Stream: synergy meeting vol. 2

Dani Iosafat - a.k.a Dani Joss [1]

[1] Die Wolke art group, Thessaloniki, Greece
danijoss@yahoo.com

Abstract. Stream, by Die Wolke art group, is an interactive performance project based on structured improvisation. Inertial and mechanical sensors on the body of a dancer transmit motion data wirelessly to computers for processing and use for musical control, modulation, or other algorithmic input by a musician on stage. A kind of information feedback loop is created as the dancer further reacts to the sounds, creating fertile ground for improvisation and an experimental method of discovering connections between gesture and sound.

Keywords: Interactivity, contemporary dance, sensors, wearable electronics, improvisation

Description

Stream is an initiative by Die Wolke art group meant to explore the applications of interactive technology within the realm of the performing arts in general, and contemporary dance in particular. It seeks to do so by inviting artists, designers, technologists, and performers to collaborate in an improvisational context. The proposed performance is part of the second round of meetings, and focuses on the use of inertial and mechanical sensor interfaces and interactive dancing performances by dancers Drosia Triantaki and Enora Gemin.

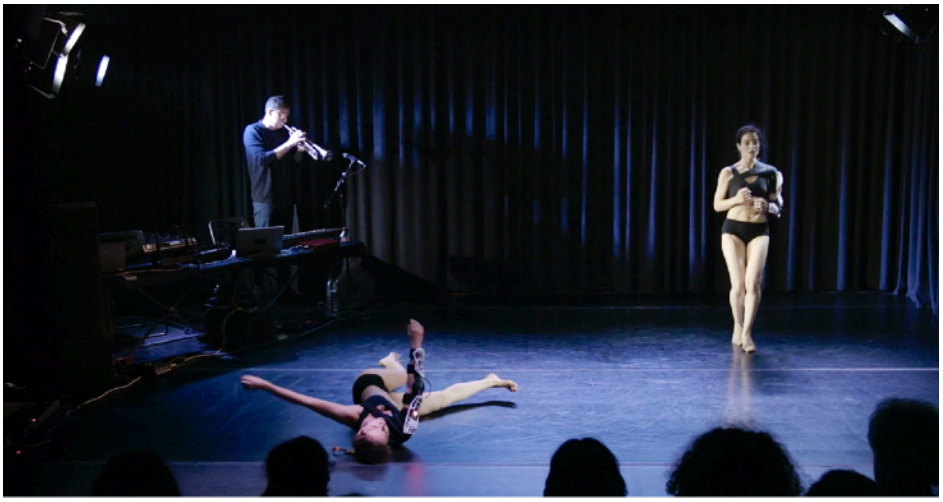

Fig.1. 4’ abstracts (https://vimeo.com/401601863)

The creative process was initiated with a prelimary phase, an exploratory 10-day meeting with the dancers and the development team, during which the performers familiarised themselves with the interfaces and the sonification of the motion data, developing a kinetic vocabulary which emerged through the interaction of the artists with technology and was in line with the concept and the interactive experimental character of the performance. Following the experiences of this first stage, the full team was assembled some months later, including the musicians - Tim Abramczik, Nikos Tsavdaroglou and Dimitris Dalezis. During that period, each of them prepared a 15 minute piece for presentation on stage.

The project was supported by the NRW Kultursekretariat, Düsseldorf, and the program *Transfer International.* The original presentation took place on November 23 and 24, 2019.

System overview

The interfaces for the performers are based on orthopedic braces that fasten to the upper arm and forearm, thus limiting rotational forearm movement, but allowing a measurement of the elbow angle. This is achieved via a standard potentiometer on the joint, whose shaft is connected to the moving part of the brace via a heavy wire.

A 9-degrees-of-freedom inertial sensor, commonly referred to as an IMU, is installed on the end of the forearm, just above the hand. The sensor of choice was the BNO055, in an implementation by Adafruit branded as an “absolute orientation sensor”. The advantage of this board is that it combines and filters data from three individual sensors, a 3-axis accelerometer, a 3-axis gyroscope, and a magnetometer, resulting in the possibility to separate the gravity and linear acceleration components. This, in turn, results in the ability to work with motion and orientation independently.

