Hacking the Body 2.0: Flutter/Stutter

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Abstract. *Flutter/Stutter* is an improvisational dance piece, part of the *Hacking the Body 2.0* project, that uses networked soft circuit sensors to trigger sound and haptic actuators in the form of a small motor that tickles the performers. Dancers embody the flutter of the motor and respond with their own movement that reflects this feeling. This research explores using the concept of hacking data to repurpose and re-imagine biofeedback from the body. It investigates understandings of states of the body and hacking them to make new artworks such as performance and costumes. Through performance we aim to communicate to the public new ways to engage with their bodies and technology with intimacy and sensation embedded in wearables.

Keywords: Wearable tech and e-textiles, Performance, Sustainable garments, Ethical data collection.

Introduction

The *Hacking the Body 2.0* project explores using the concept of hacking data to repurpose and re-imagine biofeedback from the body. It investigates understandings of states of the body and hacking them to make new artworks such as performance and costumes. Through performance we aim to communicate to the public new ways to engage with their bodies and technology with intimacy and sensation embedded in wearables.

Flutter/Stutter is one piece within the larger Hacking the Body 2.0 research project. As such, dancers embody the flutter of the motor and respond with their own movement that reflects this feeling. The sensors and actuators, along with the garments they are embedded within, are bespoke designs by Becky Stewart and Tara Baoth Mooney that interact, influence and interrupt the dance and hack the body.

Context

The current technology fervour over wearable technology that collects users' intimate body data, under the pretense of medical or fitness monitoring, highlights that it is time that critical questions were raised. The ethics of corporate ownership of body data for consumerist agendas is rarely discussed beyond the fine print on these devices. More awareness and education on these issues, would potentially allow more access, ownership, and creativity in the use of one's own body data, and ways to express personal identity through this data.

This project questions how body data may be able to demonstrate who we are, through movement, through our physiology. How does access to personal data enable the performer to show their identity, rather than what is subscribed by the corporation making the sensing device? How can we explore these issues while enabling people access to their own data, especially in performance contexts, in order to interact with it?

The new iteration of the collaborative project *Hacking the Body 2.0* brings performers together to attempt to address the ethical issues around identity and data ownership when using wearable tech in performance. The project develops methods to use and hack commercial wearable devices, as well as making handmade e-textiles sensing devices for performance. As such, we aim to engage performers to access their own physiological data for personal use, but also to create unique and interactive performances.

Performance Investigations

The latest iteration of the collaborative project *Hacking the Body 2.0*, by media artist Camille Baker and media artist/choreographer Kate Sicchio, attempted to address the ethical issues around identity and data ownership when performers use wearable tech in performance. The project has used various methods to use and hack commercial wearable devices, as well as making handmade e-textiles sensing devices for performance as was done for *Flutter/Stutter.* As such, we aim to engage performers to access their own data for personal use, but also to create unique and interactive performances. This collaboration has been evolving since 2011, and the approach is influenced by previous projects in a similar vein, such as that of Thecla Schiphorst and Susan Kozel's *whisper(s)* project, as well as Baker's and Sicchio's individual PhD research projects, not to mention the haptic, biofeedback and wearable music performance works, such as those such as Loke, Donnarumma and Tanaka, and many others now working in this field. Yet this piece and its partner performance piece *Feel Me* (also part of *Hacking the Body 2.0,* but not discussed here), stakes out a singular new terrain in its exploration of ways to address ethical issues of data collection, use of the technologies to represent personal identities of dancers, develop non-verbal communication interaction methods and incorporating a live coding of the dancers by the choreographer into the work.

The goal is to: enable dancers to interact or respond to worn sensors and actuators; to instigate new movement 'dialogue' or interaction between performers; and to explore their identities. By using the technologies developed for gathering personal data, but circumventing corporate data collection, we facilitate direct communication between each body/dancer to create a conversation. At the same time, the choreographer can also intervene directly with and participate in the dialogue between dancers' bodies and their movement responses, by triggering the chimes directly for the computer controlling the interaction. In this way, the performers reclaim the data sensing and collection by using the technology as another tool to them help devise movement and co-create or choreograph performance works. This work puts into new light, the ethical issues of corporate ownership by putting the ownership back into the hands of the user. This in turn may be considered a critical act of making and confrontation of the issues of surveillance and data control.

