Being-With

A Sound Performance for Motion and Stretch Sensors

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ABSTRACT

Being-With is a realtime embodied sound performance that involves two performers investigating notions of trust, collaboration and harmony. The project was realized over a 3 month research and creation process that involved prototyping, fabrication and sound design. The work utilizes motion and stretch sensors attached to performers and a rope and is guided by concepts described in Sonic Interaction Design, human-computer interaction (HCI), and Digital Musical Instrument (DMI) design.

Authors Keywords

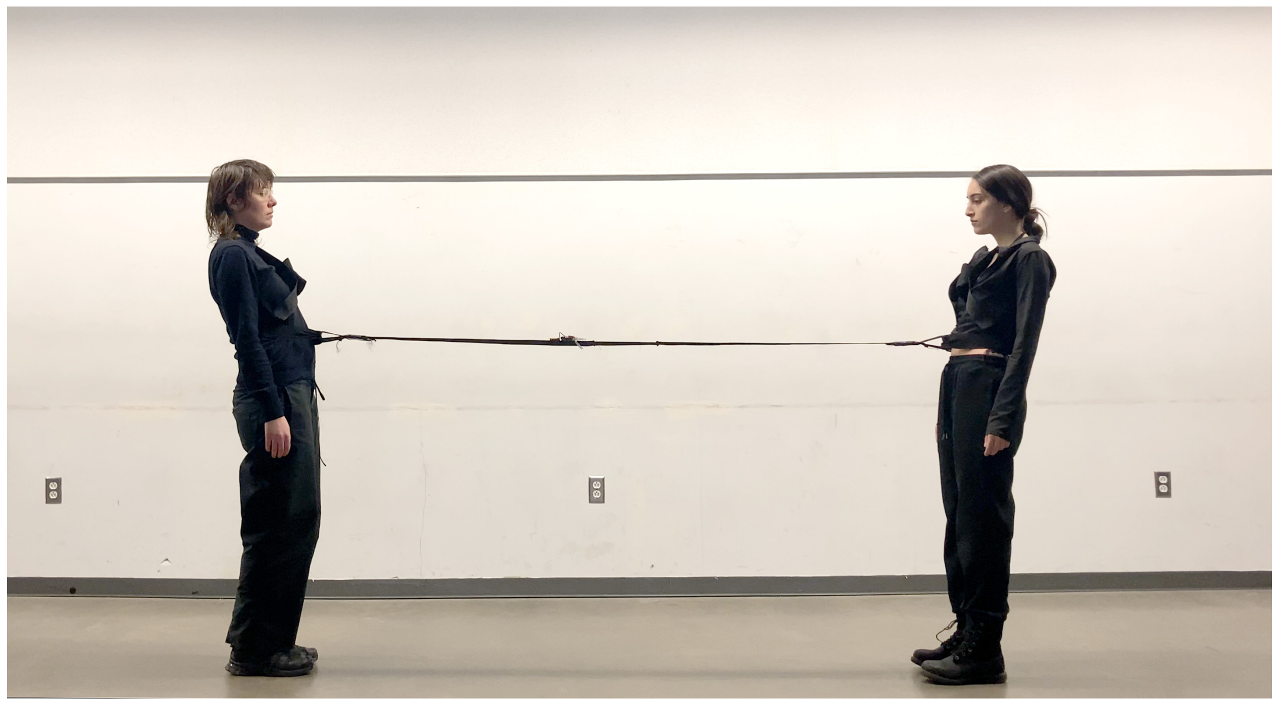
Sonic Interaction Design; performance; sound; motion sensors; stretch sensors

CSS Concepts

• Human-centered computing

INTRODUCTION

We set out on this project aiming to create a sound performance that was primarily concerned with notions of trust, collaboration, equilibrium and harmony between two people. We aimed to use sound and



movement to expose the inner and underlying effort it takes to reach equilibrium within relationships. To accomplish this and explore how to show these themes with sound and movement we embarked on a research and creation process that included researching pre-existing performances utilizing interactive sound and movement, iteratively creating hardware and software prototypes, iteratively testing sound design and sound mapping strategies and examining our own notions of what it means to trust another person. After 3 months of this process we created a performance entitled *Being-With*.

screenshot of the performance

Being-With is an embodied sound system and augmented performance that utilizes data from bodily motion to create a dynamic soundscape. The performance involves 2 performers each wearing a harness that they attach and detach to a rope. When the performers are attached to the rope (and thus, to each other) the soundscape varies. When the performers' collaborate to keep the rope still and in a sustained stretching tension a clear harmonious sound plays signifying equilibrium has been reached. Without both performers collaborating on keeping the rope still for a sustained amount of time there would not be the harmonious sound that plays and offers a moment of calm and conclusion to the performers' movement. Through collaborative stillness there is meaningful and harmonious sound generated.

