Somacoustics: Interactive Body-as-Instrument

Maros Suran Bomba
Dept. of Communication and Psychology
Aalborg University, Denmark
marosbomba@gmail.com

Palle Dahlstedt
Dept. of Computer Science and Engineering
Chalmers/Univ. of Gothenburg, Sweden
Dept. of Communication and Psychology
Aalborg University, Denmark
palle@chalmers.se

ABSTRACT

Visitors interact with a blindfolded artist's body, the motions of which are tracked and translated into synthesized four-channel sound, surrounding the participants. Through social-physical and aural interactions, they play his instrument-body, in a mutual dance. Crucial for this work has been the motion-to-sound mapping design, and the investigations of bodily interaction with normal lay-people and with professional contact-improvisation dancers. The extra layer of social-physical interaction both constrains and inspires the participant-artist relation and the sonic exploration, and through this, his body is transformed into an instrument, and physical space is transformed into a sound-space. The project aims to explore the experience of interaction between human and technology and its impact on one's bodily perception and embodiment, as well as the relation between body and space, departing from a set of existing theories on embodiment. In the paper, its underlying aesthetics are described and discussed, as well as the sensitive motion research process behind it, and the technical implementation of the work. It is evaluated based on participant behavior and experiences and analysis of its premiere exhibition in 2018.

Author Keywords

embodiment, motion tracking, dance

CCS Concepts

•Human-centered computing → Gestural input; •Applied computing → Performing arts; Sound and music computing;

1. INTRODUCTION

Expression through sound is inherent in our human nature throughout our lives. Screaming, crying, whistling, laughing, clapping, and singing are all expressive sounds and noises that originate from and are produced by the use of our bodies. When our physical capabilities no longer match our desire we invent technology. From studies of music archaeology that uncover usage of primitive ancient sound-producing tools to contemporary experimental development of new electronic and algorithmic instruments, we can recognize historically perpetual invention and innovation of such objects. The invention of new technologies accelerate this process and pushes it into the investigation beyond what is known. Kevin Kelly [7] suggests that technology is not only natural but also driven by the same evolutionary forces that had impacted on the creation of humankind. He sees the potential in the technology as it gives us new possibilities to understand ourselves and the world around us, to open up for new interactions and experiences. This has been a guiding thought behind this project.

Somacoustics is an interactive participatory performance artwork, where the blindfolded artist's body is transformed, through motion tracking technology, mapping and sound synthesis, into an instrument. Participants (visitors) interact with this instrument-body, influenced by social bodily interaction patterns, sonic responses and by their own perception of themselves and of the interaction/performance. The project combines experience design, human-computer interaction, interaction design, wearable technology, and performance art that, with artistic, somatic and conceptual practices. The central aim has been to, through a designed instrument-body in mixed reality space, explore the experience of interaction between human and technology and to investigate if such interaction, within its artistic and performative framework, has transformative effects on the subject's embodiment and perception. Also, we want to contribute to the difficult questions of the relationship between humans and technology, and how body and technology can be combined in an aesthetic interactive experience.

A video about the project is attached to this paper, and can also be viewed online.[1] See Fig.1 for action photos from the exhibited work.

The contributions of the two authors are as follows: The first author has a background in interactive arts and performance, and is the primary author and coder of the artwork, as well as performing the instrument-body. The second author is a musician, sound artist, and researcher who has functioned as supervisor and adviser throughout the project, and thus has contributed artistic input, technical solutions, and mapping approaches at all stages of the project. The paper is written in collaboration.

2. BACKGROUND

Experience from an earlier experiment with sonification of an object's movement, together with an engagement in contact improvisation practice, triggered the question: What if we could apply the similar interactive technology to ones own body, thus creating an instrument-body, which could be performed on by other people?

Soma means body in Greek, and *Somacoustic* became our word for experiencing body through sound. It combines body and technology through the application of VR

[1] https://youtu.be/CQjY8mXHm2o

NIME'19, June 3-6, 2019, Federal University of Rio Grande do Sul, Porto Alegre, Brazil.

technologies, in combination with sound synthesis software, turning the body into a musical instrument. When participants project their own movements on the body of the performer, it engages them in a dynamic exploration of a virtually augmented soundscape.

