

Dialogue between Body and Sound through Multimodal Interaction

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Abstract

This paper explores the interdisciplinary field of "*Corpo Sonoro Expandido*" (CSE) - "Extension of Body Movement with Sound", which investigates the interplay between sound, movement, and technology in mixed reality. It adopts a multifaceted approach, weaving together Art and Science to examine the convergence of dance and music concepts through a rhizomatic lens. This, understood as a complex communicative process that spawns novel organizational models on multiple scales, akin to networks. This paper builds upon our previous works, where we explored multimodal interactions [1]–[4]. The research is structured along two axes: "Expanded Sound Body" analyzes bodily movement's relationship with sound using bio-signal technology, while the second one "Existential Cycles" focuses on art creativity within composition and improvisation in music and dance. This article emphasizes the second axis, presenting a study with potential for integration into arts education programs and multimodal artistic presentations. Our goal is to orchestrate collaborative efforts that bridge gaps between dance, music, and computing languages using technological tools in real and virtual spaces. Thus, enabling the emergence of new artistic expressions. Our improvisation approach is rooted in concepts such as chain reactions and synergy, fostering engagement across distanced and in-person cycles of creative exercises. We developed improvisation cycles with dancers and musicians for testing the computational framework as a dynamic stage system where an interplay of sounds, movements, and images unfolds. Shortly, our research comprises a fabric of interactive experiences underpinned by

the fundamental principles of chain reactions and synergy. The ongoing study integrates two generative computational systems. One system processes image and movement data, generating clouds of dots by mapping each dancer's coordination and acceleration data from sensors. With this process, similar to previous literature [5], we use Kinect sensors to track dancers' movements, creating real-time interactive digital scenarios where each cloud of dots represents the joints of a dancer's body with their respective 3D coordinates.

1. Introduction

In this paper, we present creative multimodal investigations in mixed reality that have been developed as open systems. These investigations are aligned with the research project "*Corpo Sonoro Expandido* (CSE): expanded spaces between sound, movement and technology in mixed reality" at the Universidade Estadual de Campinas' Instituto de Artes and Núcleo Interdisciplinar de Comunicação Sonora (NICS) - Brazil. The project is funded by the São Paulo Research Foundation (FAPESP) through the LINCAR 2022 call. This call sought projects that blend theoretical, methodological, and conceptual approaches from diverse disciplines, aiming for transdisciplinary objectives. The (CSE) project aims to connect researchers interested in exploring the intersections of sound, movement, and technology in mixed reality environments. There is interest on the part of researchers to deepen the methodologies explored with a view to creating a creative HUB (Hybrid Sound and Movement Multimodal Interaction Study Laboratory (LabMotif) with the aim of expanding multimodal creative

research to be applied in different areas in the educational, health and artistic areas. In the (CSE) scope part of the research we investigate methods or paths for creation in multimodality in mixed reality and which we call "existential cycles". Existential cycles are based on the concept of expanded presence and interactivity [2][3] where we seek to study the convergent and divergent dynamics between the sound, computational and body movement fields in a mixed environment such as an expanded, open, dynamic and networked space. In this sense, the improvisatory and compositional exercise in multimodality and interactivity are the ways to emerge existing cycles as an expanded presence in new systems and interactive models, thus expanding new realities to the poetic and artistic aesthetic field. In the sphere of multimodal creation, the assumption is that the interaction of an agent or group of agents with an immersive space, using various interactive devices, indicates how these processes affect their poetic behavior and the meaning that is constructed by them. The notion of interaction that bases our work goes beyond analytical dimensions alone, and will be linked to several perceptual modalities. The interactive narrative is seen as the result of processes, specifically from the interaction with all agents that participate in the experience [6] This approach incorporates the concept of Creative Empowerment as outlined in Partesotti et al. (2018) [7] and is grounded in the paradigm of Embodied Cognition. The idea that being extended is a property of a cognitive process if it is partially constituted by extrabodily processes [8] implies that the subject is not only embedded but also extended within the environment. Therefore, our research is based on the premise that the

interaction between agents and the immersive space is crucial for understanding the development of poetic behavior and the construction of meaning in multimodal creation.

2. Methodology

Within an interdisciplinary performance setting encompassing composition, improvisation, and visual creation (e.g., video dance or generative computer graphics), each component can be executed concurrently or sequentially, depending on the artistic vision and the technical configuration in place. In this regard, our methodology integrates generative computational systems to architect a unified framework that harmonizes diverse data modalities. At its core, this framework relies on widely used computer graphics and mathematical representations. The process initiates by capturing a depth map of the dancer's actions, complemented by acceleration data collected from embedded sensors. These combined inputs are harnessed to generate point clouds [9], which, importantly, are not static depictions but dynamic, multi-dimensional arrays of discrete points. Each point within the array is defined by its unique (X, Y, Z) spatial coordinates and a temporal coordinate, collectively forming a digital representation that maps the intricacies of the dancer's movements.

