

Joakinator: An Interface for Transforming Body Movement and Perception through Machine Learning and Sonification of Muscle-Tone and Force

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ABSTRACT

Joakinator is a wearable interactive interface that allows users to activate different media materials, such as sound, music, and video, through body gestures. The device, designed in the context of music and performing arts, integrates surface electromyogram, force sensors, and machine learning algorithms with tailored-made software for sonifying muscle-tone and force. This allows the body to reflect expressively the content of the media and the architecture of the device. Recently, we have started to investigate the potential of Joakinator to alter body perception in the context of BODYinTRANSIT, a European Research Council Project focused on the transformations of body perception through the use of interactive sound/haptics technology. At NIME-2023, we will showcase Joakinator and invite visitors to experience the device firsthand. Visitors will have the opportunity to try on the device, observe others using it, and reflect on its capabilities to transform body movement and perception through the sonification of muscle-tone and force. Overall, Joakinator is a technology that pushes the boundaries of body-computer interaction and opens new possibilities for human-computer interaction and expression.

Author Keywords

Wearable interface, embodiment, body perception, transformation, sonification, Machine Learning

CCS Concepts

• Human-centered computing → Human computer interaction (HCI) → Interaction devices → **Sound-based input / output**; • Applied computing → Arts and humanities → **Sound and music computing**

1. INTRODUCTION

The Joakinator is a wearable interactive interface initially developed through an art based research methodology in the context of an art-based doctoral research endeavor examining the interconnections between technology, body and performing arts. With Joakinator the performer is able to control media materials such as sound, interactive music systems and video. Joakinator creates a bidirectional relation among the performer and the media material. The fact that the interaction with the material is mediated by the muscle-tone and force of the performer creates the sensation that media materials are part of

the performer's body, giving the performer different sensations of his/her own gestures. At the same time the media material, when controlled by the performer's muscles, acquires new expressive qualities as shown in the performances in which Joakinator has been used. In those, the audiences seeing this relationship have also expressed a surge of imagination/creative thinking about the body and the technology. Joakinator is a device for creative thinking through the body, integrating the language of technology.

More recently, Joakinator has been investigated in a different context: a multidisciplinary research BODYinTRASNIT that merges neuroscience and human computer interaction research to investigate the transformation of body perceptions through the development of sound and haptic interactive technology. Within the scope of the project, we will be exploring the device's potential to transform body perception in different populations, such as dancers and physically inactive people.

Our objective in showcasing Joakinator at NIME-2023 is to introduce it to the NIME's community as an open-source, cost-effective tool for investigating the transformation of body movement and perception through the sonification of muscle-tone, and to obtain feedback from the NIME community on Joakinator's design and potential.

2. DEVICE



Figure 1. The Joakinator is composed of an Arduino MKR1010 microcontroller, three myoware-v2 electromyography (EMG) sensors and four flexiforce (FSR) sensors.



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The Joakinator system integrates in the hardware part an Arduino-MKR1010, three myoware-v2 electromyography (EMG) sensors and four flexiforce (FSR) sensors and a specific PCB circuit for noise reduction and sensor calibration (Figure 1). The system also incorporates a moving average filter in the Arduino component for improved signal quality by reducing noise. The software includes multiple interfaces for communication and sonification. The communication part was developed in Processing, while the sonification software was programmed using MAX/MSP. The specific design of the interaction, which is tailored to each performance scenario, is facilitated by machine learning algorithms implemented using Wekinator.

The device architecture comprehends not only hardware/software components, but also the way to integrate it into the performance rehearsals and presentations. In this way the Joakinator is integrated as an additional performer. In each performance the position of the EMG-electrodes and FSR-sensors is re-defined based on the performer's movement style. The chosen position is determined through the transformation of the performer's movements.

For each project, the machine learning models are trained based on the movements to be executed by the performers. In Figure 2 we can see an example of the architecture designed for one of the projects, showing the multiple relationships among the different sensors placed over the body and how the machine learning system creates the bridge with the instrument's different sound-control elements programmed in MAX/MSP (Figure 3).

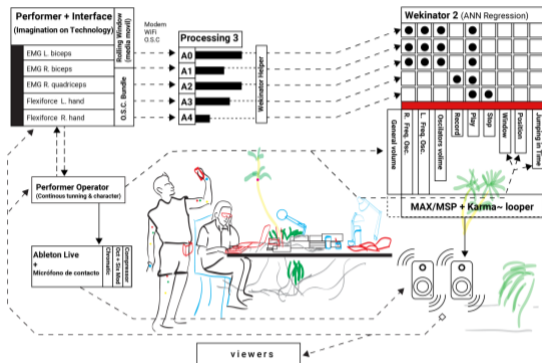


Figure 2. Architecture of the system for the performance Cuerpos Digitalizados 2020.

Joakinator integrates the body sensor interface, the communication system, the machine learning trained models, the sound instruments tailor-made and also the methodology of how to mix everything together.



Figure 3. Patch created in MAX/MSP for the project Lo Permanente, 2022.

3. MUSIC AND PERFORMING ARTS EXPERIENCES



Figure 4. Lattice performance, 2022 where the Joakinator was controlling audio and video.

