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# *Vibez*
# A Small Sense of Presence at a Distance

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Abstract
The paper describes a performance by live coding duo ALGOBABEZ in which they communicate telematically using biometric sensors and haptic devices. Inspired by the recent relocation of one of the band members to Australia, ALGOBABEZ are interested in how they can recreate a sense of the other's physical presence in performance and/or what additional data they could share to build a sense of empathy between performers. As algorithmically inquisitive beings, they are also interested in how algorithms may disrupt, disturb or subvert this process, and give the opportunity for performer's to actively adjust the honesty level of their biometric data stream.

Keywords
Biometrics
Haptics
Telematics
Live coding
Algorithmic systems
Improvisation
Presence

## Introduction

Vibez is a telehaptic live coding performance where performers share their biometric signals across the internet with algorithmic intervention. In this project, several streams of ongoing research intersect: haptics, biometrics, telematics and algorithmic systems. In Vibez we expand on our previous research using these technologies in performance, and contextualize ongoing research at SensiLab in haptic devices for social cohesion, in a specific performance context. We combine these interests with the aim of creating a sense of embodied collaboration at a geographical distance, exploring how we can extend our senses to negotiate a reduced bodily presence and situating our research in the needs of an evolving performance practice.

ALGOBABEZ are a recently geographically separated, transcontinental Algorave duo who, until recently, were regularly performing in a co-located live coding collaboration. We embarked on this research project in an effort to find technical solutions to performing at a geographical distance. In recent months, we have been performing telematically at raves around the world, sending one physical body to the performance space while beaming in the audio waves of the other half of the duo over the internet. In this project, we have been working on methods to extend this sense of trans-location, by mechanically replicating[1] ourselves through sensors and vibrations.

Building on previous work (e.g. *BabeNodes*, a system embedding sensor data related to audience dance activity into the sound generation), in *Vibez*, ALGOBABEZ perform with a networked sensor/actuator system developed to incorporate biophysical data into telematic performance. Through this, we embed a greater and extended sense of physicality into performance, and share with each other, and the audience, a representation of our levels of stress, moments of stasis and general head-bobbing enjoyment. We use sensors such as Heart Rate and Galvanic Skin Responses to detect biophysical markers of stress and enjoyment, and accelerometers and key-presses to detect and amplify physical interaction with the sound and interface (keyboard).

In collaboration with researchers at Monash University, we have developed haptic armband devices which amplify these biometric signals through pressure and vibration. We have integrated a set of algorithms with this hardware which translates the incoming data into a vocabulary of haptic sensations, making use of the tactile modalities available in the armband. The data is shared telematically via a remote server, so that each armband receives the biometric data of the other performer.

Responding to ethical implications of the performance (e.g. biometric privacy), and the mediated nature of haptic sensation at a distance, we also implemented algorithmic means to subvert the process. The performers have the option to switch the armband of their collaborator to conveying different levels of randomised information ranging from unmodified data direct from the sensor inputs to entirely random data. As is standard practice in live coding (See Fig. 1), the performers project their code interface (Brown 2007), however we also augment this information by using the sensor data to generate visuals relating to mood and mediation.

## 1.Background

Systems for improvisation are negotiated by performers bodies in the critical moment of performance. They can work to constrain a performer, facilitate a (new) collaboration or reveal a different way of negotiating or experiencing a performance. Many systems are motivated by presenting opportunities for performers to experience new challenges (through instability or pushing their physical limits), novel interactions or controls, and representations performance elements in novel ways. All these approaches work to reveal new ways of knowing through and in performance. In this section, we situate *Vibez* within the field of improvisational systems and provide context to its development.

1 Though fully engineered, self-aware replicants (Fancher and Peoples 1982) are beyond our technical capabilities, we propose through this research that some aspects of humanity may be replicated by circuits and data.

The design of our system intersects several areas of research and technological development which impact presence in digitally mediated performance. This investigation grew out previous experiments with embodiment in live coding (Armitage and Knotts 2017), and experiencing a sense of loss of connection when transitioning to performing through telematic technologies. Presence is of particular concern in the context of our current performance setup as outlined through this section.

