A Body Knows the Pattern: A Performance System Exploring Embodied Rhythm and Phrasing via NIME

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Additional Key Words and Phrases: Gesture Mapping, Body Sensing, Microtiming, Rhythm, Phrase, Interactive Machine Learning

1 Program Notes

A Body Knows the Pattern harnesses muscle and movement sensors to explore embodied relationships to rhythm and phrase, and the influence of a person's daily environment on their sense of musical timing. Improvised percussive phrases and field recordings are stretched, pulled, and layered through direct mapping and machine learning of expressive movements, placing sounds and patterns in dialogue with one another through the mediation of the body. Gesture data is used to sculpt both ambient soundscapes and grid-based percussive music, shaping everything from table-tapped rhythmic patterns to harsh noise textures. The result is both a detailed exploration of embodied expressive timing and a meditation on the body's lived relationship to the patterns of its surroundings.

Fig. 1. Performance with IMU and EMG sensors, 2025.

2 Project Description

This project builds on several decades of gesture mapping research in NIME to explore connections between body movement and tension and rhythmic phrasing in live electronic music performance [8, 9]. While there have been many applications of wearable sensors in performance practice, comparatively few NIME studies have applied these to work with rhythm and expressive timing. However, embodied cognition research suggests strong links between rhythm and movement [4], making this a fertile area for exploration. In this performance, I will harness inertial measurement units (IMU) and electromyogram (EMG) sensors to shape the outputs of a bespoke composed system using both direct mapping and interactive machine learning. I will explore and unpack multiple strategies for connecting arm and hand gestures to rhythmic phrasing, pattern, and texture, applying these to shape a library of field recordings and processed room samples in the context of both free and grid-based musical timing. By investigating embodied rhythm through wearable sensors and this library of sonic materials, I will unpack and reflect on the influences of the body's lived daily environment on its expressive timing, and how this may emerge in both intuitive and unexpected ways.

This performance forms part of a longer-term research project on the use of wearable sensors to explore embodied rhythmic phrasing and expressive timing in an electronic music context. Through a movement-led design process [5]

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and practice research methodologies [1], I developed a series of bespoke interactions placing data from IMU and EMG sensors in dialogue with a corpus of rhythm-based audio files. I used prior analyses of my performance practice to identify useful movement-rhythm relationships, gestural trends with features suitable for machine learning, and promising compositional and performance strategies using these tools. Specifically, I explored different approaches to phrase shaping and segmentation, expressive timing and emphasis, rhythmic call-and-response, and the construction of novel improvised phrases, influencing these via muscle tension, event detection, movement triggers, and machine learning of gesture categories [7]. Finally, my previous composition work exploring microtiming and expressive variation in a digital context informed the development of the musical material.

The compositional theme of this performance was influenced by my developing Zen Buddhist practice, and a curiosity about the relationships between events in a person's daily environment and their sense of expressive timing. Much of the sonic material used in this piece is drawn from recordings of my living space or percussive improvisations using domestic materials. The seated position of the performance reflects its meditative tone, which maintains an element of distance and observation even at moments of high intensity. To what degree do the patterns of our surroundings emerge in our embodied rhythmic expressions, and what kinds of stories can we tell as performers by exploring these correlations via gesture sensors? While this performance remains only speculative in relation to this theme, it is conceived as a platform to meditate and reflect on these relationships, while investigating the expressive potential in working with them.

3 Technical Notes

The performance system presented here harnesses multimodal gesture data via two devices: a glove-based Mugic inertial measurement unit (IMU) sending gyroscope and accelerometer readings via OSC over WiFi [6], and electromyogram (EMG) sensors placed on both arms and processed via the EAVI board and BBDMI library [3]. These signals are mapped directly to various playback parameters and effects, such as rate, pitch, volume, and filters, using the Max programming environment. The system also uses the Fluid Corpus Manipulation (FluCoMa) library [11] for feature extraction and interactive machine learning, specifically via a combination of neural network classification and regression objects which recognise pre-trained gesture types and output confidence ratings for each class [10], allowing for smoother interpolation. In the context of this performance, neural network predictions trigger the playback of some files while controlling the mix of others, while running averages of these confidence ratings over longer intervals guide bigger-picture shifts in the piece.

To build the sound library used in this performance, I recorded single-shot samples, short motifs, and longer phrases via percussive improvisation with domestic materials such as curtains, chairs, desks, cups, and clothing. I also captured ambient sounds and improvised body percussion. I processed these recordings in Ableton Live, in some cases only applying compression while in others applying filters and distortion through longer FX chains. Some of the resulting sounds were used as samples in MIDI-based phrases, while others were used to build short-tail convolution reverbs to alter the timbre of other recordings. Finally, I used a RAVE model [2] for timbre transfer and call-and-response on percussive phrases triggered by my arm movements, providing another parameter for improvisation.

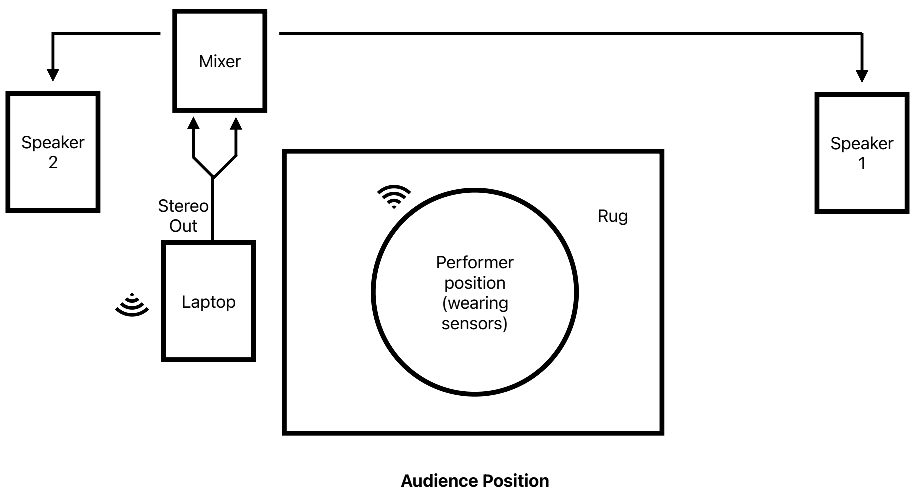

Fig. 2. Performance stage plot

4 Technical Requirements

This performance requires the following items:

- x1 3.5mm to stereo output jack
- x1 Sound card or preamp mixer with at least two inputs and outputs
- x2 Speakers
- x1 Power strip with at least three outlets
- x1 Rug or carpet

The artist performs seated on a rug with sensors on each arm, facing the audience. The running time of the performance is 10 to 15 minutes.

5 Media Links

- Video Excerpt 1: https://vimeo.com/1162290842
- Video Excerpt 2: https://vimeo.com/1162290914

6 Ethical Standards

The author has no conflicts of interest to report. All sonic material used in this piece is the author's own work, and all software was used under an appropriate license. Machine learning was carried out using only the author's personal data.

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