2.1 Aesthetic and theoretical background

In this section, we will present theories and aesthetics that has served as framework for the project, forming a sequence of connected concepts, together focusing the project: body–somaesthetics–aesthetic experience–technology–interaction–mixed reality.

In Merleau-Ponty's *Phenomenology of perception* [9], he presents his thoughts on existential perception with a focus on the **body**, towards an understanding of the embodied experience of human existence in the world: "I cannot understand the function of the living body except by enacting it myself, and except in so far as I am a body which rises towards the world" ([9], p. 87). We try to understand the physiological function of the body through cognitive processes which retroactively influence its mechanics that eventually appears effective toward the world and our thinking in it. The body is our vehicle of being in the world.

A use of embodied practice and perceptional awareness of the artists own body represents a vital element in this project. Here, Richard Shusterman's theory of **somaesthetics** can help to analyze embodied experience throughout the process of project development and performance/exhibition. Shusterman presents a philosophical discipline defined as "the critical, meliorative study of the experience and use of one's body as a locus of sensory-aesthetic appreciation (aisthesis) and creative self-fashioning" ([12], p.302). The body has the role of a mechanism that strengthens our sensorial perception of the world around us. If somatic practices can improve our sensory richness, muscle mechanics, and bodily awareness, it could productively contribute to the more profound appreciation of different (non)art forms and enhance our experience of the environment in which we, entities with our bodies, live.

But what does it mean to have an **experience**? Does an interactive technology allow for having an appreciated experience as an outcome of interaction? Pragmatist philosopher John Dewey [4] distinguishes between ordinary experiences and those that have a potential aesthetic value. In his terms, "an experience" has gained the aesthetic and emotional properties because of its fulfillment. "Such an experience is a whole and carries with it its own individualizing quality and self-sufficiency. It is an experience" ([4], p.36). In this context, we might be able to determine that some parts of the experience were much more effective then the others defining the experience as a whole. An experience is a process of balancing the relationships between conscious doing and undergoing from which an experience can achieve specific value and meaning. Nevertheless, referred experiences are undergone through the interaction with **technology**. Our lives are intertwined with many kinds of interactive technologies, they exist with us, they exist for us, they shape us. But how do we clarify the importance of technology's impact onto our lived, aesthetic, experience?

McCarthy and Wright propose that it is because the interaction with technology can evoke emotions, impression, ideas, meanings, it is profoundly embedded in our living experience [8]. They argue that to see "technology as aesthetic experience requires that we see any boundaries between humans and technology as constituted by the dialogical relations sustaining them..." ([8], Ch.3). As we see this project as an ongoing experience of the relationship between human and technology, we find the pragmatic views presented by Dewey, and by McCarthy and Wright as relevant analytical tools for theorizing about the experience of this project.

Interaction is the driving force of the experience in Somacoustics. Here, we can apply Dalsgaard and Koefoed Hansen's theory [3] concerning the experience of user and observer within user-system interaction and the chains of acts and roles that it implies. The user not only perceives the outcomes from the interaction with the system but also her act of interaction, thus her perception is influenced by the knowledge that her own interaction with the system is a performance for others. This defines the three acts in which the user is simultaneously engaged: interacting/operator – perceiving/spectator – performing/performer. This helps clarify the classification and analysis of the experience of human-computer interaction because it defines different modes of experience, as well as it allows to frame performative qualities of the experience.

Somacoustics interaction and experience takes place in a **mixed reality** space. Benford and Giannachi [1] advocates that new digital technologies (such as Virtual Reality) opens up for inclusion into the artistic practices and performances, which leads to new kinds of experience. They refer to these experiences "as mixed reality performances, a term that is intended to expresses both their mixing of the real and virtual as well as their combination of live performance and interactivity" ([1], p.1). In relation to Milgram and Kishino's taxonomy of mixed reality display, a "virtual continuum" as a spectrum from a purely physical environment to a fully virtual one, they propose a theory based on trajectories, which expresses how participant experience such mixed reality "in terms of multiple interleaved trajectories through complex hybrid structures of space, time, interfaces, and roles that establish new configurations of real and virtual" ([1], p.1). A participant maps this environment, in terms of the information gained during the experience. "They map in that they reconstruct, often collaboratively, predesigned journeys by using physical and digital signposts not only to orient themselves in a given mixed reality environment but also to design it at the same time" ([1], p.20).

