xCoAx 2019
Conference on Computation, Communication, Aesthetics & X
Milan, Italy

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Multi-sensory transformation of biological signals

Keywords
biological noise
data transformation
musical interface
post-digital media
bioart
artscience

The aim of this Ph.D. project is to transform the physical behaviors of living cells into multi-perceptional experiences for a wide range of audience based on the combination of both scientific and artistic methodologies. Applying contemporary scientific research methods, with an artistic research method is an unconventional approach to understand our environment and ultimately the research question that has driven my work as a researcher and life. In this study, the smallest discovered unit of life will be examined in a new way, to open up our thinking about the multi-scalar systems of relations between human, and non- human living beings and technology. This can lead us to the human and non-human and post human discourses which can broaden the insight of humanities and aesthetics in general in relation to how there relations are valued both environmentally and through perceptual systems. Furthermore, this study contributes to the field of digital data processing as well as analogue technology to create a tangible musical interface. This project could encourage active exchanges between any array of diverse academic disciplines, from artist, scientist, ecologist, anthropologist, and physicist, that can generate new knowledge thought their collaboration and questioning through looking at the knowledge stored in the microbial scale of life.

1 PURPOSE

This research aims to create multi-perceptional transformations of biological signals from human cells into artistic frameworks based on scientific significances in bioscience domain such as biophysics, molecular biology, and nanobiotechology with questions: how a work of art can be aesthetically represented as an interactive performative installation, and how through the experience of this environment, become a reference to the sonic interactions between living cells, and human sensory perception. Biological noise is derived from various kinds of communications between intraspecies (cell to cell), interspecies (a process of gene expression) such as decision making on dynamics of protein conformation — growth, death, inflammation, disease, etc (Balázsi, et al. 2011).

This study is focused on the physical mode of communication types, specifically motion, vibration and frequency. There is some experimental evidence that microorganisms can generate, and respond to physical signals such as sound waves, electromagnetic radiation (e.g. biophoton) and electric current (e.g. nanowire) (Reguera 2011). The advantages of physical signal cell communication are that it requires less energy consumption than chemical signaling, which means that information delivery through physical signals (e.g light and sound) can respond faster and wider. However, human senses are limited to a certain range (the human audible range is 20Hz to 20kHz and visible light region ranges in wavelength is 400-750nm), so the biological noise (signal) has to be translated to be perceptible by either amplifying (e.g. audification) it or transforming (e.g. sonification) it.

With advanced technology such as genetic engineering, and super-resolution microscopy, biological entities have been used, and analysed physically and chemically in artistic frameworks. However, most of the current sound, and music projects often focus on measuring biochemical energy rather than physical observation. Further artistic practice in musical expression of biological material can be more engaged with materialistic nature and physical attachment of our perceptions such as physicality and tactile perception including a multi-sensory transformation of biological data.

2 BACKGROUND AND RELATED WORKS

Using high-resolution technology such as an Atomic Force Microscopy (AFM), we can record cellular nano-mechanics in an acoustically insulated environment. A single yeast cell creates periodic nanoscale motion at the temperature-dependent frequency of 0.9 to 1.6 kHz with an amplitude of ca. 3nm (Pelling, et al. 2004). Also, molecule's unique vibration is related to olfaction, and it can be synthesised by replicating a certain vibrational frequency. For instance, methyl sulphide has 256 wave numbers and its audible frequency is 256 Hz, and synthesised sulphur-hydrogen molecular bond vibrates at around 76 terahertz (76 trillion oscillations per second) (Turin 2005).

The discoveries, and techniques from scientific researches in biological noise have become the intellectual catalyst to artist, and scientist collaborations within the context of artistic research practices. In an audio-visual installation “Blue Morph (Vesna 2007)”, AFM was used to record the sound of morphology of pupa by observing the process of growth for one week.

“CellF (Ben-Ary 2016)” uses bioelectrical signals of his own cells to create an autonomous musical instrument. He extracted his own skin cells, turned them into stem cells, and then transformed them into a neural network. The neural network grew on a MEA system which has 60 electrodes and is connected to a custom-built analog synthesizer.

Within the field of biophysics, observing the physical movements, and recording there biological feedback in search of creating new knowledge of relations out of a large quantity of noise is also one of the aspirations of this research trajectory through artistic experimentations. One of the many challenges in this form of observation using microscopy technology, and detectors is that each device has precise limitations in filtering out the noise. The molecular scale also reflects the same noisy nature of human life, a lot of noise can be observed when a cell molecular is being scanned, or detected by machines. The noises are complex numbers which have characteristics of amplitude, and phase. In order to process the massive amount of noisy data, the computational process is inevitable. For example, David Glowacki and the University of Bristol researched a molecular dynamics into an audiovisual simulation. They calculated free energy and sonified the data by using the Markov State Model algorithm and an open source visualization program called PyMol (Glowacki, et al. 2018).

3 APPROACH

The goal is to create a performative installation based on current scientific findings of biological noise and the interaction between living cells and humans. It is a challenge because of technical difficulties, and it requires therefore research procedures carried out within a biological science lab for the process of extracting the human cells from the host to detecting cell behaviors. The detailed detection technology will be decided based on what types of behavior the specific cell displays. Besides sonic recording the motion of cells, other physical evidence methods such as electrical signals could be examined with biophysicists’ advice.

After anatomical research on an array of cellular types, I have decided the heart cell is the strongest candidate because of its musical characteristics, arrhythmias, and pulsations. The heart cellular modulation, and rhythmic pulsation can be compatible with the fundamental feature of sound. Other parts of human cells also have potentials to be examined such as the brain, muscles, liver, and kidney. These could be examined to detect the different characteristics of vibrations in physiological nature such as blood pressure, heart rate, respiration, EEG measurements, body temperature and galvanic skin response; alter immune and endocrine function; and ameliorate pain, anxiety, nausea, fatigue and depression;

living being's consciousness (Homma, et al. 2008). In this sense, it would be interesting to investigate the interaction between human cells and living beings by observing different types of bio-feedback.

Other methods of observing cellular noise such as biochemical signaling, as well as computer science will also be incorporated within the research experimentation. Especially the computer data processing, which is very helpful in simulating cellular activities. A huge amount of data analysing cannot be separated from the computational process. Also, a large body of research in contemporary bioscience have exemplified that interdisciplinary cooperation can lead to the best understanding of life mechanisms. In this sense, this research will not be limited to one discipline for successful completion of the project, rather the social relationships across disciplines, and fields of research will become the foundation of creating a meaningful representation within the context of an artistic practice. Therefore, this research requires interdisciplinary collaboration between art, and the multiple fields of science as well as a rigorous study of post digital media.

4 EXPECTED CONTRIBUTIONS

This research is an interdisciplinary project between art and science in the context of post digital media. The work can contribute to establish an interdisciplinary perspective to develop the work aesthetically based on scientific research, and to push forward boundaries between art, and scientific disciplines. The research outcomes will be submitted to related academic conferences, and to relevant journals to be published. Moreover, as an artwork, it will be presented to the public such as media art festivals, exhibitions, and talks. Archived documentation and hands-on workshops could be introduced to open source communities.

5 PROGRESS

This research is in the very early stages of its development, which has taken form in the process of reading and collecting appropriate reviews. In order to find a solution for proper technical expertise, this project is currently collaborating with AFM group in Institute for Biophysics at Johannes Kepler University in Linz. While the detailed experiment schedule is to be discussed, we are establishing background knowledge by attending relevant bioscience courses and conferences.

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