Since 2019 Joakinator has been used in five different projects encompassing thirteen performances. Among them we have presented Lattice (2022) at Medialab-Matadero (Madrid, Spain), Lo Permanente (2022) at Teatro Pradillo (Madrid, Spain), Cyborg Interface: This is Not Your Body (2021) at Cuerpo Romo Festival (Madrid, Spain), A Latent Game (2019) at Tabakalera-Donosti and Birth of a Cyborg (2019) at Noche de Scratxe13 (Vitoria-Gasteiz, Spain). In those projects we have explored different applications for the use of Joakinator, such as creating and embodiment of the media material (sound/video) in the performers body, sonifying the movements of the performer with an interactive music system and exploring new dramatic narratives by the use of the body muscle to control recorded voice sounds.



Figure 5. A Latent Game, 2019.

SD In the project Posibles Presentes the performer's body controls an interactive system based on voice recorded samples, that speaks of certain theoretical and subjective notions. The configuration for this performance made it possible to explore randomly the different samples triggered by the FSR sensors and control the distortions of the sound through the tone muscle activity and the balance of body weight. This architecture has produced the feeling that the sound material is part of the body, because when you strengthen a muscle, it produces a direct influence on the sampler you are listening to. This shows the potential of Joakinator for transforming body-muscles into an instrument.



Figure 6. Lo Permanente performance, 2022, Madrid.

Lo Permanente performance uses voice recorded samples on the fly and pre-recorded sounds of voice, foley effects and environments (Figure 6). Usually, the signal from an EMG sensor has a very variable behavior because it is related with the biological state of the body, which is in continuous change. Having that in mind we created the interactive architecture of the

performance to embrace and enhance this characteristic. In this project we found two main effects in the use of the Joakinator: the first was that creating a direct relationship with the sound material and its control with the muscle-tone generates a new point of view of the material itself, the second effect was that the audience seeing these relationships have also expressed a surge of creative thinking about body and technology. This is relevant for the NIME's community because it opens new forms for music/performing arts composition and dramaturge.

4. RECENT CONTEXT

SD In the BODYinTRANSIT project, we are investigating the capacity of Joakinator to transform body perceptions. People's bodies do not often change quickly, but how people perceive them is actually highly malleable [1], as evidenced by neuroscientific studies demonstrating continuous updates of body perceptions through sensory inputs to the brain [2] [3]. Recent works have shown that perceptual illusions of body transformations, such as elongated arms or altered body size, can be created using sound [4] [5]. In this context, the sonification of body movements with metaphorical sounds like water, wind, mechanical gears or musical notes, has shown its potential to also transform body perceptions (e.g. feeling stronger), movement perception (e.g. movements appearing more fluid or effortless) and proprioceptive awareness, as well as to affect movements [6] [7].

We have started to probe the potential of Joakinator to transform body perception in a workshop with professional dancers, a population that often experiences negative feelings about their body capabilities or image [8]. The workshop explored how different wearable sensorial technologies, among those Joakinator could affect the perception of their own bodies. Four participants in the workshop explored the Joakinator with two sound conditions: an electric buzz and musical notes, both activated through muscle tension. The participants performed embodied explorations of Joakinator, moving and dancing with it to experience first-hand how the Joakinator mediated their body perception. Participants were asked to report on their experience through interviews and body maps [9], a blank silhouette of a human body where people can draw sensations where they have felt them in their body. Qualitative insights from this study show that the Joakinator positively mediated the participants' body perception, helping them become more aware of their muscle tension and their capability to activate particular muscle groups. Interestingly, the different sounds elicited different emotional responses in some participants: while the musical notes sound was found pleasurable and thought as a tool to foster creativity in the dance movements, the electrical sound was found to overwhelm some participants, prompting negative body perceptions.

These preliminary results show the potential of Joakinator to impact body perception but also point to the need for future research studies investigating the differences fostered by different sounds of the Joakinator in body perception.

5. DEMO

SD In NIME-2023 we want to present Joakinator as an open-source interface for sonification and interaction to explore body perception transformation. We will invite visitors to experience the device firsthand, wearing the sensor on their own body, and to observe others using it, as spectators. The demo will involve exploring two different sonifications, one of metaphorical sounds and the other with an interactive musical system which uses the stochastic algorithm for notes generation [10] and the

Real Time composition Library from Karlheinz Essl¹ for rhythm generation. Both systems will integrate machine learning models pre-trained for the previous performances.

We expect this interactive demo to foster new reflections and insights on Joakinator's capabilities to transform body movement and perception through the sonification of muscle-tone and force. We are particularly interested in insights from the NIME community, due to the attendants interest and expertise on new musical interfaces for musical expression. We intend to interview visitors to our demo through short qualitative interviews. We will also invite people trying the Joakinator to capture their embodied experience in body maps. Finally, we will use the opportunity to demo Joakinator at NIME to network with attendants and explore opportunities for future research and artistic collaboration.

6. ACKNOWLEDGMENTS

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¹ RTC-lib is a library for MAX/MSP written originally for Karlheinz Essl, composed by different objects for real composition techniques <https://www.essl.at/works/rtc.html>.