Our system operates at the intersection of movement and sound, with a focus on creating a sonic database using a technique known as granular and concatenative synthesis [10][11] This method involves the generation of an array of points, each sharing a common representation, primarily based on pre-recorded piano and saxophone sounds. Our ultimate aim is to develop a

versatile tool that facilitates interdisciplinary artistic and creative dialog, allowing for the simultaneous manipulation of sound, movement, and visuals. This enables an improvisational synergy between dancers, musicians, and live visual artists.

In recent experiments, we have adopted a distributed approach, where dancers and musicians initially engage with our tool. This collaborative effort is geared toward building a consistent database of sound and movement data. The repository created in this process serves as the backbone of our system, ensuring smooth interactions and coherent improvisational exchanges. Consequently, the database becomes an indispensable resource, enabling performers to access, manipulate, and repurpose stored information seamlessly. We have achieved this through the utilization of software tools like TouchDesigner and Max/MSP, particularly leveraging the CataRT system [10] (Interactive Corpus-based Concatenative Synthesis) within the MuBu external. Here is a brief description of how we are using those tools to record, process, and combine sound, movement, and visuals:

TouchDesigner for Visual Processing: TouchDesigner is a node-based visual programming language, ideally suited for creating real-time interactive multimedia content. In the context of capturing movement, TouchDesigner can interface with depth cameras or other motion sensors to generate visual representations, such as the point cloud mentioned earlier. These visuals can be manipulated in real-time, responding to the data inputs from the dancer's movements.

Max/MSP and CataRT for Sound Processing:

Max/MSP is a visual programming language designed for music and multimedia applications. Within Max, the CataRT package allows for real-time sound manipulation through concatenative synthesis. This method involves dividing audio into small segments called "grains," which can be recombined to create unique textures like sound clouds and masses with varying densities and frequency ranges. CataRT takes this a step further by analyzing and organizing sound grains in a multi-dimensional space based on audio descriptors such as pitch, loudness, and other timbral qualities.

Combining Movement and Sound: The process of recording movement and sound separately, and integrating them interactively in a performance involves several steps:

1. Recording the Movement:

- Movement data is captured using sensors or cameras and then fed into TouchDesigner.
- TouchDesigner interprets this data to create corresponding visual elements, such as point clouds.
- These visuals can be manipulated and transformed in real time, resulting in a dynamic visual output.

2. Recording the Sound:

- Sound is recorded using microphones or electronic instruments and is input into Max/MSP.
- CataRT analyzes the sounds by breaking them into grains and

categorizing the grains in a phase-space graphic.

- These grains can be triggered and manipulated in real time through a graphical interface.

3.Synchronization and Interaction:

- Real-time data from TouchDesigner can be sent to Max/MSP using the OSC protocol.
- The movement data can influence the playback and processing of sound grains in CataRT. For example, the position of a dancer's arm might control the pitch of the sound grains being played or even which grains are played.
- Conversely, the sound processing can also impact the visuals, creating a bi-directional interactive system.

4.Database and Retrieval:

- All interactions, movements, and sound grains can be stored in a database for later retrieval.
- This data can be accessed during live performances to recall specific movements or sounds, enabling performers to layer past and present interactions.

2.1 Existencial Cycle - I

Our initial focus was on the computational exploration of the body, aiming to deepen its relationship with images and technology. This involved conducting experiments and explorations within the domains of imagery, computation, technology, and the virtual universe. Our goal was to establish

unique connections between images and movement, physicality and virtuality. One of our primary objectives has been to investigate the body through its digitized and technologically mediated representation, all with the intention of highlighting creative possibilities within this context. Ultimately, we sought to expand this data into the realm of poetry, incorporating elements such as sound, music, augmented reality, real-time virtual creation, and various other forms of knowledge.

The Point clouds consist of the imagery and three-dimensional representation, taking into account the three axes of acceleration (x, y, and z), depicting the physicality of the body from an infinity of points. The grouping of these points facilitates the remodeling of the body's surface through the use of 3D technologies.

The geometric " Point clouds " model is the most basic representation obtained directly by the 3D scanner. Each point, which forms the point cloud, is represented by its Cartesian coordinates (x, y, and z) and one or more attributes associated with it. [...] This feature can be used for many purposes, such as measuring, three-dimensional visualization, "rendering", animation, but mainly for the creation of basic geometric models to be reworked in CAD tools, and more recently in BIM tools [12] Translated to English by the authors

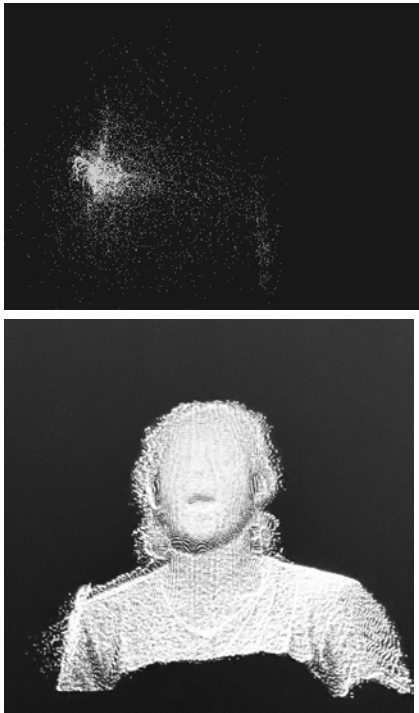


Image 1 - Representations of movement (acceleration) with the Point Cloud model Source: (CSE) Database

Our exploration of the Point clouds method was greatly enhanced by the use of specialized devices and software. To create and explore the Point clouds version of the body, This process involved the creation of a programming code within TouchDesigner, which received image data from a motion sensor (the Kinect). The Kinect was responsible for capturing and encoding body movements, mapping them, and transforming them into data. This data was then processed by the software to generate a set of points that could be organized based on different qualities, quantities, and organic characteristics, allowing us to provoke new experiences for both the body and images.

