5500: performance, control, and politics

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ABSTRACT
In the period between June 2014 and June 2015, at least 5,500 immigrants died trying to reach Europe from Africa while crossing the Mediterranean Sea.

In this paper we present *5500*, a piano performance that is a part of an on-going project that investigates the incorporation of electrical muscle stimulation (EMS) into musical performances, with a particular interest in the political significance of the negotiation of control that arises.

5500 consists of a performance of Beethoven's *Sonata Pathétique*, where the pianist's execution is disrupted using computer–controlled electrodes which stimulate the muscles in his or her arms causing their involuntary contractions and affecting the final musical result.

Author Keywords
Performance, data visualization, muscle memory, glitch, piano.

ACM Classification
H.5.2 [Information Interfaces and Presentation] User Interfaces–Haptic I/O, I.2.9 [Artificial Intelligence] Robotics–Propelling mechanisms, H.5.5 [Information Interfaces and Presentation] Sound and Music Computing.

1. INTRODUCTION
In this paper, we present *5500*—a piano performance part of an on-going project that investigates the incorporation of electrical muscle stimulation (EMS) into musical performances with a particular interest in the political significance of the negotiation of control that arises.

5500 is not only a piano performance but also a "data-visualisation performance"; in it we augment (or disrupt) the performance with an embodied data-visualisation of politically-charged data (the deaths of African illegal immigrants attempting to cross the Mediterranean Sea).

Although "art becomes political only through its integration with the social" [1], the aesthetics of this integration plays a fundamental role in the *artistic success* of a piece. *5500* is first and foremost a musical performance (based upon Beethoven's *Sonata Pathétique*) and its politicality is also musical: the disruption produced by the EMS also presents itself in terms of the resulting musical performance.

2. BACKGROUND
2.1 Electrical stimulation and performance
The artistic exploration of the effects of electricity on the human body has a long and rich history. Stephen Gray's performances in 1730 were probably the first public demonstrations of humans being affected by electricity (his subjects, after being statically charged and electrically isolated, would attract metallic objects) [2].

Several of these early performances, with the metaphorical crucifixions of statically charged subjects by Georg Mathias Bose in the mid-1700s being a clear example, already exploited the strong emotional and aesthetic impact that electricity applied to humans invokes [3].

The electrically-induced involuntary activation of the muscles known as "electrical muscle stimulation" was achieved as early as 1747 by Jean Jallabert, who exerted muscle contractions in a patient's arm which had been paralyzed for 14 years [4]. This was followed by the works of Caldani and Fontana in 1756 and of Luigi Galvani in 1780. Galvani's experiments with dead frogs have entered the collective imaginary and had the strongest cultural impact (inspiring, for example, Mary Shelley's *Frankenstein*) [3].

This exploration continues today, with artists investigating the aesthetic possibilities of EMS, scientists researching its properties (with applications ranging from pain relief to treatment of comatose patients [5]), and HCI researchers working on force feedback mechanisms which employ the user's own muscles [6].

Contemporary artists who have had performances with external muscle stimulation include: Stelarc, Arthur Elsenarr [3], Daito Manabe [7], and Choy Ka Fai [8], among others. Both Manabe and Elsenarr explored the relation between music and EMS-induced facial contractions, while Choy's work focuses in dance performances, and mainly thinks of EMS as a choreography tool.

Also related to our work is *Possessedhand* by Tamaki et al., where they achieved individual finger control, and proposed using EMS to assist users in, for example, learning how to play a musical instrument [9].

2.2 African illegal immigration in Europe
Even if, as Samers points out, "illegal immigration as an analytical category is somewhat odd because ultimately it is an epiphenomenon of migration and citizenship policy" [10], this *produced illegality* has a tangible and dramatic social impact. In the words of the journalists' consortium *The Migrants' Files*, "the blue waters of the Mediterranean have become a bloodbath for desperate immigrants seeking refuge in the European Union."

This systematic migration receives increasingly extensive media attention with "discourses giving rise to an apocalyptic image of a wave or 'exodus' of 'desperate' Africans fleeing poverty at home", while obscuring the fact that "African migration to Europe […] is fuelled by a structural demand for cheap migrant labour in informal sectors" [11].

The externalization of the roots and causes of massive migration has led to the enforcement of (failed) restrictive immigration policies which purportedly aim at keeping Africans at home [11], with an increasing focus on the legal status of the migrants [12] and on the perceived security problem they pose [13].

