Augmented Embodied Performance

Extended Artistic Room, Enacted Teacher, and Humanisation of Technology

Rikard Lindell
Mälardalen University
Box 883, 721 23
Västerås
rikard.lindell@mdh.se

Tomas Kumlin
Mälardalen University
Box 883, 721 23
Västerås
tomas.kumlin@mdh.se

ABSTRACT

We explore the phenomenology of embodiment based on research through design and reflection on the design of artefacts for augmenting embodied performance. We present three designs for highly trained musicians; the designs rely on the musicians' mastery acquired from years of practice. Through the knowledge of the living body their instruments —saxophone, cello, and flute — are extensions of themselves; thus, we can explore technology with rich nuances and precision in corporeal schemas. With the help of Merleau-Ponty's phenomenology of embodiment we present three hypotheses for augmented embodied performance: the extended artistic room, the interactively enacted teacher, and the humanisation of technology.

Author Keywords

Embodiment, Performance, Music, Bio-signals, Interaction Design

ACM Classification

H.5.5 [Information Interfaces and Presentation] Sound and Music Computing, J.5 [Arts and Humanities] Performing arts, H.5.2 User Interfaces.

1. INTRODUCTION

We need to be critical to the digitalisation and automation and consequently the dehumanisation of industry and services. In a completely digitalised world the body as our living expression in the world withdraw to the background. We seem to need our bodies mainly as a mechanical interface to the devices. The radical digitalisation and automation will rise questions on what role we will have as humans and what it is to be human in this world [17, 15]. However, in post-digital art and embodied interaction we can explore the interplay between the analogue and the digital, between the body and the machine [1]. In the last one and a half decade, since Dourish [3] presented embodied interaction to the Human Computer Interaction (HCI) field, the HCI and interaction design research community has had embodied interaction as ubiquitous theme. The 1990s' had brought ubiquitous computing (UbiComp) [22] and tangible user interfaces (TUI) [8]. Both these fields are still vital and reinvent themselves, Ubicomp has transformed into Internet of Things (IoT) whereas TUI continues to thrive in the design research community. The technology focus of UbiComp and TUI was founded in a notion that the computer interface ought to be richer than mouse-keyboard-screen. Dourish put this in a more intellectual and sociologically grounded perspective. He brought the interaction design community's attention to Dreyfus [4], how shows that the Merleau-Ponty's [13] Phenomenology of Embodiment is relevant to the world of computing. More recently, Höök et al. [7] presented *Somaesthetic Appreciation* as a strong concept to create embodied interaction, and to focus on the being-in-the-world where presence in time and in space matters, where the actual shape and innate capacities and rhythm of the human body make the conditions for a design.

In this paper, we explore embodied interaction with classically trained musicians. We focus on performance, the rich actions our bodies can, and that physical actions are both faster and more nuanced than symbolic cognition in interaction design [10]. Merleau-Ponty describes the living body as being in between concrete and abstract bodily movements, where the *concrete* refers to movements related to a known world and the *abstract* refers to movements in an *as-if-world* [13]. We are always open to the abstract and unfamiliar albeit we most often live in the concrete and familiar. Merleau-Ponty illustrates this with an example of a skilled organist who has to play an unfamiliar organ. An hour before a concert the organist manages to get acquainted with the instrument. Here, the musician adjusts his embodied knowledge of playing an organ, without mental representing or learning of the unfamiliar organ. With a similar intent, we introduced designs for the musicians that, on one hand, relied on their acquired embodied skills and their repertoire of concrete movements, and that, on the other hand, challenged those skills. The designs introduce unfamiliarity to a familiar situation; thus, as with Merleau-Ponty's example with the organ player, adjusting the world for the musicians. This revealed new embodied relations between the musicians; the saxophone, cello, and flute; and, the designs.

2. RELATED PROJECTS

We introduce three designs —MIST, Whirlpool Bach, and Critical Digitalism — to explore embedded interaction. The first project visually augment the performance of a solo saxophonist using audiovisual input, the second project visually augment the performance of a solo cellist using biosignals of muscles, and the last project utilise live sampling to augment the performance musically based on biosignals of muscles. There are many related projects in the past decade that relies on similar approaches. This section present a selection of projects that provide a context for our work. Graham and Bridges [6] presents a design for mapping strate-