CONTEXT

Our project sits squarely within a long history of computer music, sonic interaction design (SID), human-computer interaction (HCI), and Digital Musical Instrument (DMI) design. We also approached our research from an 'embodied interaction' framework outlined by Paul Dourish in his book *Where the Action Is*.

APPROACH AND METHOD

Design interaction in our performance is kinaesthetic-centered through measuring the movement of our individual bodies and the movement and tension of a sensor-enabled rope. This movement and stretch data is then turned into sound in real-time. Our approach and method to designing this performance system was guided by a problem space that was concerned with how to translate performer movements into sound. This issue is directly related to mapping, which is a concept that has been well documented and investigated by researchers in SID and DMI. Andy Hunt and Marcelo M. Wanderley provide a good definition for mapping, defining it as "… the act of taking real-time performance data from an input device and using it to control the parameters of a synthesis engine." (98, Hunt, Andy, and Marcelo M. Wanderley) [1]. We use this definition of mapping in our research and any reference to it in this paper refers to this definition.

Furthermore, developing a mapping strategy was important in our research because as Eduardo Reck Miranda and Wanderley point out in *New Digital Musical Instruments*; "The mapping of gestural variables onto the parameters of a synthesizer needs careful consideration because the relationship between them is far from obvious" (14, Miranda and Wanderley) [2]. Indeed, as we will explain in our prototyping section we had to go through many iterations of movement to sound mapping to get to a result that sounded meaningful and rich.

In designing our mapping strategy we heavily consulted Miranda's *New Digital Musical Instruments*. Notably, we decided to use what Miranda calls an 'Explicit mapping strategy' which can include:

> *a. One-to-one, where one synthesis parameter is driven by one gestural parameter*
>
> *b. One-to-many, where one gestural parameter may influence various synthesis parameters at the same time*
>
> *c. Many-to-one, where one synthesis parameter is driven by two or more gestural parameters* (Miranda and Wanderley, 16) [2]

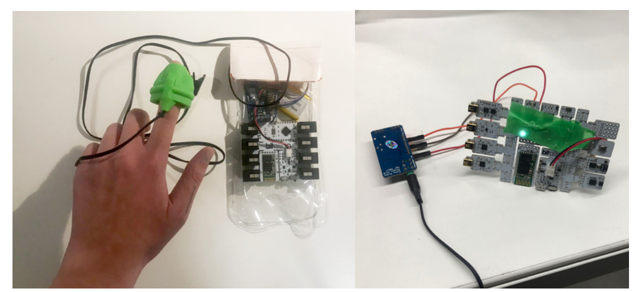
We ended up using a combination of these sub-strategies in the creation of our work and the ones we chose were guided by the movements that we would perform in our performance. Ultimately, our mapping strategy was in part informed by our performance choreography and in part informed by the sensors we chose to measure movement and stretching.

PROTOTYPING

Our prototyping process was long and iterative and started with us determining what type of sensors and microcontrollers we would need to realize our project.

From Biosignals Towards Motion Signals

A few early candidates for sensors were the myoWare muscle sensor [3] and the pulse sensor [4] as we initially wanted to measure biosignals from each of the performers.



pulse sensor and bitalino that we decided not to use

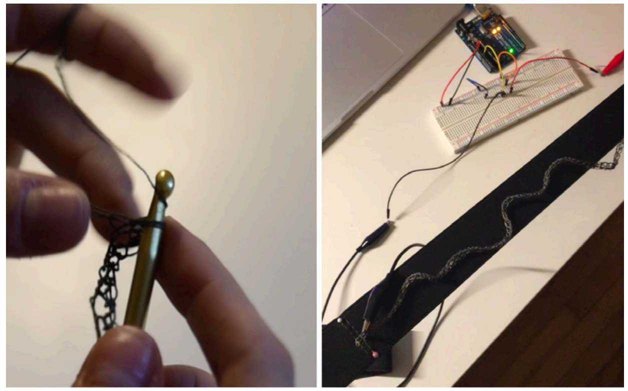
We ended up not using these sensors as our project became more focused on motion analysis rather than biosignal analysis. The reason for this switch was that we found motion sensors to be more reliable for our purposes and also allowed for quicker prototyping as generally these values remain more stable over a variety of circumstances.

