both the participant and the performer’s bodies. She approaches very slowly. And then something unexpected happens, hands touch (Figure 15). The feeling of physical belonging happens. This physical touch was not expected at all by the audience. It was a surprise, haptic. Both appear in the image, and the participants realize that they are there, within the virtual environment. Informal conversations with about 20 participants immediately after the performance presentation show that they all felt embraced and bodily involved in the performance and that the haptic experience contributed to the feeling of presence.

This work was presented two times in 2020 (Figure 16), the last one happening days before the COVID pandemic lockdown. After March 2020, all the following exhibitions were postponed as
embodied Virtual Reality between participants is very intimate, not ideal in COVID times. After the pandemic restrictions, we plan to return to new exhibitions.

During the pandemic and imposed public restrictions, we continued the project development, and after the experience with the public, we opted to do quiet tests in-house, this time wearing the helmet on the dancer as she moved. Two Kinect Azure depth cameras were used, synchronized via link cable. The two depth cameras’ streams were positionally calibrated to cover as much of the performer’s body as possible. We also did color extraction and tracked body parts. We joined the two meshes (from both cameras) into a single body (Figure 17).

The extraction and volumetric analysis processes require significant data bandwidth. For this reason, we connected the cameras directly to the same computer, and since the signal is synchronized, we obtain a stable image. It was necessary to use a powerful graphics station with a dedicated graphics card, running at its maximum power. We obtained a framerate higher than 30 fps, at the minimum limit of the ideal, being this the price to pay to have a real-time experience.

From the agglomerations of volumetric points, we extrapolated normalized vectors, which expand the body with abstract elements, like white lines from the body, moving according to the intensity of the gesture (Figure 18), or abstract lines extending the body, following elbow, arms, legs, and hands positions over the time (Figure 19).

In this experiment, we verified multiple perspectives in Virtual Reality. That of an external participant who contemplates the performance from different points of view and the self-perspective of the performer herself. From the VR performance perspective, all body areas appear except the virtual head, where the performer’s head is located with the HMD, to avoid closer pixels in front of eyes (Figure 20). In this configuration, we approach a more corporeal digital embodiment of ourselves. The performer sees her body in its digital form, inwardly interacting with the flow of the virtual scene’s abstract elements, being inside and outside her virtual body over time. We can speak of a formal and narrative path that goes from expansion to embodiment, that is, the expansion is the result of a performative interaction (an embodied form). Here, there is no spectator-actor, there


![Figure 17](image1)

Figure 18. UNA (2020). Embodied abstractions. 2020.

![Figure 18](image2)
Figure 19. UNA (2020). Embodied abstractions. 2020.

Figure 20. UNA (2020). Self-perspectives in UNA. 2020.

is no scene, and out of the scene, everything takes place at the level of the virtual dimension, and it is from this dispositif that the interactivity between two presences is generated (Barros 2019:157).

CONCLUSION

In this publication, we present two projects that combine virtual reality and spatial capturing technologies. When used together, these two technologies promote a better understanding of the body inside the digital space. In this way, we open new discussions related to the representation of the self, and the other, in the space of virtuality. VV bridges the gaps and connects the broken embodied (dis) continuity in Virtual Reality. UNA expands that into flesh, form, and touch. UNA breaks with the subject’s barrier based on a principle of double immersion of the performer and the receiver and the performer with himself. In this virtual dimension, the performer’s experience is itself of embodiment: the performer moves through the perception of the movement he generates.

In UNA, the possibility of mapping the ballast of the digital gesture is achieved. It is no longer the gesture gathered by the memory of an image but by a kinesthetic experience of the movement reinforced and offered by a type of visualization that the technological device allows performing. There is a strong relationship between micro and macro and the possibility of working with the gesture’s memory through decalage effects. All the incursions that these projects promote put performance and performativity necessarily in tension with the notion of presence or interaction, preferring an expanded domain as a territory for exploration and contact. We believe that, in the near future, these embodied digital approaches may be relevant, not only in media art or performative projects, where the body is a crucial element, but in the casual, closer or remote, contact or intimate encounter between human beings in the space of virtuality. These experiences place the participant’s body at the center of the action. They still require significant external sensing, synchronization, and calibration that cannot be quickly built at home or in small studios. We tried to strike a balance between the number of external sensors and the demand for processing capacity. More and multiple sensing technologies would benefit all the experience, but now, they would also make near real-time processing impossible with our equipment. However, these experiences reveal a construction coming from artistic actions, demonstrating a possible path for the Body, thought, present, and felt in the space of virtuality. We will see significant advances in the future, and, undoubtedly, there will be an advance in the use of these revolutionary technologies in human digital encounters.
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REFERENCES


João Martinho Moura is a media artist and researcher, interested in electronic art and embodiment, virtual environments, computer music, and computational aesthetics. For the past 20 years, he has been adopting new ways to present the body and space in digital media. Has a particular interest in art & science, perception, visualization, in the intersections between art and technology. Regularly publishes in the field of media arts, interfaces, embodiment, virtual reality, and visualization. As a media artist, he has collaborated in some international institutions such as ESA – European Space Agency, INL – International Iberian Nanotechnology Laboratory, NATO – North Atlantic Treaty Organization, UNESCO, and was selected artist at the European Commission’s STARTS and MindSpaces initiatives. In 2013, João Martinho Moura received the National Multimedia Art and Culture Award in Lisbon for his contributions to the field of digital arts in Portugal.