Kinect captures images much like a regular video camera but has the advantage of being sensor-based, allowing it to operate independently of light conditions. It reads depth of bodies through its camera, enabling the tracking and encoding of movement within its capture range. These images are then used in TouchDesigner's programming.

These experiments resulted in varied relationships between bodies, movement, and Point clouds, with differences in aesthetics and intensities. We explored different textures and arrangements for the points, including spacing, quantity, and coloration. The relationship between Point clouds and movement over time was also investigated, affecting the perception of the captured actions. Various velocities, from slow to fast and fragmented, altered the intent of body actions and provided different interpretations for observers. As Amorin (2009, p.1) [13] comments, dance's integration of digital technological interfaces introduces novel dimensions of complexity, impacting everything from education to live performances. This fusion challenges the fragility of the human body, both in the physical realm of space and time and in the virtual domain, opening doors to a future filled with unexplored creative potential in the world of dance.



Image 2 - Experiments with the point cloud in the creation of screendance

Source: (CSE) database

3. Discussion

How can we effectively translate creative experiments rooted in technological research into the realm of poetics? When discussing creative processes in the arts, we invariably invoke the concept of sensitivity as a fundamental prerequisite, enabling us to harmonize the subjectivities of diverse artists collaborating in tandem. This harmonization, in turn, serves as a conduit to trans-subjectivity, fostering a bridge that transcends individual subjectivity and promotes collective creative engagement.

Saying that we have abandoned intellectual habits is an easy statement, but how can we fulfill it? There it is, for a rationalist, a small daily drama, a kind of unfolding of thought that, however partial its object may be — a simple image — still has a great psychic repercussion. But this small drama of culture, this drama that is at the simple level of a new image, contains the entire paradox of a phenomenology of imagination: how can an image that is sometimes very singular appear as a concentration of the entire psyche? [14], translated to english by the authors

The work in screendance production combines dance and images, with a strong emphasis on visuality in both the aesthetics and the creative process. It acknowledges that the body and movement are influenced by this new exploratory environment. The screen-generated images differ from those seen in person, as they are born from computer processes. These distorted images give rise to alternative realities, offering distinct interpretations and temporal dimensions for the movement and the overall dramaturgical concept of the work.

In the singularity of dance, the unique visual expressions emanating from the moving body not only mirror the dancers' inner states but do so dynamically. It's as if every fleeting moment of a dance movement freezes a snapshot of these inner states, rendering them "capturable." Therefore, in our endeavor to capture these movements through sensors, we are not in opposition to the creative process in dance or music; rather, we are enhancing and augmenting these artistic activities.

How the singular and ephemeral event that is the appearance of a singular poetic image can react — without any preparation — on other souls, on other hearts despite all the obstacles of

common sense, despite all wise thoughts, happy for their immobility? It then seemed to us that this trans-subjectivity of the image could not be understood in its essence only through the habits of objective references. Only phenomenology — that is, taking into account the departure of the image from an individual consciousness — can help us restore the subjectivity of images and measure the breadth, strength, and meaning of the image's trans-subjectivity [14], translated to English by the authors

Touching souls using all possible means: body, sound, sensors. Sensitive sound-body, in its full and most honest expansion; a body that is singular in its investigation of movement at the same time it is plural when working in partnership. This would be one of the philosophical bases of our investigations, a basis that allows us the transcendence so desired in our times.

3. Conclusions

Through studies and experiments conducted using the Point clouds method, we explored various representations of the body and movement within the realm of imagery and technology. These investigations led to encounters between organic and artificial elements, blurring the lines between the real and the virtual.

Through technological mediation, the experiment allowed these elements to take on unique structural, expressive, and poetic qualities that transcended their traditional physical presence. This journey into technology opens up new dimensions and meanings, expanding the horizons of body and dance exploration. It also facilitates the development of diverse relationships between digital media and movement, between images

and their observers, and between bodies, dance, and technology.

The investigations at the intersection of body, movement, technology, sound, and imagery in this exploratory environment unveil diverse opportunities for artistic creation. The representation of the moving body through Point clouds can be harnessed for live performances, multimedia installations, multilingual productions, interactive experiences, telematics, hybrid forms, and virtual languages, among numerous other possibilities. Our group ventured into this realm through screendance, aiming to craft a narrative that explores the poetic potential of these images, ultimately serving as an inspiration for various other creative endeavors

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