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3. *5500*

In the period between June 2014 and June 2015, at least 5,500 immigrants died trying to reach Europe from Africa while crossing the Mediterranean Sea [14].

5500 is both a musical performance and a data visualization performance. It consists of a performance of Ludwig van Beethoven's Piano Sonata No. 8 in C minor, Op. 13, commonly known as *Sonata Pathétique*, where the pianist's execution is disrupted using computer–controlled electrodes which stimulate the nerves in their arms causing involuntary contractions of his or her muscles, and affecting the final musical result.

In this work, the calendar dates on which these deaths occurred are mapped onto the time sequence of the performance, in such a manner that the calendar year is spread over the course of the sonata. This means that, for the average performance length of *Sonata Patéthique* being around eighteen minutes, the nine-minute mark represents six months into the year.

The duration of the electric shock corresponds to the severity of the corresponding incident. These durations were calibrated so that the smaller incidents do not affect noticeably the performance, while the most dramatic ones twitch the performers' hands, not allowing him or her to extend his or her fingers.

Accompanying the musical performance, a timeline is projected on the stage. In it, the migration incidents are represented as vertical lines of height proportional to the severity of the incidents. This timeline is also visible to the performer, via a monitor, providing real–time visual feedback.

Figure 1. *5500* performed by Bruno Benedetto. The computer shows the timeline with the vertical lines representing the severity of the incidents.

The data of the immigration incidents was obtained from The Migrants' Files, a project launched in 2013 by a group of European journalists and researchers who joined forces to quantify the deaths of immigrants seeking refuge in Europe and identify the locations of these tragedies on maps. It involves the organizations Journalism++, Dataninja; Neue Zürcher Zeitung, El Confidencial, Sydsvenskan and Radiobubble as well as freelance journalists Alice Kohli, Jean-Marc Manach and Jacopo Ottaviani. The project created a publicly accessible database[1] that nucleates all the reports of immigration incidents and the estimated casualties. [14]

5500's representation of the deaths of the migrants unfolds in two orthogonal axes: a digital muscle memory implant that transforms the body itself into an apparatus for representing and remembering socio-political processes; and the resulting music, a classical piece of European Culture directly affected by its own representation. The first only exists *in* and *for* the performer but is empathically perceived by the audience while the musical performance falls into the more usual paradigm of performance–audience.

3.1 Design

The performance involves a standard ("unprepared") piano, a computer, a projector, and the EMS device.

The EMS device consists of a laser–cut black acrylic box, from which the electrodes are connected. Inside the box, there is a medically compliant signal generator. The signal generator generates an asymmetrical bi-phase square pulse, with an amplitude of 0-80 mA, a pulse width of 30 to 260 μs, and a pulse rate of 2 to 150 Hz. It outputs a maximum of 30V/100mA over a 500Ω load.

We use an Arduino UNO and four relays to control whether the signal from the pulse generator reaches the electrodes. The communication between the box and the controlling computer is via Bluetooth.

The electrodes are situated on top of the ulnar nerve in both arms of the performer (see Figure 2). This way, when electricity is conveyed, the hands of the performer twitch, preventing the normal execution of the piece. We use a frequency of approximately 25Hz and a pulse width of approximately 290 μs; however, these values are calibrated before the performance as they depend on the exact location of the electrodes and on the performer's sensibility.

The system is programmed in Java.

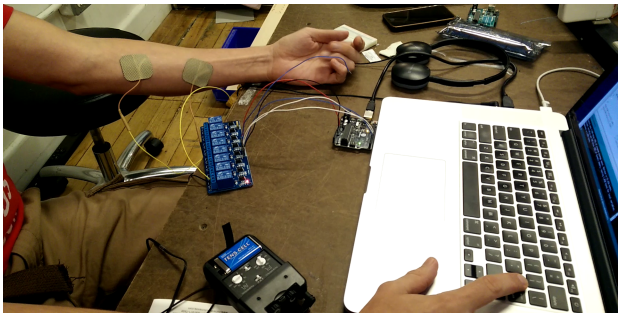

Figure 2. The computer–controlled EMS device with electrodes applied on the arm stimulating the ulnar nerve. The Arduino, the pulse generator, and the relay array can be seen in the image.