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gies in a performance system that combines motion detection and feature extraction to manage multichannel audio material in improvisation. Their design utilises a Microsoft Kinect and extends the artist performance with bodily gestures similar to, but also more sophisticated than our MIST project. Like Graham and Bridges, other projects have studied mapping strategies of gestures. Visi et al. [21] designed a gesture mapping system based on embodied music cognition for performance to be used in performance to enhance the expressiveness and the liveness that provides an extra layer of possible motions and musical expressions over the instrument. Beside visual and aural technologies, Donnarumma [2] explored gesture control using mechanical myography (MMG) audio signals. The aim of the design was to make biological signals the main audio and control source. Donnarumma also aimed at making a perceivable connection between the performer's kinesthetic expressions and the sound for both the audience and the performer. Application of techniques for acoustic feedback controllers (AFCS) to different contexts, such as musical performance, sound installations, and product design, presents a unique insight into the research embodied audio interfaces and environments. Van Troyer [20] illustrates with three prototypes novel designs for AFCS used in different environments sonically augmented environments based on users' audible actions. Besides extending performance and musical expression via gestures embodied interaction is also used for novel interfaces. Yamaguchi et al. [23] designed a wireless music interface in the form of a ball. The performers' movements and grip pressure control various parameters in a musical process. The design is loosening the link between the physical object and how it sounds and thus provides freedom in the physical performance, for instance allowing the performers to play the instrument through dance. Whereas, Tahiroglu et al. [19] designed an instrument —Network of Intelligent Sonic Agents (NOISA) — with a tight coupling between appearance and sound to explore physical interaction in performance with emphasis on engagement. Their focus was on a novel design where they increased their performance skills with the instrument through rehearsal and training. The novel design implies that it will take time and practice before the users acquire embodied artist skills. Another approach is to augment traditional instruments relying on the trained movement schema of the artists. For instance, McPherson [11] augmented the piano with a portable optical measurement system designed for capturing continuous key motion. The design enables the pianist to be more expressive and adjust a broader and continues range of parameters of the played note. This increases the world of the instrument; the performers need to expand their abilities and their living bodies knowledge the this augmented piano. Capturing the motions of the artist can also be used for training purposes. Menzies and McPherson [12] created a digital bagpipe chanter system to assist in one-to-one piping tuition. The system allows students to record and see a visualisation of their performances. They designed the hardware to accurately and quickly detect continuous finger movements of the player to allow a nuanced input. Various forms of sensors can be used for input in novel designs. Donnarumma [2], above, developed a sensor to measure and sonify mechanical vibration of muscles. Jaimovich [9] presented the work of Emovere: an interactive real-time performance that uses physiological signals from dancers to propel a piece that explores and reflects on the relations between biology and emotions. Jaimovich focuses on the design of collaborative tools and materials, he contributes to the creation of artistic projects working with dancers and physiological signals. The design uses muscle sensors electromyogram (EMG) and electrocardiogram (ECG) that measures the heart activity. The use of biosignals in interactive art is not particularly widespread; albeit there is a tradition in a small community of interactive art artist to use biosignals that goes back since the early 1960s. A growing number of artists have since then collaborated with neuroscientists and engineers to design methods that enable the acquisition of minimal electrical signals of the living body. This has enabled direct manifestations of embodiment into interactive artworks.

3. METHODOLOGICAL NOTE

Out method for the work in this paper is based on designing or supervising the design of artefacts through a "conversation with the materials of a situation" that intervene in the practice of train musicians. We relied on Schöns [16] reflection—on—action to formulate our thesis on embodied augmented interaction grounded in the design process and experiences of the designs. We have grounded our theories of the designs in research through design, presenting examples of designs [5, 24], reflections on the designs, and the view of Merleau-Ponty's phenomenology of embodiment [4, 13].

4. MIST

The Music Interaction Symbiosis Technology (MIST) (Figure 1) design used audio amplitude and frequency spectrum features to control a visual particle system and particle flow. The system used a Microsoft Kinect connected to a computer programmed with OpenFrameworks. A professional saxophone player collaborated in the design process to explore how the system could augment the players performance. The presence of the player body afforded a design in later iterations to include a luminous image of the player on the screen where the bursts of particles originated from. Instead of mapping gestures to symbols [6, 21], we mapped the movements and audio to a continues visual flow. In performance, the artist described how he tried to make the performance more visually interesting. This the design became an extension to the saxophone expanding the artistic space.

