ICLI
PORTO
2018

liveinterfaces.org

Performative Sound Design A Bio-signal Control Metaphor for Performative Sound Design

Luís Aly
up200203376@fe.up.pt

Rui Penha
gba@inesctec.pt

Gilberto Bernardes[1]
bernardes7@gmail.com

INESC TEC, Porto, Portugal
University of Porto, Faculty of Engineering, Portugal
[1] University of Aveiro, Portugal

Abstract
Sound design for performance art have long explored creative strategies based on improvisation which demands great invention and flexibility from the sound designer, which barely complies with the typical fixed media practices employed in the field. To organically bind sonic elements with the performance structure, we strive to design a sound-instrument capable of interfacing the stage performer's bio-signal with specific (sonic) constraints defined beforehand. By mediating bio-signal we intend to create control metaphors for a sound-instrument, which aims at expressive, dynamic, and interactive symbiosis between performative action and sound design.

Keywords
Performance studies
Sound design
Bio-signal
Human-computer Interaction

1.Objectives of research

Towards the definition and development of a collaborative framework for biofeedback sound design practice, our research agenda includes four main objectives: i) the definition of a computational interactive instrument capable of retrieving and sequencing sounds from large annotated audio collections based on the performer's psychophysiological measures; ii) a taxonomy of psychophysiological measures adapted to performative practices; iii) a mapping scheme between human psychophysiological activity and sound attributes; and iv) formal meta-composition method to explore the definition of musical sequences in real-time by recombining (structurally segmented and annotated) audio segments.

2.Related work

The multidisciplinary nature of this projects extends across four following domains of knowledge, for which we provide a short list of state-of-the-art references:

- *Cognitive science* studies that can support my research hypothesis on using bio-signal as a strategy to drive the generation of interactive artistic content (Damásio, 2000; Gallese, Keysers, & Rizzolatti, 2004; Ortiz-Perez, Coghlan, Jaimovich, & Knapp, 2011).
- Studies on a *user centred taxonomy of psychophysiological measures* for use in interactive art in general (Bongers, 2002; Kivikangas et al., 2011; Nacke, Kalyn, Lough, & Mandryk, 2011; Nogueira, Torres, Rodrigues, Oliveira, & Nacke, 2016; Yannakakis, Martinez, & Garbarino, 2016).
- *Bio-signal driven musical/sound artistic practises* starting on 1960's (Donnarumma, 2016; Knapp & Cook, 2005; Lusted & Knapp, 1996; Ortiz, Grierson, & Tanaka, 2015; Rosenboom, 1977; Tanaka, 2009; Tome-Marques & Pennycook, 2014).
- Studies on the design of *digital musical instruments* and mapping strategies to relate action/ sound (Bernardes, Guedes, & Pennycook, 2012; Birnbaum, Fiebrink, Malloch, & Wanderley, 2005; Hunt, Wanderley, & Kirk, 2000; Knapp & Cook, 2005; Miranda & Wanderley, 2006; Tanaka, 2000, 2010).

3.Research methodology, contribution to the field and progress towards goals

Following the contextually-sensitive design principles and theories in (Wang & Hannafin, 2005), we will pursue a design-based research (DBR) methodology as a systematic, but flexible, collaborative and iterative practice with theatre and dance practitioners to develop and implement the core components of the research. Moreover, we will also rely on an art-based research (ABR) methodology that promotes the use of artistic practises as a primary strategy to understand the experience resulting from both the researcher and the artistic community involved in the study (McNiff, 2008). In greater detail, our methodological plan can be break down into the five following tasks:

1. To review sound design practices for performing arts, namely those with an open narratives;
2. .To undertake an exhaustive assessment of existing biofeedback sensors, namely those processed by the OpenBCI brain-computer interface;
3. To design a sound-instrument which draws on meta-composition models to intelligently map multidimensional biofeedback data to sound narratives which organically bind with a live performance;
4. To perform a subjective evaluation of the meta-composition models and their applications in performing arts we are planning to conduct: i) questionnaires and direct observation in professional performing art production ii) direct observations and questionnaires to gauge the efficacy and efficiency of the proposed instrument.
5. To disseminate the results of our research by i) reporting the main contributions to the scientific and artistic community; ii) to plan

a series of live performances and public presentations where the instrument will be explored under constrained test situations; and, finally, iii) to fully develop the sound-instrument and make it available to sound designers, allowing it to integrate real-world performative scenarios outside controlled lab conditions.