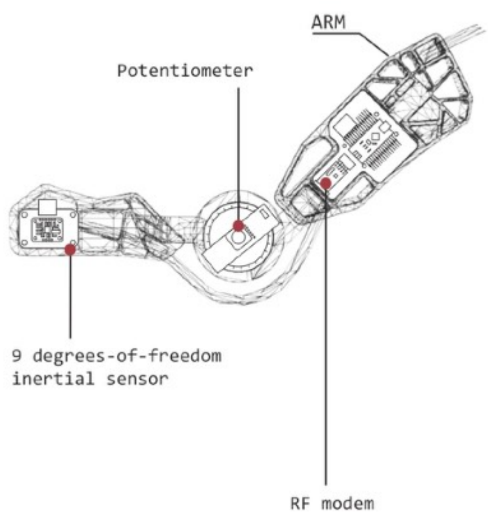

Fig.2. Design diagram of the interface

The sensor is connected digitally to an Arduino Nano board on the upper arm part, along with the potentiometer. The data is read and transmitted in realtime to receiver Arduino boards via the nRF24L01 family of 2.4GHz RF transceivers, chosen as a compromise between available data bandwidth and low power consumption - thus also longer battery life. This decision illustrates one of the earliest design decisions that were made: the system needed to be practical, robust, and performance-ready in the real-world. For performance reasons, each transmitter had its own receiver board: this allowed the full bandwidth of the system to be available for each interface, but would otherwise be unnecessary for less data-intensive applications.

The receiver Arduino boards collect the data frames, pack them into a simple network message in the Open Sound Control protocol (OSC), and transmit them using ethernet to a router, to which the computers are also connected. The network packets use the broadcast IP adress, so that multiple machines can listen simultaneously.

Each OSC message corresponds to a sampling frame, and includes the following information, in order: linear acceleration, rotational velocity, gravity vector, and raw measured acceleration, all in 3D, the 3 Euler angles, plus the single potentiometer value. The packets are received by one or more computers running Supercollider. A few special classes were written to rearrange the message array to vectors, and then store them in container objects that also maintain a history buffer, which they can use to obtain statistical information such as mean value and standard deviation, apply a median filter for noise reduction, calculate the first derivative, and more.[1] A Biquad class was also designed, to allow language-side arbitrary data filtering.

Depending on each musician's working method, style, and programming experience, the data was either passed directly to them, along with the Supercollider classes for assistance, or preprocessed according to their instructions and forwarded to them already mapped to their specifications, either as OSC or MIDI. Of course, the process was highly experimental, but the extensive array of tools available in Supercollider, along with the convenience classes designed, made it straightforward and fast enough so as not to interrupt the creative dialog between performer and musician. Thus, the system stayed on the background, performing all necessary mappings and calculations as per the ever-changing desires of the musicians, thus enabling a truly interactive working environment.

Performance and Improvisation

The intent was always to establish a creative platform, a kind of system with its methods and tools, that would facilitate the interaction between the performers and musicians in real-time, while also enabling improvisation. There were a number of implementation decisions that were crucial in this regard.

The first issue is that the more the sensor responses get refined and tuned to the motion and result, the more interactive the piece looks, and the less reusable the work becomes: a highly specific, sensitive, mapping can rarely produce enough variation for reuse. On the other hand, a generalised one-to-one mapping to, say, a secondary parameter such as global filtering or effects modulation, is too broad to feel interactive or, indeed, remain interesting for more than a few seconds. A careful balance was struck, often using broad responses for predictable outcomes and more detailed work for more forgiving elements, such as textures and ornamentation.

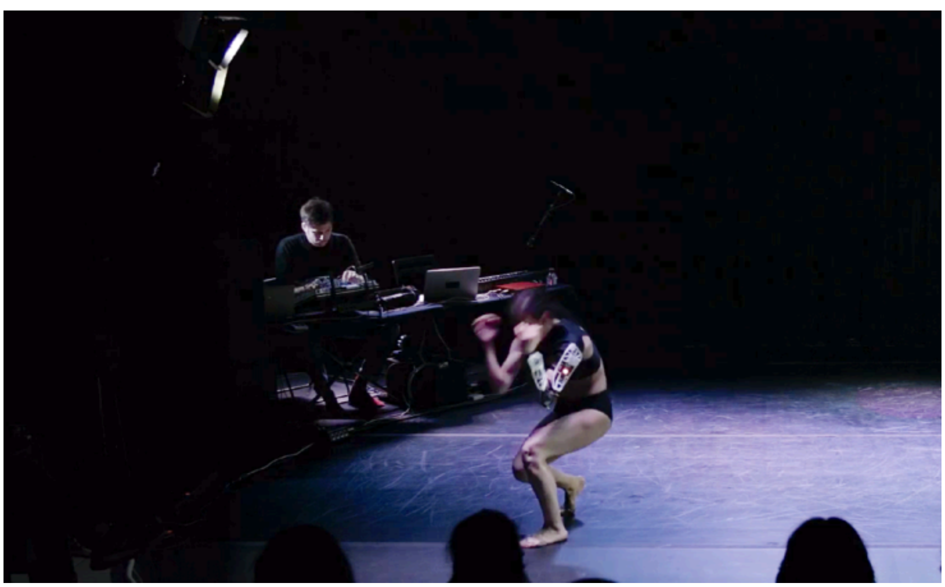

Fig.3. Tim Abramczik and Drosia Triantaki

---

[1] The "SenseWorld" Supercollider quark (Baalman 2007) was an important inspiration for some of the techniques.

