Instrumental Movements to Physical Models: Mapping Postural and Sonic Topologies through Machine Learning

Federico Visi, Eduardo Miranda

Interdisciplinary Centre for Computer Music Research (ICCMR), Plymouth University

We describe an approach for mapping body motion data to sound synthesis based on machine learning and inspired by studies of topologies and embodied music cognition. This approach aims to move away from a low-level movement representation constrained by a Cartesian coordinate system and obtain a control paradigm that is less dependant on it. A system based on orthogonal axes is indeed a convenient way to digitise movement. However, meaningful conceptualisation that help interpreting the expressivity that body movement conveys may be hindered if subordinated to a highly disciplined method of quantitative representation. In his 2009 article “Topology and Data”, Carlsson argues that “coordinates [...] are not natural in any sense, [...] therefore we should not restrict ourselves to studying properties of the data which depend on any particular choice of coordinates.” . Moreover, describing the characteristics of topological methods, he states that in order to obtain knowledge about the data qualitative information is needed, and this has to be established before proceeding with quantitative analysis. Topology studies intrinsic geometric properties of the objects, which do not depend on a chosen set of coordinates. This approach provides very useful notions for interpreting movement data generated by music performance gestures. In fact, such body movements are bound to multimodal expressive features, which are inherently qualitative. To put these concepts into practice, we used machine learning algorithms to define interaction models based on different postures a saxophonist may adopt during a performance. This was done by asking the

performer to play freely while wearing two sensors armbands. A small number of postures (4-5) are then defined by observing recurrent idiosyncrasies and peculiarities of the performance. The qualities of the movements were discussed with the musician, so as to better understand how certain gestures relate to instrumental techniques and musical features of the piece performed. Each posture is then mapped to a state (e.g. a set of parameters) of a wind instrument physical modelling algorithm. During the performance, a machine learning classifier compares the incoming sensor data stream with the recorded postures, returning the values for the probability that the current posture of the musician matches each of the defined classes. The values of the probabilities are then used to interpolate between the parameters sets of the physical model. The synthesised wind instrument sound merges with the saxophone sound, creating a rich timbre that varies also through the performer's movements. Early tests with different musicians and granular synthesis can be viewed here: https://youtu.be/stWI43-EZGA . A research musical piece was composed using the technology, with body movement articulations included in the score. The piece served as a test bed for the software developed as well as a practice-as-research work, showing how different multimodal musical features are inherently entangled as each one mutually influence the other.

Authors info

Federico Visi is a researcher, composer and performer. After obtaining his master’s degree in communication, multimedia and design, he studied music for image in Milan and composition at the music academy Accademia Pianistica in Imola. He is currently based in Plymouth (UK) where he is conducting his doctoral research at the ICCMR (Interdisciplinary Centre for Computer Music Research), focusing on body movement in performances with traditional musical instruments. He has composed music for films and installations, performed live in solo sets, with bands and in contemporary theatre and dance performances. He has presented his research at several international conferences and symposia. He has worked and is currently working on collaborative interdisciplinary projects with researchers in Europe (Ghent University, University of Bologna), North America (NYU, UCLA) and South America (Universidade Federal do Rio Grande do Sul).

Eduardo Miranda is Professor of Computer Music, and head of the Interdisciplinary Centre for Computer Music Research (ICCMR) at Plymouth University. He is a composer of chamber and electroacoustic music and he is most notable for his scientific research into computer music, particularly in the field of brain-computer interfacing, evolutionary computing and artificial intelligence.