Our project aims to explore the experience of interaction between human and technology through the use of instrument-body. However, the instrument-body within itself constitutes the relationship between human and technology. Marco Donnarumma has explored this relationship [5], proposing that the performer and instrument are in a relationship of configuring, which allows us to analyze the corporeality of the technological body, which consists of such relationships.

Referencing Shilling [11], Donnarumma explains the *technological body* as "contemporary technology has moved inward. [...] Through technical methods and applied knowledge, technology has modified the body's organic properties by literally occupying its own space on and within it". Our bodies have opened up for artificial organs, chips and implants. Therefore the technological body can also be referred to as the current state of the relation between human and technology and that it is precisely "human-technology relationships, that is, their physical contact and exchange of informational data, which enacts new corporealities in sound performance, new ways of experiencing and expressing sound and music" ([5], p.17). Hence, we can understand the performer-instrument relationship, where they constantly influence each other, as an "ecology of things, energies and strategies forming the particular embodiment of the player-instrument," thus configuration.

These theoretical frameworks will be brought back into the discussion about the work in the analysis section.

2.2 Previous works

Many artists within the field of digital art, performance art, sound art and instrument design have tackled the notion of human-technology relationship by merging the technology with a body in various art forms, on account of which they challenge and confront different forms of interaction. We will only be able to mention some of the most relevant artists and artworks that have serve as an artistic, inspirational and conceptual standpoint in relation to our project.

As the most notorious body-technology artist, Stelarc challenges the biological body through extending it with technology. He argues that the body is obsolete and that it needs to be considered as an extendable evolutionary structure which is enhanced by the technology that is inherently better, more powerful, efficient. Throughout his works (e.g., Ping Body (1995)[2] and Exoskeleton (1997)[3]), by deliberately merging the body with technology, in terms of extending and enhancing its qualities, to illuminate the importance of the human-technology relationship, he developed several modes of interactions and embodiments. More recently, Marco Donnarumma constructs his artworks through merging his body with biotechnology, biophysical sensors, AI, and neuro-robotics to produce immersive, sensual and confrontational experiences. The main medium in his artworks is sound that through the application of technology encompasses body's physicality, bio-structure, and depth. Through his artworks, he questions a traditional use of the electronic instrument and proposes new thinking on a performer-instrument relationship [5].

Joseph Malloch has, in his work *The Spine*, presented a digital prosthetic instrument that attaches to the performer's spine. It was developed for the collaborative project Les Gates, in which the artist attempted to design a new instrument that enables sonification of performer's movement. Technically, it is realized through utilization of inertial and magnetic-field sensors that track and report its orientation, shape, and angle in which it bents, which to some extent, correspond to orientation and position of the dancer's spine as well as to particular dancer's improvisational or choreographed moving patterns. Real-time data, gathered from the instrument, are then mapped to specifically designed soundscape thus giving a reflection of action immediate audio-feedback[4]. The piece demonstrates the usage of technology to sonify the movements and that the relationship between performer and technology inhabits performative qualities.

Another work that has inspired the design of Somacoustics was OtoKin by Dahlstedt and Skånberg[ref anon]. In this performance (also exhibited as an interactive installation), the skeleton coordinates of two dancers are tracked using Kinect2 sensors, and this data is subsequently mapped to realtime synthesis, transforming the whole stage into a multi-dimensional soundspace, which combined with the actual physical space forms an augmented reality experience for the dancers or participants, and deeply synchronized movement and sound – as they emanate from the same data set. In this work, the design of the sound space guides the improvisatory exploration by the dancers. Like Somacoustics, it contains a social dimensions, where participants touching each other transforms the sound character completely, forming an inherent narrative of solitude, searching and togetherness.

[2]https://aboutstelarc.weebly.com/ping-body.html
[3]https://aboutstelarc.weebly.com/alternate-interfaces.html
[4]https://josephmalloch.wordpress.com/tag/spine/

Figure 1: Visitors interacting with the instrument-body during exhibition.