Crucially, the ability of the musician to control the depth of the mappings during the performance is indispensible, as this adds a whole new layer of improvisation: the musician's ability to adjust the mapping in response to the dancer's movement. Non-verbal cues between dancer and musician developed on stage, almost unintentionally. This work-as-you-go process is much more suited to improvisation, as there is no preexisting choreography or composition to speak of.

Tim Abramczik's piece is based on an analogue modular synth and sampler setup. Tim worked by recording some talks with the dancer Drosia Triantaki, then selecting short abstracts and loading them to the *Phonogene* module of the synth, which is able to manipulate it in a variety of ways. He then used an Adat optical to CV 8-channel converter to bring the digital sensor data back in the analogue domain. Dimitris Dalezis and Nikos Tsavdaroglou followed different approaches, such as using motion data as input for algorithmic composition, or converting to MIDI and setting up complicated many-to-many modulations.

From an artistic point of view, it is crucial for the resulting pieces not to sacrifice choreographic or musical quality in favour of simply being interactive. Therefore, the visual aspect, though unrelated to the interactive system, is important to the presentation of the performance.

Future Work

Volume 3 of *Stream* aims to reintroduce computer vision into the system. This was actually the focus of the first *Stream* event in 2016; however, there have since been many developments[2] in the field and the team is considering to revisit some of its aspects, as it can solve a variety of motion capture problems that is impractical by using inertial sensors. Naturally, it would be possible to combine data from the two.

The Supercollider classes will be further extended, providing support for trigger conditions and further statistics. It is also possible to introduce machine learning to the system,[3] in the form of neural networks. This is still under development, mostly due to the difficulty of training when the inputs originate from dancers: from early tests, it became clear that some input preprocessing is absolutely essential in order to reconcile a performer's and a machine's view of *input*. Max abstractions and Max for Live devices can also prove useful.

Above all, *Stream's* uniqueness, in that it is not a strictly technical project but not purely artistic either, can be thought of as its greatest strength; that is, its ability to organise its practice and research methodology in order to expand the practical possibilities of interdisciplinary improvisation.

Additional Information

The performances took place at Vitruvian Thing, Thessaloniki, Greece, on November 23 - 24, 2019. The dance performers were Drosia Triantaki and Enora Gemin. The live music was by Dimitris Dalezis (trumpet, electronics), Nikos Tsavdaroglou (double bass, electronics), and Tim Abramczik (analogue synthesisers).

Supported by the NRW Kultursekretariat, Düsseldorf, Germany.

This author is also known as Dani Joss from his artistic practice.

[2] The Intel Realsense cameras, API, and app integrations is a lot faster, more capable, and more customisable than the Kinect 2 system that was used in 2016, and is now unsupported by Microsoft.

[3] IRCAM's *mubu* package is a great example that can be integrated into the system.

Acknowledgements. The design of the 3D-printed elements was done by Ioanna Symeonidou. The hardware and electronics were constructed by Ioannis Persoratis. The Supercollider community provided a great deal of assistance and advice.

References

Baalman, Marije. 2007. “SenseWorld”. Supercollider quark code. Open source. Latest commit on November 30, 2014. https://github.com/supercollider-quarks/SenseWorld.

Borgo, David. 2007. *Sync or Swarm: Improvising Music in a Complex Age.* New York, NY: Continuum International Publishing.

Emmerson, Simon. 2007. *Living Electronic Music.* Hampshire: Ashgate Publishing.

Jordà, Sergi. 2007. “Interactivity and Live Computer Music”. In *The Cambridge Companion to Electronic Music,* edited by Nick Collins and Julio d’Escriván, 89-106. Cambridge: Cambridge University Press.

Magnusson, Thor. 2019. *Sonic Writing: Technologies of Material, Syumbolic, & Signal Inscriptions.* New York, NY: Bloomsbury Publishing.

Rowe, Robert. 2001. *Machine Musicianship.* Cambridge, MA: MIT Press.