Our approach to interrogating presence in this project centers around using interventionist technology to produce tactile sensations that draw the performer's focus towards awareness of a collaborator. Digital performance tools exist on a spectrum of embodiment, where highly embodied tools typically induce a continuous form of interaction with sound and instrument, and highly cognitive tools (such as live coding) introduce friction in the interaction between performer and sound (Sa 2017). Though Csikszentmihalyi's theory of flow states (Nakamura and Csikszentmihalyi 2014) proselytizes uninhibited interaction with tools, and is often cited as an ideal for improvised creative expression, Rose (2014) suggests that discontinuities and frictions in improvisation can work to bring the performer's attention back in to the context and present moment. In collaborative improvisation this can be an important catalyst to returning attention to working in a mode that foregrounds co-development of a performance narrative (Gifford et al. 2017). Initial experiments on SensiLab project *Improvisational Intimacy and Haptic Interfaces* revealed that haptic devices have the potential in digitally mediated performance to break performer focus on the interface and signal a change point in improvisation to a collaborator. In this paper, we explore how awareness of the physiological state of a long-distance collaborator may feed into working more fully in this 'collaborative mode' through perceptions of stress and activity of the other performer. We also propose that sharing biometric signals coupled with activity levels may help to facilitate understanding of activity levels and contribution from the other performer and build empathy between distant collaborators e.g. by highlighting when reduced activity may be due to technical problems.

Live Coding performance practice foregrounds human interaction with technological processes, and centers exposing the process as integral to performance. However, emphasizing the technical often comes at the expense of the embodied/physiological process. Live coding already implicates bodies in interesting ways and this is something that we have explored individually and collectively (Knotts 2016; Armitage 2016). With our shared interest in process, we were interested in exploring the human biological processes alongside the technical processes revealed through code projection. Through the co-creation of sound through code, live coders are performing complex relationships with machines and demonstrating technical expertise through the banal activity of editing text. The combination of large scale projections and bodies behind poorly-lit booths in Algorave performances could be seen to displace the body and its movement into the visual representation/projection. The cognitive load of live coding is somewhat higher than in embodied performance practices (Sayer 2016), making peripheral focus on collaborators and factors beyond the immediate needs of coding more difficult. Awareness of surrounding and contextual factors such as audience and collaborators can be reduced for large portions of performance due to the central visual focus on the screen. The mundanity of the 'act' of live coding, navigating code and de-pressing keys, causes some performers to attempt explore mitigating the cognitive load (i.e. preparation or terse languages) or embellishment of it through visualization.

As performers, we find that the pressures of high concentration on coding activity means the we often don't feel present and connected in the collaboration. What brings us (back) together are fatal or highly disruptive errors—where verbal cues are necessary.[2] In the current formation of ALGOBABEZ we have the additional hurdle

2 Examples of where technical friction has structured our communication and musical output and informed our collaborative practice include a high-profile gig at Liverpool Philharmonic: http://www.getintothis.co.uk/2017/02/nik-colk-void-klara-lewis-algobabez-philharmonic-music-room-liverpool/. Limited sound check time and network issues prevented us from having a reliable clock sync. During performance we each restarted our systems, which involved negotiating appropriate times to do this with the other performer and providing audio cover while the other performer's system is down.

*Figure 1. A typical ALGOBABEZ co-located performance setup (left). Knotts testing a prototype biometric sensor wristband (right).*

of performing telematically. This further reduces the awareness of the state of the other performer. Attention to collaboration is focused solely on the audio output of the other performer, and occasional messages via internet chat where needed—e.g. informing the other performer of a system crash. This is a very different sense of presence to that in co-located performance where you can use verbal, visual and physical cues to sense the other performer's emotional/physiological state. Playing telematically, we have found it challenging to engage with chat as our coding environment immerses the visual, and audible notifications are turned off to avoid sonic disruptions.