Rope and Stretch Sensor Design

A major part of our project involved creating a stretchable rope to measure tension between the two performers. We experimented with stretchable flat materials, different lengths of conductive threaded lace, and different resistivity values of resistors to get good values from this diy sensor. Notably getting stable and consistent values from the stretch sensor occupied a lot of time. These values were sent straight to Max/Msp without any processing so determining the best way to use these values took up a lot of time.

To build the circuit for the conductive thread we looked at projects like [5] and determined how to build a simple circuit that gave analog values from stretching a knitted conductive thread.

testing the stretch of the thread and rope



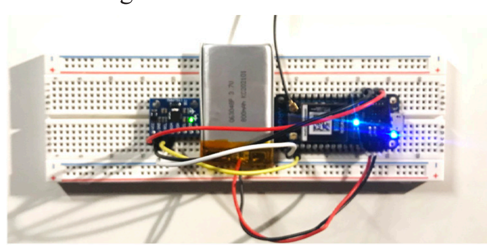
knitting conductive thread and testing a circuit

Arduino Uno to Particle Argon

While our original prototypes were built using an Arduino uno we knew we would have to migrate to a wireless capable microcontroller to allow for us, the performers, to move freely in an open area without being constrained by wires. We ended up using 3 Particle Argons to communicate sensor data to Max/Msp over OSC.

Performers Motion to Sound

To get motion data from the performers and the rope we decided to use accelerometer data from the GY-521 sensor. X, y and z values were sent directly into Max/Msp and were analyzed using the Gestural Sound Toolkit [6] for whether or not a person was moving or not. If a person was moving then a note on a synth would play. We designed 'harness modules' that detect a person walking.



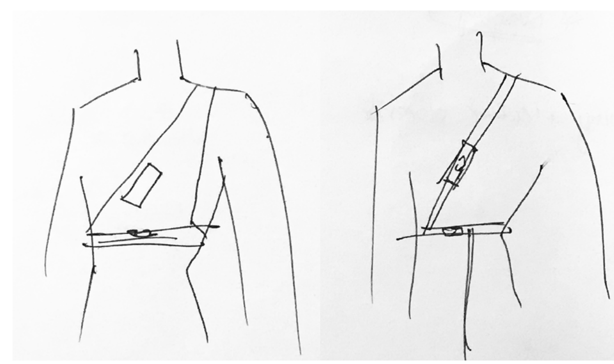
prototype of a 'harness module' on a breadboard

Rope Motion and Stretch to Sound

The circuitry for the rope was designed similarly to the harness modules but with the added addition of our stretching sensor. The GY-521 values were also analyzed for motion but this motion analysis had a little more complexity because we used gating and thresholds to enable 2 levels of motion sensing: a) slight motion b) vigourous motion. This allowed us to alter the sound based on amount of motion of the rope. We used the Digital Orchestra Toolbox's object 'dot.deviation' [7] to help us determine when the rope was being stretched. The values of the stretch sensor were constantly changing their max/minimum values in unpredictable ways so by measuring the standard deviation of the stream of sensor values we were able to determine when the sensor was not stretching versus when it was. From here we could also use logic to determine how long a stretch had occured which became a big part of our sonification.