Bernardes, G., Guedes, C., & Pennycook, B. 2012. Eargram: *an application for interactive exploration of large databases of audio snippets for creative purposes.* Paper presented at the Proceedings of the 9th International Symposium on Computer Music Modelling and Retrieval (CMMR).

Birnbaum, D., Fiebrink, R., Malloch, J., & Wanderley, M. M. 2005. *Towards a dimension space for musical devices.* Paper presented at the Proceedings of the 2005 conference on New interfaces for musical expression.

Bongers, B. 2002. *Interactivating spaces*. Paper presented at the Proc. Symposium on Systems Research in the Arts, Informatics and Cybernetics.

Damásio, A. 2000. O sentimento de si. O corpo, a emoção e a neurobiologia da consciência, 5.

Donnarumma, M. 2016. Configuring corporeality: Performing bodies, vibrations and new musical instruments. Goldsmiths, University of London.

Durka, P. J., Kus, R., Zygierewicz, J., Michalska, M., Milanowski, P., Labecki, M., Kruszynski, M. 2012. User-centered design of brain-computer interfaces: OpenBCI.pl and BCI Appliance. *Bulletin of the Polish Academy of Sciences-Technical Sciences*, *60*(3), 427-431. doi:10.2478/v10175-012-0054-1

Gallese, V., Keysers, C., & Rizzolatti, G. 2004. A unifying view of the basis of social cognition. *Trends in cognitive sciences, 8*(9), 396-403.

Hunt, A., Wanderley, M. M., & Kirk, R. 2000. Towards a model for instrumental mapping in expert musical interaction. Paper presented at the ICMC.

Kivikangas, J. M., Chanel, G., Cowley, B., Ekman, I., Salminen, M., Järvelä, S., & Ravaja, N. 2011. A review of the use of psychophysiological methods in game research. *journal of gaming & virtual worlds*, 3(3), 181-199.

Knapp, R. B., & Cook, P. R. 2005. The integral Music controller: Introducing a Direct Emotional Interface to gestural control of sound synthesis. Paper presented at the ICMC.

Lusted, H. S., & Knapp, R. B. 1996. Controlling computers with neural signals. *Scientific American, 275*(4), 82-87.

McNiff, S. 2008. Art-based research. Handbook of the arts in qualitative research, 29-40.

Miranda, E. R., & Wanderley, M. M. 2006. New digital musical instruments: control and interaction beyond the keyboard (Vol. 21): AR Editions, Inc.

Nacke, L. E., Kalyn, M., Lough, C., & Mandryk, R. L. 2011. Biofeedback game design: using direct and indirect physiological control to enhance game interaction. Paper presented at the Proceedings of the SIGCHI conference on human factors in computing systems.

Nogueira, P. A., Torres, V., Rodrigues, R., Oliveira, E., & Nacke, L. E. 2016. Vanishing scares: biofeedback modulation of affective player experiences in a procedural horror game. *Journal on Multimodal User Interfaces, 10*(1), 31-62. doi:10.1007/s12193-015-0208-1

Ortiz, M., Grierson, M., & Tanaka, A. 2015. Brain Musics: History, Precedents, and Commentary on Whalley, Mavros and Furniss. *Empirical Musicology Review, 9*(3-4), 277-281.

Ortiz-Perez, M., Coghlan, N., Jaimovich, J., & Knapp, R. B. 2011. Biosignal-driven art: Beyond biofeedback. *Ideas Sonica/Sonic Ideas, 3*(2).

Rosenboom, D. 1977. Biofeedback and the arts: results of early experiments.

Tanaka, A. 2009. Sensor-based musical instruments and interactive. *Oxf. Handb. Comput. Music*, 233.

———. 2010. Mapping out instruments, affordances, and mobiles.

Tome-Marques, H., & Pennycook, B. 2014. From the unseen to the s [cr] een eshofuni, an approach towards real-time representation of brain data: xCoAx.

Wang, F., & Hannafin, M. J. 2005. Design-based research and technology-enhanced learning environments. *Educational technology research and development, 53*(4), 5-23.

Yannakakis, G. N., Martinez, H. P., & Garbarino, M. 2016. Psychophysiology in games *Emotion in Games* (pp.119-137): Springer.