3. EVALUATION AND METHOD

We emphasize the use of the body and its sensual perception that in combination with interactive technology fosters performative characteristics. Here, Pelias' method of "Performative Inquiry" [10] can be applied. He asserts that performance has a power to convey meaning-making and understanding of human behavior that impacts on social sphere, as a way of knowing the world around us. Hence, it must employ embodiment, and embodied practice fuels the method of performative inquiry. As the performer acquires more knowledge, the body start to inhabit qualities of the exploratory instrument. In contrast to the more theoretical works presented earlier (Merleau-Ponty, Shusterman), Pelias's' method demonstrates a direct methodological approach towards using a body as a location of knowing about your audience in a particular performative framework.

An improvised contact between participant and performer occurs naturally during manipulation of the instrument-body. It employs spontaneous exploration of different manipulation approaches, kinetic inputs and bodily communication, which fades in to diverse movement patterns and interaction of two or more bodies. Contact improvisation is a contemporary dance genre which explores the kinaesthetic possibilities of body movements through contact with another body. It not only opens up

for exploration of dynamic interaction between bodies, but it also examines individual body physical and agile condition, posture, balance and muscular system, that is to say, body research. Attending these practices, the artist was able to reflect on most peculiar posture his body could generate and hold without losing the balance, to adjust to the shifts of posture as well as to distribute the weight of the body accordingly to avoid falling. Although it did guide him through exploration of his own body's capabilities, it did not establish particular scenarios relevant to the desired interaction within Somacoustic. During contact improvisation practices, he was not only being moved by other practitioners but he was actively and willingly engaged in moving them as well, while in Somacoustics, he is expected to be primarily reactive to participant input, thus entirely submissive to their initiatives.

In reaction to that, we conducted two individual research sessions with two different groups of people: two non-dancers, and five contact improvisation practitioners. In these sessions the artist's body was presented to them as being an object which they are allowed to manipulate. At that point, the interface was not yet fully developed, therefore they were told to imagine that any body manipulation would leave audio feedback – this was important to clarify since it could impact on their manipulation approaches. Both sessions were recorded on video[5], as well as the final exhibition which delivered a rich set of data for further analysis.

3.1 Mapping

This project is based around a mapping from motion tracking data to sound synthesis, thereby transforming the experience of one's movement and of the space. Movement sonification as a method has, aside from the arts, also been used in rehabilitation or sport techniques for motor control learning and improvement (e.g., in [13]). Through conversion of movement into auditory feedback, it enhances perceptual awareness of the body motorics.

Hunt & Wanderley [6] refer to mapping in instrument design as "mathematical process of relating the elements of one data set onto another" more explicitly "[. . .]act of taking real-time performance data from an input device and using it to control the parameters of a synthesis sound." They mention two approaches to mapping, *generative* and *explicit*, where the former relies on algorithms such as machine learning to deduce a mapping from training data, while in the latter the mapping is defined explicitly by hand. We chose the latter approach, but with a twist. Explicit mappings can be described in terms of how input variables are assigned to output variables [6]: *one-to-one, one-to-many*, or *many-to-one*. A combination of these can be referred to as *many-to-many*, as is the case in many acoustic instruments, where, e.g., the pitch in a wind instrument is affected by several input parameters (air and lip pressure, fingering), and simultaneously a single input parameter (say, the air pressure) affects a number of output parameters (pitch, timbre, amplitude, etc.). In our approach, we were also inspired by Dahlstedt's work on randomized all-to-all vector mappings [2], which in a sense is a hybrid between generative and explicit mappings – not designed by hand, but using a randomized translation matrix providing a complex translation between input and output, where each parameter is affected by every other, while retaining control over gestural contour and magnitude through a few explicit mapping choices. This has shown very suitable for situation where there is no obvious connection between input and output parameter sets.

[5]Excerpts can be seen in the video linked in the Introduction section.

4. DESIGN AND IMPLEMENTATION

4.1 Interface

For motion tracking, we chose to use he HTC Vive. Originally designed for VR applications, it consists of a head-mounted display, two hand controllers and an optional set of point trackers. It provides millimeter precision tracking of all devices, which is crucial for capturing expressive movement, and low latency and high data rate, which is important in musical applications. Ideally, we would like to track a large number of points of the instrument-body, but the Vive point trackers are quite bulky, so we had to limit ourselves to tracking the 3D coordinates of five points, in addition to tracking coordinates and angular direction of the head-mount. The hand controls were not applicable in a dance environment. Trackers were mounted on elastic bands allowing for flexible placement on limbs.