3.2 The video projection

As mentioned, the performance is accompanied by a projection of a timeline which represents the year from June 2014 until June 2015, as well as the approximately 19 minutes of the performance (see Figure 3).

The immigration incidents are represented with vertical lines proportional to the magnitude of the tragedy. When a line appears, the number of victims is displayed on the bottom of the screen and it immediately fades out.

This projection re–enforces the metaphor of the data visualization, reminding the audience of the proposed symbology. Its minimalist appearance paired with the dry number of deaths conveys a sensation of objectivity in clear contrast with the "viscerality" of the electric shocks.

4. BODY, PERFORMANCE, POLITICS

The integration of the body into an artistic performance has always been a source of tension. The body is "outside to language", and therefore it is "a possible site of disruption" [15].

[1] Database accessible at https://migrantfiles.silk.co/ and https://www.detective.io/detective/the-migrants-files

Figure 3. Stage setup of a 5500 performance. The projection of the graphical visualization plays a central role.

Political activity, on the other hand, "is whatever shifts a body from the place assigned to it or changes a place's destination" [16]. The *explicit* inclusion of the body into an artwork shifts the ontological centre of the piece, almost inevitably charging it politically. Even if we forget that all relevant enough cultural phenomena admit a political interpretation and, therefore, carry a political stance, we must remember that it is *back* to "re–appropriate certain imaging conventions when they effectively destabilize conventional paradigms of representation" [12].

This is particularly clear in the case of illegal immigrants who, by definition, fall outside of the prescribed categories of social inscription: "the anonymous faces and bodies that we are invited to identify, recognize as illegal immigrants, are literally in the background, as if to mirror their invisible and underground existence" [12].

If illegal immigrants are invisible (outside the objectification of news reports, which almost never represents them as complete humans), the explicit use of the body in our performance aims at turning them visible. And, of course, the metaphor of electricity should not be overlooked; electricity is invisible yet propels our muscles. Similarly, the violence of the spasmodic contraction refers to the triple violence that illegal immigration entails: the immigration process itself, the institutional prosecution, and the violence within the contradiction between their role and their societal inscription.

The inclusion of the body in contemporary performances poses a problem, for there are no conventions on *how* it is to be included, nor there is an established expressive language. Similarly, the design –composition– of new instruments, which potentially propose radically new interaction languages, leaves the audience without clues of how to interpret the movements of the performer, nor how to identify virtuosity.

In 5500, however, the body adopts a new, different role for the relation with the instrument, for it is inscribed in a traditional artistic language. The data representation exists *in* the body but, also, is present in the final musical output.

5. DISCUSSION

5500 uses an iconic piece of European culture to question the existent "relationship between a racialised, ethnicised and xenophobic construction of 'Europeaness', an emphasis on security, the absence of proactive human rights legislation, and the development of restrictive immigration policies in Europe" [10].

However, it is not anecdotic that this questioning takes the form of a musical performance.

Musical performances can be modelled as being collaborative between performer and instrument, or –in the case of NIMEs– between the performer and the instrument designer, mediated by the instrument. However, *5500* also exists in a parallel *artistic axis:* the body as representation. This parallel activity is an artistic performance in itself that exists in the clash between the performative intention of the pianist and the interference introduced by the EMS system.

The piece is also proposed as an exploration of the relationships between several components: the performer, the data representations, the *referent* (the information being represented), and the musical performance. Underlying we find the question: are we expanding the possibilities of piano performance or this is an exploration that is parallel to the instrument and its use?

And this is an aural performance. The sounds of the relays when they allow the flow of electricity also add to the sensory experience; they introduce the cold, inhuman sound of an automated process (in the same way, the chosen graphical representation is minimalist and conveys objectiveness).

If, as Rokeby proposes, "interfaces are content" [17], then it is in the interface between the pianist and the piano where the artwork resides. The re–signification of playing an instrument allows for the exploration of a new symbology and, perhaps more importantly, of an uncharted artistic terrain.

However, similar explorations have a long history. Not only "the acoustic piano is among the most versatile of instruments, capable of complex polyphony and rapid passagework across an extremely wide register" [18], but also the inclusion of random chance (such as the effects of the EMS in *5500*) into music performance also has a rich tradition, with John Cage's compositions and experiments in 1951 being perhaps the most famous examples [19]. Similarly, the preparation of pianos expanded the aural possibilities of the instrument, allowing for new strategies in composition.