Harness

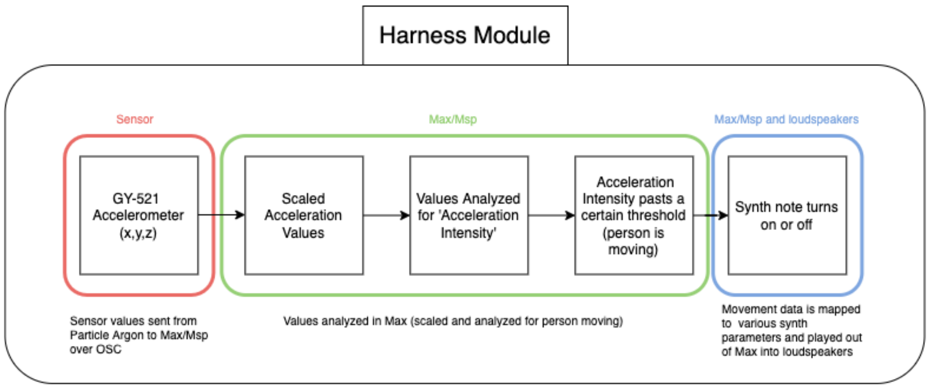
To attach ourselves to the rope and to also attach the motion sensors to our bodies we designed harnesses with clips that allowed us to easily attach/detach ourselves to the rope as well as carry a motion sensor (harness module). We experimented with different fabrics and clip positions to determine the best design.



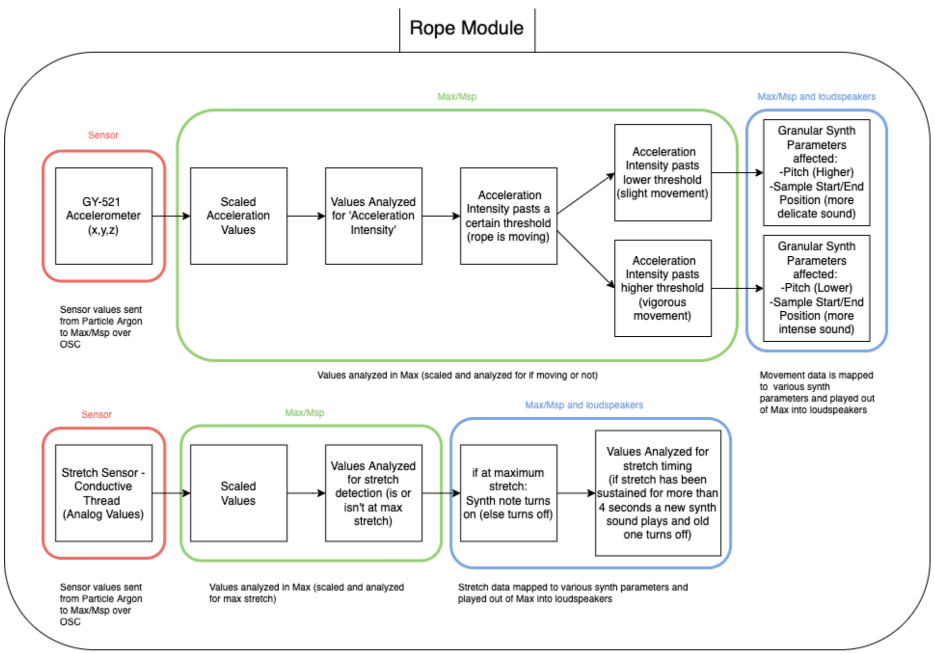
initial sketches of harnesses

SOUND + MAPPING

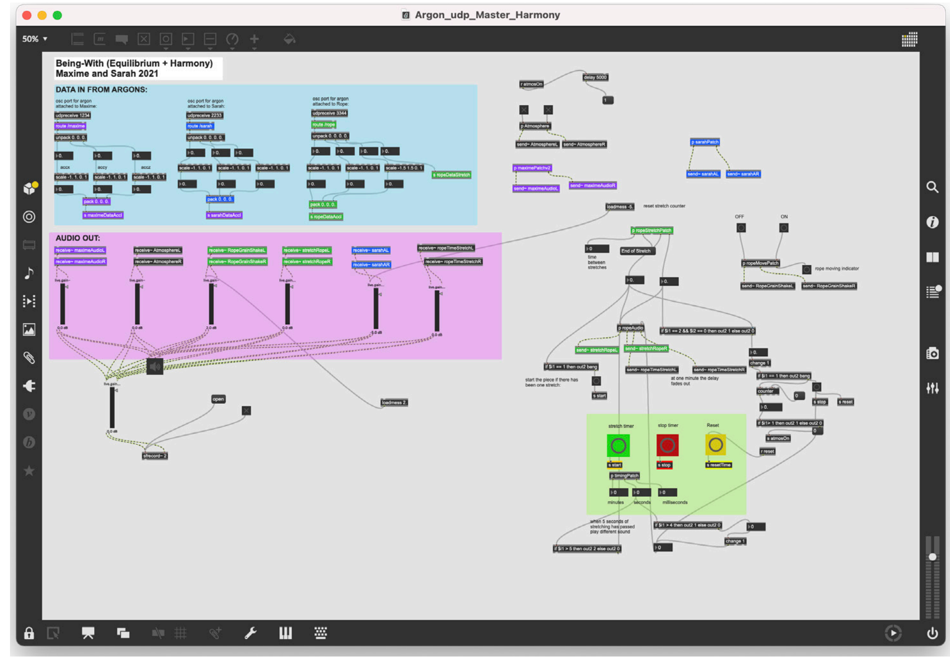
The final motion and stretch to sound mapping is outlined in the following diagrams. A combination of granular and vst synths are used to create the sound and all logic for timing and when to play particular sounds is coded within Max/MSP.