In the movement research sessions, participants tended to both change the position and the specific posture of the instrument-body. Based on this, we chose to place the trackers according to the following: One on the chest for capturing the trajectory of whole body, one on each hand for capturing oscillating motion that tended to appear during manipulation, and one on each foot. Even though the feet were not explicitly manipulated as frequently as the upper parts of the body, it increased control possibilities.

Also, the two test groups behaved very differently. The first group were very gently activated the parts they wanted to move, as well as directing its trajectory. In contrast, the second group (experienced contact improvisers) approached the manipulation more dynamically, being in complete and continuous control over the artist's body. This resulted in two distinct levels of submissiveness in which to perform.

Because of the blindfolding and cabling, expected interactions were not supposed to result in big movements across the floor, so we chose to use a square space of 3x3m, marked on the floor with tape, and tracking coordinates were scaled accordingly. For the Y axis, the Vive covered the whole range of a human body height.

4.2 Sound

In this project, we focused on the aesthetics of the interaction, with less emphasis on the aesthetics of sounds, so sound engines were kept quite simple. Both sound synthesis and mapping were implemented in the data-flow programming environment Pure Data, which received coordinate data over the OSC protocol, as gathered by a small custom Python program using the OpenVR library. Sound was projected through four speakers located in the corners of the square performance space.

The sound synthesis part consists of three smaller sound engines, each mapped to a range of the floor area, divided in concentric squares, based on the floor coordinates of the chest sensor (see Fig. 2). This means that only one of the synthesizers is sounding at any moment, depending on the position of the instrument-body. Each synthesizer consists of a small set of oscillators and filters, utilizing standard synthesis techniques such as subtractive synthesis, frequency modulation, waveshaping, ring modulation, and feedback through modulated short-time delays. The three synthesizers were designed based on a spatial narrative, going from smooth sounds in the middle (the supposed starting point), towards gradually more intense, rich and harsh sounds towards the edges, to be explored as the bodily interactions progressed.

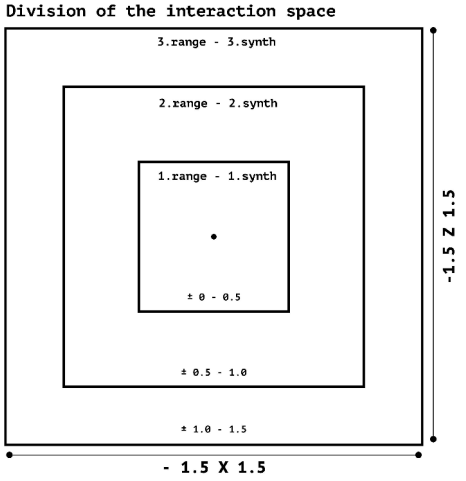

Figure 2: A map of the space use for Somacoustics, and the distribution of sound engines.

The Y value from the chest tracker, i.e., as an indicator of the degree of being upright, was generally mapped to audio filters allowing higher frequencies to pass when body was up and lower when body was closer to the ground, to somewhat mimic a sense of increased intensity when standing up.

For the other synthesis parameters (different for each synthesizer), the mapping was more complex. The three coordinates of one limb were scaled and subjected to a linear transform (with initially randomized coefficients), in order to avoid only mapping in parallel to the axes. Then this transformed value was mapped to a single synthesis parameter. In this way, x, y and z values of this particular tracker all contributed to a parameter change. In addition, for core synthesis parameters, input from another limb (similarly transformed), to achieve increased complexity and expression. Combined, they form a non-trivial many-to-many mapping from limb coordinates to synthesis parameters. In this way people did not recognize immediately what they were controlling, but instead remained in a constant state of investigation.

Additionally, having four channels offered the possibility of surround panning the resulting sounds according to the floor coordinates of the chest tracker, so that the sound followed the position of the body.

4.3 Exhibition

During the development, the interface was informed by the initial movement research workshops, and continuously tested by ourselves. The final exhibition was meant to serve as a chance for both evaluation of the interface as well as obtaining further research material about the response in relation to the aesthetic goals that were set at the start of the project. Regarding the evaluation, we choose to devise the two-day exhibition into two parts, first with the artist as instrument-body, second with visitors offered to try to be instrument-body themselves.