In February 2016, we were able to take the project to the performance stage, with performances in London and Sheffield. *Flutter/Stutter* was performed once at each location in front of an audience. The choreographic side of the piece focuses on two technological aspects. These can be used as methods for both developing movement as well as a structure for improvisation. Firstly, the dancers were responding to actuators on their costumes and to each other through movement. By moving in reaction to these impulses on their body, the rhythm, timings and dynamics were affected in a feedback loop. A more subtle approach to movement was taken by the dancers, to reflect the sensation of being tickled on the neck by a ribbon on a motor triggered by the other dancer. The relationship between data and subsequent reactive movements by the performers is that touch on the shoulder pieces and the subsequent actuation responses are meant to initiate movement by the dancer receiving the vibration or tickle, as the response in the "call and response" non-verbal dialogue. Each dancer also has to take into consideration how to initiate the trigger of the actuation on the other dancer, as part of the "conversation" between them.

The second way the technology is repurposed into the choreography, was through the structure of the interaction design. The system was developed to adapt and provide several opportunities for user interactions by the dancers. The score for the dance improvisation was then structured around time and a variety of these dancer interactions. Each one led to a distinct moment in the piece and allowed the overall composition to build over time. The audience was able to understand the interactions not only through the expressivity by the dancers and the way in which they had a 'call and response' behaviour when activating the devices, but also by the sounds the garments also triggered, to create a improvised soundtrack of variously pitched reverberant chimes. The operating modes of the sensors and

actuator may not be clearly discerned by the audience through these pitched chimes, as the intention of the piece is not to make improvised music, but to allow the audience to understand that the interaction and the actuation is live and created by the haptics. We chose to restrict the system to use a single sensor and actuator at this point in the research due to funding and time limitations, but intend to introduce more sensor/actuators as the project progresses, in order to increase the performance potential in future iterations.

Wearable Performance System Implementation

The sensors and actuators were built into garments worn on one shoulder of each dancer and incorporated into a complete costume worn during performance. The network connecting the sensors and actuators utilised the infrastructure tools, emerging as the preferred protocol for 'Internet of Things' applications, while the visual design of the garments actively distanced itself from a technological aesthetic.

Figure 1. Images from performance of the piece in February 2016 in London, UK

Garment Design

The garments, which have been created for this research project, explore the idea of making and designing for interaction design through hacking. All garments can act as an interface between individuals and their immediate environment. This applies to both garments for performance and garments for everyday wear.

Like the acquisition of clothing for one off events, so too garments which are created for a specific performance or event can be rendered obsolete after the performance has taken place.

This collaboration prompted questions around the continued value of performative garments in a world which increasingly devalues objects. The challenges for the garment designer in this project were to create a modular garment which might contain within them the potential to become something else after the performances have taken place. A secondary challenge was to work with the interaction designer, Rebecca Stewart, to create a collection of garments which did not visually betray the technology embedded within them.

For the *Flutter/ Stutter* piece, pre-existing cotton t-shirts were used which were already owned by the designer, along with some cast off long-sleeved cotton t-shirts found in thrift stores, and were considered as raw material for a new manifestation of the material. The product development took place over a 4-month period, where the designer intermittently worked with the interaction designer and then each withdrew to work alone. The pieces needed to be flexible enough to make small changes if necessary, and also needed to have a solid structure. Thus, the modular elements were situated above the structure. These elements included the fabric sensor and embellishments, which acted as the ties to secure the garments on to the body.

As both artist and designer the aim was, through a deep engagement with the materials, to create something, through hacking, which was visually organic rather than technological, something which moved with the movement of those wearing them, and finally something which was inherently modular and re-purposable, and which could

potentially manifest as something else in the future. It was through the destruction of the original garments that a reconstruction of new garments took place.

Electronics Design

The wearable computing system consists of a collection of capacitive touch sensors worn on one shoulder of each dancer and a motor with a ribbon attached placed near the neck. The sensors and actuator on each dancer are controlled by a wifi-enabled microcontroller[1]. Each of the capacitive touch sensor electrodes are a single conductive thread sewn to the underside of a fabric pleat as seen in Figure 2. The electrodes are connected to a capacitive sensing chip[2] which handles the calibration and measurement of the signals.

Figure 2. Image from a rehearsal in Sheffield, UK of the dancers interacting with the textile touch sensors embedded in the pink pleated fabric.

The actuator is a small motor with an integrated planetary gearbox. The motor's circuit is constructed from conductive fabric mounted on a patch of black leather seen in Figure 3. A fabric ribbon is connected to the motor so that it rotates and brushes against the wearer's neck, causing a tickling sensation. For this reason, the actuator is referred to as a 'tickle motor'.