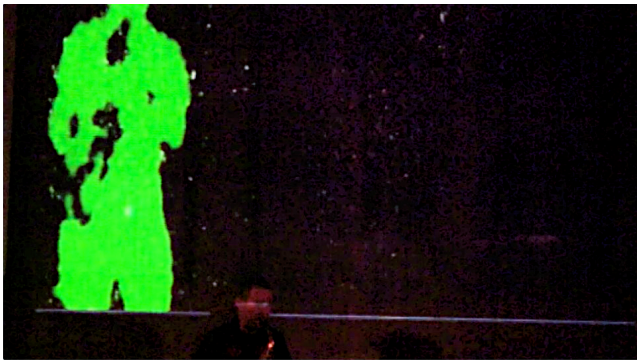

Figure 1: Performance at the Norberg festival 2012

4.1 Whirlpool Bach

The visual augmentation of the MIST project inspired us to further explored the interplay between visuals and the performance of a trained musician. In the Whirlpool Bach project, we created a visual augmentation of a cello player performance via controlling the framerate of a video displaying water whirlpools in a stream (Figure 2). The stream is

part of a channel used in the eighteenth and nineteenth centuries to ship iron, then the most important export of Sweden. Today, all the mines and mills are closed. Using the electromyography (EMG) signal to reverse the whirlpools of the stream while playing Bach's cello suites symbolising transience of industry and nostalgia for what has been. When the player relaxes the stream start to flow forward, washing away the past.

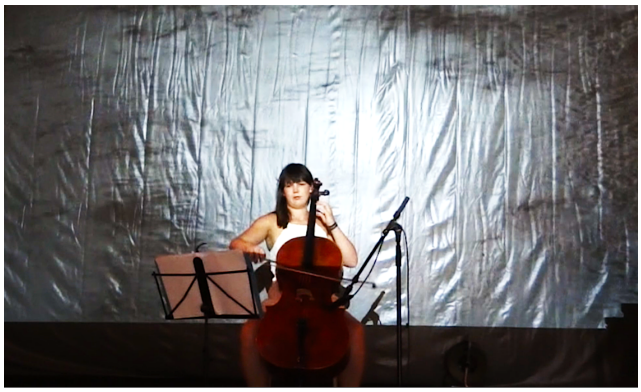

Figure 2: Performance at the Norberg festival 2014

We used a custom build EMG sensor connected via a data acquisition (DAQ) device to a computer programmed with the data flow programming language LabVIEW (Figure 3). Laboratory Virtual Instrument Engineering Workbench (LabVIEW) is an electronics system-design platform development environment. The LabVIEW program sends open sound control (OSC) messages with the muscle signal amplitude values from the 20 - 50 Hz band to another computer running a QuartzComposer program. QuartzComposer is a data flow programming language designed to manipulate multimedia. This program manipulates the video frame rate based on the muscle amplitude.

Figure 3: Custom build EMG sensor

The artist described an increased awareness of her movement while playing. Where Menzies and McPherson [12] introduced a sophisticated design for learning visualising the performance with precision, we mapped the body signal with a looser connection between the movement and the visual expression. Even so, the artist was consciously reflecting in action on her body "not just the cello." This is to one end making subconscious movement conscious thus making deprecating the embodied presence, however to another end it makes the artist reflecting on her actions; thus, the technology acts as a teacher. The interplay between the in action and on action is what Schön [16] describes as learning and expanding one's repertoire.

5. CRITICAL DIGITALISM

Critical Digitalism explores embodied interaction and augmented acoustic performance utilising biometric signals (Figure 4). The music was performed on a flute, an analogue synthesiser, and computer running a custom built live sampling and loop player software. The software samples four seconds and played back twelve seconds completing sixteen seconds cycles of sampling and playback, four bars in common time based on the larghetto tempo, 60 beats per minute. The music loops are field samples of fans in academic institutions and a time stretched reversed piano chord. Thus, all sound sources are either acoustic or analogue.

Figure 4: Critical Digitalism, flute, synthesiser and computer performance 2016

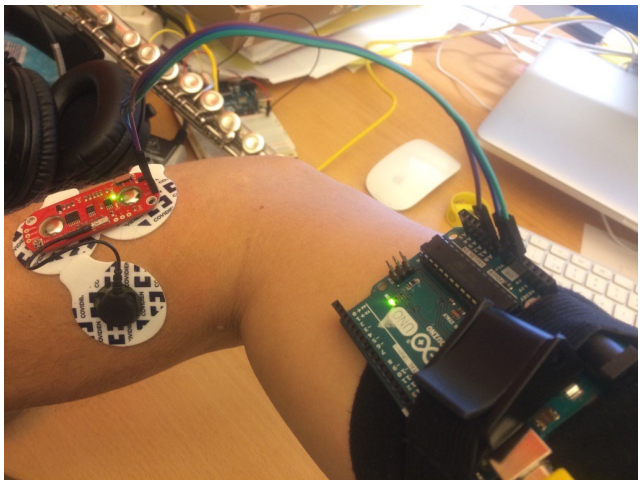

Figure 5: EMG Sensor connected to Arduino

In this design, an electromyography (EMG) signal, measuring the muscle signal amplitude, affects the grain size of a live sampled acoustic and analog performance utilising granular synthesis. The digital signal processing and music programming is based on the Processing Beads audio library [14]. The Beads' granular synthesis manipulates