5. ANALYSIS

In this section we analyze the project in the light of the theoretical frameworks presented earlier.

While the body is being our vehicle, it also gives us senses, and a chance to have pleasure for something. Therefore, we consciously direct our appreciation, driven by our own sensory experiences [12]. We argue that participants during the experience, employing sensory embodiment, thus through the bodies, were able to perceive particular appreciation acquired from the interaction with *Somacoustics*. For instance, most of the participants who tried to interact were very keen to explore the possibilities of interaction; therefore also fully invested in the use of their body. Not only that, but their sensory perception enabled them to vary the approach and manipulation as they were seeing and hearing the reaction of their input. Therefore they were able to direct their perception and find appreciation. Their bodies as sensory medium fueled the appreciation accordingly. It enhanced their perspective on the experience.

The participant enters the room, sees the body, approaches it, interacts with it, reflects upon it and leaves. He/she undergoes a particular process from beginning to end. The process of experience contains structure within which the participants do and undergo things through which the experience become fulfilled (according to Dewey [4]). The participant moves the body, which changes the audio. It happens because of the application of interactive technology, and through interaction with technology the participants do and undergo modes of perceiving, creation, reflection, not in alternation, but simultaneously, related. This relationship creates new processes and structures that constitute the experience and convey new outcomes and meanings. It happens simultaneously, and it is precisely through this constant balancing between modes of interaction that the experience can achieve specific meaning that gives us true experience [8]. We argue that the interaction with the technology, designed by us, evokes meanings, emotions and impressions which gives the experiences the aesthetics and quality of a whole and enhance the experience of appreciation.

To support these arguments, we will examine a particular scenario which happened during the exhibition. One of the participants is a puppeteer by profession. His embodiment in such a process incorporates his bodily perception which eventually reflects on the mechanics of the puppet, thus his appreciation towards the experience of moving the puppet is enhanced, stronger than it would be when it is still. His body fuels the experience of appreciation. However, the interaction with technology indicates the same quality. When he started to manipulate the artist's body, and this action offered him audio feedback, he suddenly acquired another perception from his interaction that gave him new sense and meaning of what he is doing. It reflected on his appreciation towards his action besides the one that his body enabled him. The technology increased his bodily perception of actions as well as his environment in a different, enhanced way. His perception gained auditory stimuli. Thus we would argue that interaction with technology, within the use of body, allowed him to undergo a stronger aesthetic experience.

Scenarios with more than one participant occurred frequently. At some point, it spontaneously turned into a performance with differentiated performers and an audience. Here, through the application of Dalsgaard and Hansen's theory [3], we argue that the participant (user) became a performer because of his performing perception. The interaction is socially situated, which is perceived by the participant. In other words, the participant's interaction with the instrument-body is affected by being aware that the way he perceives the instrument-body is a performance for the other people who are only observing, not interacting. It engages the participant in three roles, through acts of interaction, perception and performance.

The experience of *Somacoustics* is located in a physical environment overlaid by virtual information, thus creating an augmented reality. In this case, what is augmented is the soundscape, which can be explored through the interaction. However, we argue that the experience of *Somacous-*

tics can be referred as mixed reality performance because the performance is combining the real and virtual as well as live performance and interactivity, according to Benford and Giannachi's theory of trajectories [1]. A participant can experience mixed reality when he undergoes a particular process of changing his journeys through, perspectives on and durations in hybrid space while interacting in it, which establishes a new configuration of trajectories between real and virtual, simultaneously mapping it. Similarly, the participants in *Somacoustics* through the interaction explored and mapped the augmented soundscape driven by their curiosity to design new sound expression. They varied their trajectories through the physical space overlaid by virtual information in the sonic dimension, derived from the physical movements of the instrument-body, and their reactions towards what happened. Once they moved the instrument-body out of the square, they could easily distinguish that it is a virtual layer that makes the augmented sound. Because they were shifting through hybrid space we argue that they have experienced mixed reality.

5.1 Discussion

Throughout the investigation the chief aim was to explore the experience of interaction between human and technology and its impacts on embodiment and perception. However there are some aspects that were not addressed above. The interaction with the technology not only occurs between instrument-body and participant but also between instrument and body. The artist merged with technology – he was a performer and technology was an instrument. His embodiment allowed the instrument to be expressed.