Haptic technologies present an opportunity to create new tactile experiences when collaborating within a digital space. These devices have been applied in consumer electronics to heighten a user's bodily connection within a virtual system (in gaming) or as a form of notification to a digital communication (mobile phone). Other haptic devices allow users to gain a tangible sense control whilst kinaesthetically interacting within a virtual system to form a sense of presence of a distant other, or 'co-presence'. These systems are designed to remove an individual from their physical environment and transport them to the virtual space. In such applications, haptic representations are often designed to reflect real life interactions that can be measured and recorded, then simulated on a mechanical device. An example of this is the 'PHANToM' device, whereby users can telematically input and output gestures—allowing human to human communication that is mediated via touch (Paterson 2008). This replication and remediation requires expensive hardware systems, and approaches the haptic as a direct representation of exteroceptive motion.

Armitage (2017) discusses how haptics can facilitate new tactile relationships in performance, extending touch beyond the mimetic and representational to facilitate new modes of 'knowing' through performance. In this work the haptic, used telematically, facilitates a sense of presence at a distance in collaborators. Turchet (2017) suggests the need for haptic communications across networks to enhance inter-group communication and communication between performer and audiences. This performance system is using the haptic to communicate an element of a performer's emotional state through bespoke haptic mappings. In *Vibez,* we are looking to haptics as a means of rendering of emotion—something that is embodied. In this space, the haptic becomes more abstract. It has the potential to facilitate an intimate performative connection through an immersive and embodied experience.

To begin to understand the emotional state of a performer, we need to consider some way of translating metrics relating to their physical body into something machine-readable. Biometric sensors offer an affordable means to detect physical markers of interaction with an interface, through this we can detect physiological symptoms of emotions such as stress and enjoyment.

In a previous ALGOBABEZ project, *BabeNodes*, we used sensors to detect markers of audience dancing to control aspects of the music. This included a Heart Rate sensor which audience members could attach to their fingers to trigger tempo changes and distance sensors which triggered samples. In this context, the heart rate sensor was most important in building a sense of connection with the audience, building a feedback loop between music and dancing, through bodies and physical interaction with technology. Beyond this, the use of technology situated in the audience, solidified the technological foundation of the performance, making it solid and touchable for the audience and not just ephemeral, complicated, ungraspable.

The Sacconi Quartet's work *HEARTFELT* explores touchable technology, combining biometrics with haptics, in doing so connecting the audience to the physiological processes of performance:

The question is whether this heart-exposing experiment will do what the quartet hope—namely get the audience closer to the physicality of their performance in a way that will reveal new musical dimensions, or rather, give an insight into the players' individual and collective stress levels and performance anxieties around the challenges of performing Beethoven (Service, 2015).

In *Vibez*, we are interested in how these concerns may affect us as distant collaborators. We are using a number of types of biometric sensing to build a broad picture of stress and concentration levels of performers: Heart Rate (HR), Heart Rate Variability (HRV), and Galvanic Skin Response (GSR). These biometric factors have been shown to relate to physiological states including stress (Taelman et al. 2009). In Vibez we are interested in how awareness of stress states may add to the audio information, structuring how we perform, communicate with and respond to each other.

As performers we use algorithms to build, subvert, disrupt and dissolve process. When live coding we use this as a process for developing sonic structures, but beyond this we are interested in how we might explore interaction between collaborators with intrusive algorithms. Though we see biometric data as a possible avenue to extending communication where bodily presence is reduced, we also see that using this data as part of a performance system raises interesting issues around privacy. This aspect of performance is usually not shared, and performers are trained to counter the outward expression of stress during performance. We found it imperative to provide a possibility for the performer to subvert this process, so we implemented the simple mechanism of an 'honesty' slider. This allows the performer to increase or decrease the level of 'noise' on the biometric data stream. Part of our investigation includes interrogating the extent to which algorithmic noise impacts performer perception of presence and empathy built through biometric data streams, and whether it effects their level of comfort with publicly sharing this data.

## 2.System Design

*Vibez* is in the prototyping and development phase with completion of a refined system expected in the coming months. We have built and tested prototypes of the biometric sensor band and the haptics armband and are in the process of refining the data mapping through iterative testing. In this section, we describe how we implement the theoretical streams of our research in the system design, its constituent parts and the flow of data during performance.