Under the traditional paradigm of a musician playing an instrument for an audience, *5500* involves the piano plus the electrical stimulus apparatus—a sort of exogenous prepared piano that affects –as many prepared pianos do– the playing of the musician but uniquely exists in the body of the player and not in the piano.

5.1 Emotion in *5500*

If we analyse *5500* in terms of a traditional piano performance (or a *prepared performance*), it is clear that the sound output remains unchanged (except for the sound introduced by the relays). But what happens with the expressiveness of the system? What happens when a significant part of the performance depends entirely on an automated process?

The question of expressiveness in machine/computer music is a perennial one. And the "tension between body and machine in music, as in modern life itself, can only exist as an experience to examine and criticize and not as a problem to resolve" [20].

We do know that the encoding of emotions into physical characteristics (tempo, dynamics, timing, and spectrum) is usually successfully decoded by the listeners [21] [22]; however, it is hard to find experiences of the separation onto a new layer of emotional encoding that the collaboration between the performer and the apparatus proposes in *5500*.

Even if we are not attempting a definitive answer to the problem of machine expressiveness, we understand that there exists a path towards expressiveness in the "use" of the performer as an instrument. If all that matters is the "appearance of expression", then using the empathy of the human performer appears as an effective strategy.

If expressiveness is related to the "psychophysiological distance, in the minds of the player and the audience, between the input and output of a device mapping" [23], then *5500* explores two ways of reducing this distance: a traditional piano and the embodied performance.

In effect, there is a layer of musical expressiveness which is present in *5500*. There is empathy from the audience, not (only) with the referent –the immigrants' deaths– but with the performer themselves; even if we have not ever been subjected to electrical shocks, it is easy to imagine that they are uncomfortable. And in *5500*, they are acting *against* the performer.

Although it is clear that the piano player is voluntarily participating, it is difficult not to view them as a victim of the setup, trying to perform in spite of the situation. There is a feeling of uneasiness, of discomfort, which is communicated from the performer to the audience as they both anticipate the advent of electrical shocks.

5500, as a performance, can also be seen as a reflection on control. Every control is partially illusory and all we can aim at is a fruitful collaboration with the circumstances. The performer fights to gain control (he or she succeeds at the end, although only because of the distribution of data), the collaboration between man and machine is at the same time antagonistic (the struggle for control), and collaborative (the artwork emerges from this struggle).

Finally, we can also discuss the musical results. It seems unlikely that people would say this offers a more accomplished performance than a "pure" rendering of Beethoven's *Sonata Pathétique*. However, the comparison seems futile. Instead, the question that can be asked is: Is this *still* a performance of the *Pathétique*?

There is a surrendering from the pianist, allowing the system to express itself through his or her body. The body becomes an instrument for the designed performance, a passive receiver of commands, his or her role reversed.

This reversal is orthogonal and complementary to the role as pianist. *5500* exists in this complementarity; we think that this is a fertile area of artistic exploration, the creation of spaces of musical complementarity where the roles of controller and controlled are dynamically negotiated (this, of course, has been explored in conferences like NIME, however, the space of this negotiation is always external to the body. We propose the inclusion of the body in the contested space).

5.2 Cage and the silence

To finish, we quote this conversation between John Cage and Daniel Charles. [24]

Cage: [In the third movement of the Concerto] I had decided to accept rather than seek to control.... At the same time I grant more and more space to silences. Which may signify that I ceased being a composer. The silences speak for me, they demonstrate quite well that I am no longer there.

Daniel Charles: They are no longer expressive silences?

Cage: No. They say nothing. Or, if you prefer, *they are beginning to speak Nothingness!*

An opposite tension between communicating sounds and "sounds that speak Nothingness" appears in *5500*. The silences, with the performer's hands away from the piano, suddenly receive an electrical discharge. They twitch. The silence is expanded in is theatricality, yet this expansion is not aural, it is part of the musical performance. The inclusion of the body into the contested space expands the expressive spectrum.

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8. Appendix: video documentation

A full performance with pianist Bruno Benedetto can be found at https://www.youtube.com/watch?v=qEnUtsx6b7A.

A shorter video with only the first movement can be found at https://www.youtube.com/watch?v=5TfUCLDmuBs (same performance).