Therefore we ask: How do we constitute such a combined identity which is instrument-body that participants interact with? Does a technology become part of the subject or does the human become object? Perhaps both, which constitutes not a subject-object relationship but rather a relation of configuration. As Donnarumma proposed [5], it is because constant exchange of information, energies and forces that perform through each other that we are in relationships of configuration. Our actions are in correspondence with each other. This is not only a concern in the world of music performance, but could be adapted to any situation were human merges with technology, which is more and more the case in society.

Additionally, there was a scenario, where the trackers were distributed to several people. It became an instrument with a particular agency. In this case, the technology created a relationship between participants, through which they communicated and performed. The fact that the tracker mapping is co-dependent was reflected on the participants by means of influencing each others actions and perceptions, and invisible relationships were formed. It showed interesting performative potential and it could potentially be applied into the theater sphere as both interactive prop and perhaps a performance of its own. However, this would require further research.

There are many ways to further develop the project, regarding the design of the interface as well as project re-conceptualization. In regards to interface design, more precise, and perhaps more complex mappings and sound engines could enhance the system's expressiveness. This would then reflect onto both aesthetics of interaction and its perception, and more expressive outcome of the exploration of the soundscape.

Somacoustics could also be considered as a suitable interface for visuals. Initial experiments with visualizations of gestural data in using the *vvvv* programming environment showed great potential.

6. CONCLUSIONS

By designing an interactive body instrument and instrument-body, located in mixed reality space and experienced by active participation in bodily interaction, we were able to explore the experience of interaction between human and technology and investigate the interaction's transformative effects on subject's embodiment and perception. We argue that through creative and artistic interaction with technology, we humans can change the understanding of ourselves in the world. Because we perceive through our bodies and sense what technology offers us, as utilized within artistic practices, we can experience not only ordinary things but also things that give much more profound and sublime emotions and feelings. Technology can fuel our meaning-making by enhancing our perception towards the living and nonliving. With the rise of new technologies, we can experience new forms of embodiment in our environment and appreciate what we perceive. The experience of *Somacoustics* inhabits humble but creative and artistic ways of how can we see the future of human-technology coexistence. It fosters the relationships that we should care about, wonder about, instead of being bored and annoyed by. Somacoustics interconnects them and shines a little light on what it might be in the future. Merging with technology, not in the way that we cannot live without but in the way we can enjoy it.

7. REFERENCES

[1] S. Benford and G. Giannachi. *Performing mixed reality*. The MIT Press, 2011.

[2] P. Dahlstedt. Dynamic mapping strategies for expressive synthesis performance and improvisation. In *LNCS 5493*, pages 227–242, 2009.

[3] P. Dalsgaard and L. K. Hansen. Performing perception - staging aesthetics of interaction. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 15(3):13, 2008.

[4] J. Dewey. *Art as experience*. Penguin, 2005.

[5] M. Donnarumma. *Configuring corporeality: Performing bodies, vibrations and new musical instruments*. PhD thesis, Goldsmiths, University of London, 2016.

[6] A. Hunt and M. M. Wanderley. Mapping performer parameters to synthesis engines. *Organised Sound*, 7(2):97–108, 2002.

[7] K. Kelly. *What technology wants*. Penguin, 2010.

[8] J. McCarthy and P. Wright. *Technology as Experience*. MIT Press, 2007.

[9] M. Merleau-Ponty. *Phenomenology of Perception*. Psychology Press, 1962.

[10] R. J. Pelias. *Performative Inquiry*. Handbook of the Arts in Qualitative Research: Perspectives, Methodologies, Examples, and Issues. SAGE, 2008.

[11] C. Shilling. *The body in culture, technology and society*. Sage, 2004.

[12] R. Shusterman. Somaesthetics: A disciplinary proposal. *The journal of aesthetics and art criticism*, 57(3):299–313, 1999.

[13] K. Vogt, D. Pirró, I. Kobenz, R. Höldrich, and G. Eckel. Physiosonic-movement sonification as auditory feedback. In *Proceedings of the 15th International Conference on Auditory Display, Copenhagen, Denmark*. Georgia Institute of Technology, 2009.