The system is made up of several component software and hardware parts and a data flow structure that determines how they interact (See Fig. 2). The system includes: a biometric

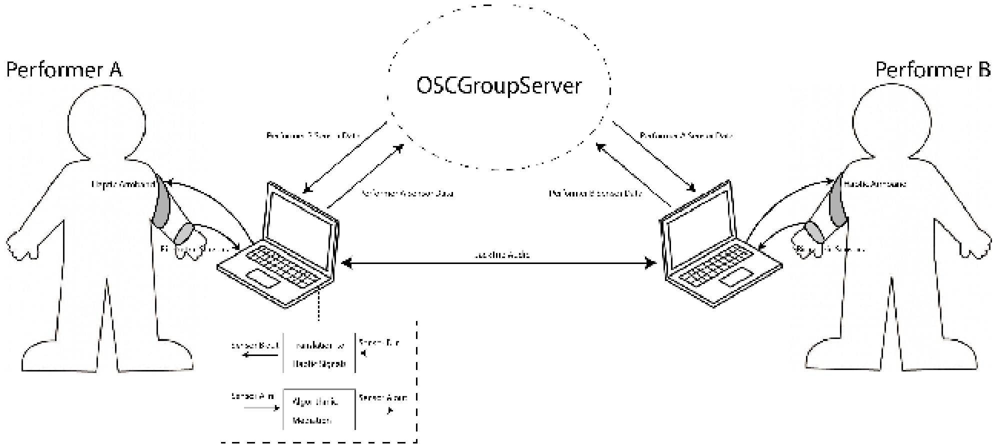


*Figure 2. Overview of the system and data flow.*

sensor band which attaches to the wrist; a haptic band, which attaches to the upper arm; a network server which manages the transfer of data from one location to another; a set of algorithms written in SuperCollider which control the data flow, mediation and haptic actuation; and a simple visualisation which communicates the system state to the audience.

## 3.Biometric Sensor Armband

The biometric sensor wrist band (see fig. 1) consists of a HR sensor (pulsesensor.com), a Grove GSR sensor and an accelerometer attached to an elastic wristband which fastens with Velcro. The sensors are connected to an Adafruit Feather. Though more accurate sensors are available, this setup was chosen over professional grade sensors because of the ease of integrating all sensors into a single band and the availability of Arduino libraries. Because the performers need to interact with the computer keyboard throughout the performance, the armband is designed to not restrict arm or hand movement and to be relatively unobtrusive. The sensors send a constant data stream to the mediating algorithms during the performance.

## 4.Haptic Armband

Haptic systems require several components including microcontrollers, drivers and the haptic actuators themselves. Due to the nature of our collaboration, the control signal is coming from a laptop. These would need to be received by a microcontroller, to communicate with a haptic driver and generate haptic waveforms from the controls. A haptic driver circumvents the current limitations of microcontrollers to provide higher quality vibration output. In turn, the drivers control motors, or haptic actuators that render the inputted information as vibrations for the user. The haptic armband incorporates two vibrating actuators controlled by bespoke driver chips which are multiplexed to a wireless Adafruit Feather.

The motors are driven by a DRV2605, which was selected for two main reasons: firstly, it interfaces with both ERM and LRA motor types, at a range of operating currents and voltages, which is advantageous for testing and comparison purposes; secondly, it affords a wider range of bespoke controls including an integrated library of haptic effects. One DRV2605 driver can only control one motor independently so a driver is required per motor. To address individual devices through Serial communication, an I2C multiplexer is required as each DRV2605 has the same, fixed I2C address. We have used the TCA9548A multiplexer, which has eight bi-directional switches controllable through the I2C bus. This enables control of up to eight motors independently. The motors are encased in foam and embedded into a band worn on the wrist by the performer.

## 5.Network Infrastructure

The performance uses OSCGroups 'a system for routing OSC messages between a group of collaborating users' (Bencina 2013) to manage sending the data streams between performers. OSCGroups consists of a remotely accessible server and clients running on each connected machine, allowing us to use Open Sound Control to send data over the internet. The OscGroupClient library in SuperCollider, can then be used to set up responders to receive data from the server, as we would when playing on a LAN. Each computer sends the biometric data to the server using tags such as '\hr' and '\gsr'. The OSC responders on each machine listen for messages received by the server with these tags allowing us to send data from one computer to another via the remote server. Managing the data flow from within SuperCollider facilitates easy integration of the sensors and haptic actuators with our pre-existing performance system.