The microcontrollers connected to the sensors and actuators publish messages to the network whenever a sensor is activated by a touch - by either the wearer or the other dancer. The microcontrollers also subscribe to a feed to be notified when their motor should be turned on to rotate the ribbon. This system of passing around messages is implemented using the Message Queueing Telemetry Transport (MQTT) protocol. A program called a broker[3] is run on a server connected to the same local wifi network as the microcontrollers. A separate program that acts as another client of the broker, listens to the incoming sensor messages and redirects them to the corresponding actuator feed. This program also acts as a portal for the choreographer to intercept these messages and directly send her own messages to the actuators.

Sounds of reverberant chimes with various pitches are triggered when messages are received. The sound of the chimes is the entirety of the audio accompanying the performance. The sounds triggered are mapped to corresponding lines of conductive stitching in the shoulder pleats, giving the dancers some control over the sounds made and therefore another form of physical input in the interaction to enable the call and response dimension.

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[1] ESP8266 HUZZAH https://www.adafruit.com/products/2471
[2] MPR121 Breakout Board https://www.sparkfun.com/products/9695
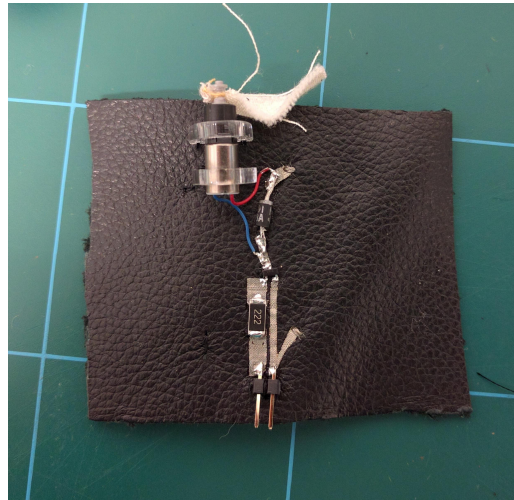[3] Mosquitto http://mosquitto.org/

Figure 3. Leather-mounted textile circuit of the tickle motor worn by each dancer to provide haptic feedback

This arrangement of sensors reporting to a broker and actuators responding to the same broker using MQTT is an increasingly standard architecture for networked devices commonly referred to as the 'Internet of Things' (Al-Fuqaha et at 2015). However, instead of monitoring air quality across a city or the contents of a refrigerator, our network is monitoring the actions of dancers within a performance and providing an invisibly-connected network with physically-realised endpoints.

Discussion

Researchers in recent years have been exploring wearable technologies from the mobile health dimension, but as Susan Elizabeth Ryan has noted in her recent book *Garments of Paradise* (2014:8), few are exploring the full potential of wearable technology in performance, let alone the other related issues of identity and body data ownership in performance. She writes:

> *Wearables in the context of performance present opportunities for exploring our relationships with our bodies and how we move them… [or how] communications interfaces, and other soft and sensory technologies allow us to experience or transcend our bodies, and how the concept of theatrical performance can be expanded in virtual space (2014:8)*

This collaboration addresses the issues, challenges and problems of developing methods of making and using handmade wearable sensing and actuation devices to access physiological data and create unique interactive performances. As such, we see this as way to draw in new communities, especially within performance, into the development, evolution of, and conversation around wearable technology and etextiles production, the sustainable fashion issues, data collection ethics, and in particular how these skin-based technologies might enhance performance creation, while making them playful and challenging.

Future practical explorations include: organising more performances in the UK and the US, continuing to develop different approaches to using wearable tech and etextiles in performance contexts, as well as making more robust custom wearable tech garments, embedded with both specialist sensors and actuators, that enable the performers to intervene with each other's expression using their body data. The ultimate goal is that performers engage with their own and other's body code to create new forms of 'live data performance', where the performer is initiating the interaction using the wearable devices to aid their interaction.

The overall long term direction of this project is to refine methods of working with performers, to enable them to control how they use the physiological data from their body or the data from another performer to interact and move. This will be developed through further iterations of the devices and garments worn, to enable them to interact and respond to each other and create a new movement 'dialogue'. In this way, the performers reclaim the data collection by using the technology as another tool to them help devise movement and co-create or choreograph performance works, and eventually with choreographer's role changing more to that of performance experience designer or artistic director, while the audience's role will change to part performer / part audience/ part choreographer. This circumvents and hopes to shine new light on the ethical issues of wearable technologies by putting the control back into the hands of the users, in this case, the performers and artistic director**.** This in turn is may be considered a critical act of making and confrontation of the issues of surveillance and data control.

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