the time-domain of the time—frequency space of a signal. The MyoWare Muscle Sensor is connected to an Arduino micro controller running Firmata allowing the Arduino to be programmed via Processing (Figure 5). The sound of the acoustic flute and the analogue synthesiser is reversed and stuttered like an old pin printer or disc-drive. High muscle tension calms the lengthens the grains and relax the signal; this mapping implies constant tension in the muscles of the performer or in the ears of the audience. Touching the MacBook trackpad blends samples based on distance to the touch. Thus, the digital instrument was played though very light swipe gestures. This design included many elements —touchpad, synthesiser, flute, and sensor. Thus playing the piece was moving between focusing the different parts and reading the whole situation (including the audience). Jaimovich [9] described the difficulties for the dancers to map dance to music; however, we experienced in this project that the complexity was not a difficulty but instead created another layer of situation awareness that demanded a conscious thought to gear the performance in a desirable direction.

6. DISCUSSION

We can formulate three themes of augmented performance on the basis of embodiment and Merleau-Ponty: the extended artistic room, the interactively enacted teacher, and the humanization of technology.

6.1 The Extended Artistic Room

According to Merleau-Ponty [13], the embodied subject is deeply intertwined with the world on a pre-reflective level. Actually, much what we normally ascribe to "mental life" happens here. The world is conceived as a constant ambiguous calling, and the embodied subject responds to this by interrogating the world with its capacities to perceive and act. In the dialectic between world and the lived body both the world and the subject take shape as something meaningful to each other.

For the saxophone player in the MIST-project this means that the physical reality of the concert hall and the audience is a latent possibility of a musical world. The saxophone player is responding to this calling by playing the saxophone. In this, he is at one and the same time perceiving and acting with the pre-reflective intention to call forth this world into being. The means to this are his habitual embodiment as a musician where the saxophone is one with the lived body. The saxophone is actually not noted as a thing in itself but only through the effects of playing it. And through attending to the musical idea and applying spontaneous creative effort in playing the saxophone the musical room comes to life. The room is filled with music, the audience becomes the "listeners" and "enjoyers" of the music and the saxophone player becomes the "joyful performer." But this is not static. With every sound the saxophone player is responding to the world before him and at one and the same time perceiving, acting, and enacting it.

It is important to recognize that this is a socially constructed event. The saxophonist is performing as countless saxophonists have done before him. He is the now incarnated endpoint of at tradition making a performance in an almost traditional way with his skill and his music. It does not feel socially constructed or traditional though. In the act of playing it feels as the most natural and important thing to do and in the sense that the player is creative he is not weighed down by tradition. But through the MIST visualisation system a non-traditional element is introduced to the performance. Theoretically this could destroy it. But, we found out that the saxophone player could easily adapt to this and attach the new possibility to his performance. Furthermore, in the iterative design process he suggested improvements of the design, the appearance of his silhouette as the origin of particles, and a more deterministic flow of particle making it possible to perform loops of music and visuals that emphasise the connection between the music and the visuals. He now had the opportunity not only to respond to and create the room with music but also with something visual. This opens for new artistic possibilities. We all know the difference between watching a movie without sound or music. But, what is interesting here is that this is done in real time as a spontaneous part of the performance. In this sense, the artistic room gets extended.

6.2 The Interactively Enacted Teacher

According to Merleau-Ponty [13] the key to the embodied subject or the lived body is habit. But here we must refrain from the idea that habits are more or less mechanical responses to the environment. They are learned ways to perceive and act that works intentionally but on a pre-reflective level. There are always habits in everything we do in every part of our lives. Habits can be described on three levels. They are the concrete habits that I am at this moment, the lived body as it is right now. But they are also the sedimented habits that I have acquired but lies dormant as a background with a potential meaning to what I am doing now. Finally they are also what I could imagining myself doing as abstract habits that I have the capability to learn.