In the past year we have been experimenting with telematic setups for distributed Algorave performance practice. Live Coding systems such as Estuary (Ogborn et al. 2017) and Gibber (Roberts and Kuchera-Morin 2012) provide the possibility of long distance collaboration with local synchronisation, but are language specific and do not facilitate the integration of sensors and other hardware in the standard coding environment. For this reason we have been using audio streaming to facilitate collaboration, which supports continuation of our co-located performance practice with easy integration of our sensor system to enhance communication. We use JackTrip (Cáceres and Chafe 2010) to manage audio streaming, which on stable, high-bandwidth internet connections allows low latency streaming. We add latency locally in SuperCollider to offset any network latency to enable the output in the performance space to sound in time.


*Figure 3.Example of visualisation showing heart rate, honesty level and overall mood of each performer (left). Honesty Control fader set to 100% honesty (right).*

## 6.Interface

We programmed a slider control in SuperCollider (see fig. 3) which modulates the 'honesty' level of the outgoing biometric data. This simple interface was implemented to facilitate ease of use in demanding performance scenarios. The slider adds various levels of 'noise' to the biometric signal, from no noise at the 'full disclosure' end of the slider (this is the default setting) to entirely random data at the other extreme.

## 7.Visualisation

In order to communicate the biometric data and performer mediation to the audience during performance, we implemented a simple visualisation which represents these parameters through text and colour. The visualisation shows the overall mood of each performer as text. The honesty and heart rate values are also shown. We created gradients by mapping the mood to associated colours (outer side of gradient), and mapping the honesty values to a greyscale where white = 100% honesty and black = 100% noise (central side of gradient). Through this simple mapping audience members can easily perceive the performer emotional state and the amount of data mediation in play.

## 8.Application in Performance

In performances of *Vibez*, the two performers live code in SuperCollider in two different geographical locations, sharing audio via JackTrip. They each employ different approaches to live coding sounds, whilst Armitage uses SuperCollider to generate MIDI note, control and SysEx data that is sent to hardware synthesizers, Knotts writes software synths from scratch. During the performance, we each wear a biometric sensor wristband and a haptic armband. This allows us to feel vibration in relation to the activity levels, mood and heart rate of our collaborator.

## 9.Discussion

*Vibez* observationally addresses concerns pertaining to presence in telematic performance by extending inter-performance communication through data. This creates a physical connectedness through haptics and algorithmic mediation. We have discussed how biometric sensors can be useful in determining human emotional states, including stress, excitement and calm. Translating this data to the haptic allows it to be rendered as a form of heavily mediated touch. In this context, the haptic serves to implicate the body in the improvisational experience, bringing attention to the body in space and place. Considering the cognitive load inherent in live coding performance, connecting the tactile body allows new forms of communication that do not occlude the auditory or detract from the performer's visual immersion in the coding environment. With this, the system embraces elements of uncertainty—algorithmic mediation explicitly acknowledges the technological aspects of the performance and how we inevitably lose detail and nuance in the translation of biological processes and sensing through digital tools (Cadoz et al. 2014). We added a performer controlled mediation to subvert the translation process as an expression of this imperfection and response to the ethical implications of unmediated personal data streaming.

Although we are yet to test the system in a real-life performance situation, and acknowledge this may have a significant impact on physiological signals detected by the biometric sensors, we conducted initial tests of the system and recount observations from this above. A further system evaluation that will enable us to understand the significance of the haptic communication is in planning stages and will consider the following: how does the body react to error/uncertainty? How does the performer respond differently when they feel the stress of another performer?

## Conclusion

We propose that telematically activated haptic devices may provide an opportunity to develop a greater sense of presence between geographically distant collaborators. In addition, we claim that using physiological state as an input to the haptic feedback may aid with this empathy building by giving a small sense of the physical presence of the other performer. In this performance system, we explore this through the ALGOBABEZ method of disrupting spaces and processes and consider how algorithmic intervention can facilitate new modes of knowing in performance.


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