harness module's motion to sound mapping



rope module's motion and stretch to sound mapping



screenshot of our max patch

PERFORMANCE REHEARSAL

We based our movements on our initial concept of wanting to portray equilibrium and collaboration between two people. As we ironed out our choreography the sound also changed to reflect our movements.During our rehearsals we noticed that as our movement altered the soundscape the soundscape also informed our movement. There was a level of improvisation with the coded sound interaction as timing, repetition and fast vs. slow movement all had a noticeable effect on the soundscape. This improvisation allowed for new motions and new combinations of sound to develop.

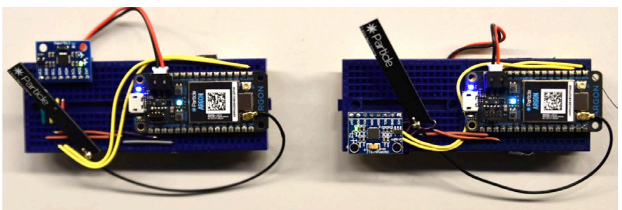
FINAL ARTIFACT

Upon researching and prototyping, the final artifact is considered to be the highest fidelity version in our project. The modules mounted on the performers are neatly hidden, and the rope module is intentionally left exposed to enable view of the stretching sensor.

The hardware for *Being-With* includes:

- 2 fabric harnesses worn by each performer.
- 1 stretchable rope that is attachable to the harnesses.

- 2 ‘Harness Modules’ that each consists of a Particle Argon and a GY-521 sensor placed in a pouch on each performer’s harness.
- 1 ‘Rope Module’ attached to the stretchable rope that consists of a particle argon, GY-521 sensor, and conductive lace sensor.
- 1 laptop running Max/MSP.



completed harness modules

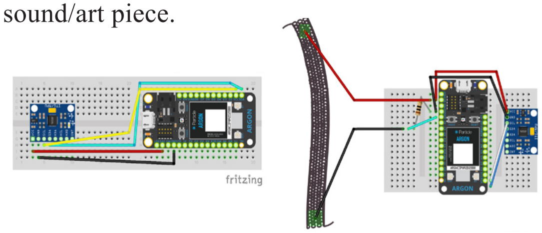
final harness

DISCUSSION

While we believe we achieved our goal in showing harmony and collaboration between people through sound and movement, we acknowledge that the performance could have been improved in many ways. The sensor data acquired from our movements could have included gyroscope input which would have determined our orientation, adding another dimension to the sound. The data-to-sound mapping could have been enhanced further by adding more parameters rather than simply triggering a sound for some of the data. We also agreed that the choreography of the performance was limited since we are not trained dancers that are able to gracefully perform harmonious moves together.

FUTURE WORK

In the future, we discussed choreographing a longer and more dynamic performance and hiring professional dancers that are able to perform the more intricate movements that we wouldn’t. We also want to create a performance that uses more complex and nuanced sound mapping, which would yield better results in terms of sound. This would enable us to couple the sounds with a larger variety of movements while keeping the element of improvisation in mind, resulting in a more engaging sound/art piece.



fritzing diagrams of harness and rope modules

final rope

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