The habits are collected into corporeal schemas. These are more encompassing attitudes that can be described as my embodied perspective containing both perception and action pertaining to a certain world. The corporeal schema is a whole that is more than the sum of the habits that constitute it. It is at one and the same time an immediate knowing of how my lived body is configured at the moment and of the kind of world I am trying to respond to. It can be changed by incorporating and letting go of habits. It is rough in the novice and refined in the master. But even then the corporeal schema can be fully adequate. The novice musician can awaken as enthusiastic responses from its parents as the master can do from the concert hall audience. The corporeal schema always admits spontaneous improvisation but in a low degree in the novice and a high degree in the master. It takes a very well developed corporeal schema to master a musical instrument. It is through this development that the instrument eventually becomes a part of the musicians lived body barely noticed.

In Whirlpool Bach we investigated the corporeal schema with the help of a cellist in the later years of her training. With the introduction of the EMG sensor and the visual performance a new element was introduced to her corporeal schema. It had the effect of transforming her concrete habits of playing in the moment to abstract habits open for reflection. In one way this interrupted her performance. She started to reflect on her body as an object rather than living it as a subject and the free flowing movement between the lived body and a world of music could not be upholded. But the interruption on the other hand was relevant to what she was doing. She could use it to reflect on how she actually lived her body while playing the cello enabling adjustments to the corporeal schema.

One way to conceptualise this is that the cellist used the EMG sensor and the visual performance as cultural objects.She could understand them according to their use as a way to monitor her muscles during her performance. We would rather argue that the cultural objects that advanced technology makes possible takes on a "higher" meaning in this situation. To be aware of another human being as a

subject is understood by Merleau-Ponty as the actual perception in the world of another who intentionally perceives and acts in the world. In comparison with this we feel that a lot of today's technology has reached the level of "quasi-subjectness". A lot of the devices that surrounds us are not really possible to conceive as mere cultural objects calling us to be used (albeit possibly creatively). We all feel that they in some sense also perceive us and we can perceive them perceiving us. It is in this meaning that we would not conceptualise the EMG sensor and the visual performance as mere biofeedback through cultural objects but as an interactively enacted teacher.

6.3 The Humanisation of Technology

There is no real distinction between humanity and technology. Technology has always been "humaine" in one way or another. It is simply an extension and empowerment of the capacities of perceiving and acting that are already there in our embodiment [13]. But technology is "inhumaine" in the sense that it has most often actualised delimited parts of the human potential to be put in service to interests directed by production and consumption and ultimately profit. The human is a producer and consumer for sure but we are so many other things. Among a range of things we feel, love, play, create, socialize and reflect on the mystery of being alive. Today's technology are of course more responsive to this than ever before. For instance our social capabilities are enlarged by smartphones and internet of things.

We design Critical Digitalism to have a more intimate relationship between the musician and the technology. The project is also autobiographical based on previous examples of exploring embodied augmented performance using kinaesthetic creativity in combination with technology. Svanæs [18] introduces kinaesthetic creativity to enable the body to be part of the design process. "Kinaesthetic creativity makes it possible not only to use the body in the design process as an object to be studied or as a vehicle for acting out proposed solutions, but also to create design processes and environments that will take advantage of the ability of designers and users to explore and enact alternative futures through abstract movements." [18] However, our focus was on concrete moments, or rather learning through interaction with instruments on the basis of acquired skill as described above: the Interactively Enacted Teacher. Jaimovich [9], tried to connect the dancers to sound parameters making them being musicians, playing the instrument. However, this design had to be discarded because of the dancers not being familiarized with a musical-performer motions. The dancers worked with the whole of their bodies and controlling separate parameters with certain muscle was not part of their embodied kinesthetic knowledge. This is an important difference from our work, where we used the knowledge of the living body to augment the performance with appended layers. Using the kinaesthetic creativity in performing with the instrument, the acoustic technology, the analogue synthesiser with its buttons, knobs, and patch cables, and the computer trackpad we designed interactive technology "sees" the human. However, we can say that even the clunky laptop, the mechanic typewriter before it, or the smartphone sees the human too. However in the strive to not dehumanise users into screen tapping fingers, embodied interaction calls for more rich interaction that can "see" the humans' nuances and precision in their bodily motions. The digitalisation and automation of industry and services can learn from interactive art, critical design, and interaction design. Designing for embodied interaction allows users to be seen as humans. The technologies' more complex and nuanced embodied perception calls for more sophisticated interaction technology to become more humane.

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