Phantom Undulations: Remote Physiological Sensing in Abstract Installation Works

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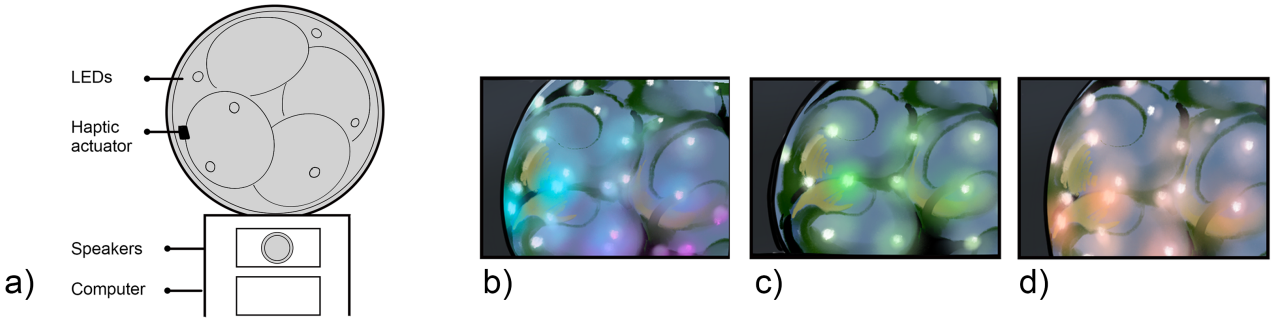

Figure 1: a) The Conceptual Sketch of this work. b,c,d) Three artifacts .

ABSTRACT

Phantom Undulations is a mixed-media work in which an artist's physiological data is being used remotely to manipulate the sounds and visuals of an abstract artifact in a gallery setting. This work relies heavily on the concept of showing the artist's presence or liveness in an abstract and remote manner through changes in the harmony, rhythm, and timbre of a loosely structured soundscape as well as the physical appearance of the artifact. We propose a method of utilizing real time physiological sensing data through a custom built sensing wristband and accompanying software. This system reads the physiological data of the artist and sends it to the Internet, where it can be received by the artifact anywhere on Earth. In addition to the artist's physiological data, we also offer a way for the audience to incorporate their own data into the work via several sensing wristbands which will accompany the artifact. Through this collaborative process, we wish to invite the audience to join the artist in manipulating the sonic and visual characteristics of this artifact and create a contrapuntally fluid and responsive musical experience.

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CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; *Interaction techniques*; *Interactive systems and tools.*

KEYWORDS

physiological sensing, remote music, sound art, interactive art, liveness

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1 INTRODUCTION

Following our previous exploration of using physiological data for multi-modal experiences [11], we present an interactive installation *Phantom Undulations* which aims to recreate a sense of presence of a living organism. In this work we utilize an artist's biophysiological signals, such as breathing, heart activity, and electrodermal activity (EDA) to convey a sense of an alive being by directly mapping this data to the installation's behavior and appearance.

Although this work is exploitative, we believe such works will lead to more refined methods of creating the sense of liveness or presence. Instead of taking the data of a performer during a musical work or during some kind of specific activity, we have decided to use non-specific data from the artist during their daily life in order to emphasize the natural state of said artist. Our intention is to explore, refine and verify our assumptions and aesthetic and musical choices. In the future, we plan to exhibit several of these installations in different parts of the world, while utilizing the physiological data of the same artist.

2 CONCEPT

Phantom Undulations is a mixed media installation which will utilize the real-time physiological data of an artist from Tokyo, Japan while being materialized at Augmented Humans in Glasgow, Scotland. Their data will be manipulating the sounds, musical structures, visuals, and vibration of a sonic/visual object.

We are greatly interested in how the daily life of the artist and the physiological data that comes from it can be transmitted and utilized in an aesthetically appealing way. These objects could then be made in duplicates, thereby affording the chance to share this work simultaneously with people in far parts of the world, which will be explored in future works. We want to investigate how much and what kinds of connections people can make with these abstract representations of the presence and liveness of the artist from afar. Will people be able to understand or guess what they are doing at any given time? How will this physical separation from the objects affect how much the audience can connect with the direct human intervention they are inputting?

This work is being designed so that multiple objects can exist on their own while also existing as a remote ensemble. A close analogy would be a string trio in which each performer is in a different country. While there solo works are engaging and complete, they also combine to create the ensemble as well. This leans heavily on theories in early counterpoint compositions. In these works, every individual voice is meant to be satisfying on its own, while also contributing to a cohesive full composition as an ensemble. As stated by theorist Ernst Kurth, counterpoint is "how two or more lines can unfold simultaneously in the most unrestrained melodic development, not by means of the chords but in spite of them" [9]". By taking this theory as a basis for this work, we will present each "voice" or object as one contrapuntal line within the ensemble. In this, our pilot study, we will focus on one object while allowing for the integration of physical attendees of the conference.

3 RELATED WORK

There have been many works which have utilized physiological data in the context of musical and sound works. One example of utilizing EEG data to perform musical works based on the physiology of the user is *PsychDome* which utilized the data to induce an experience of 'form constant' hallucination [17]. Some less obtrusive data collection methods include detection of heartrate, which was utilized in [12] to observe how two performers' heartrates would be affected by improvising music together. With our work, we want to explore how these kinds of novel applications of physiological sensing data can be used to express the performative and aesthetic intentions of the artist while they are located remotely from an installation exhibit.

Koelsch et al.[6] presented an overview of the recent works investigating the relation of music and human physiological data changes. They observed that Heart Rate (HR) is higher with exciting music than with calm music, while the Heart Rate Variability (HRV) is the opposite. In addition, the standard deviation of the beat-to-beat intervals (SDNN), as one of the HRV features, seems to be widely used metric when it comes to evaluating the perception of the music[7]. There is also an association between higher ElectroDermal Activity (EDA) and positive emotion elicit by music [8, 13]. Heart Rate Variability (HRV) describes the changes in time intervals between each consecutive pair of heartbeats [14]. HRV is based on the analysis of the patterns in the Inter-Beat Intervals (IBI), also referred to as the RR-interval. By monitoring the heart rate using ECG or PPG, we can get a series of R-R intervals (the time gap between two consecutive R-peaks). The variance of the duration of those intervals is referred to as Heart Rate Variability (HRV). It is suggested that it is possible to use an HRV-based evaluation for high arousal emotions [5].

ElectroDermal Activity (EDA), also referred to as Skin Conductance (SC) or galvanic skin response (GSR), refers to the change of the electrical conductance properties of the skin in response to the change of the sweat secretion rates by sweat glands [2, 16]. EDA measurements mostly concentrate on two parameters: Skin Conductance Response (SCR) - quick changes (on the scale of seconds) in response to emotional or stress stimuli; and Skin Conductance Level - slow changes (within minutes and hours) commonly associated with the general condition of the subject. In recent decades, Skin Conductance (SC) is one of the most sensitive markers and frequently used to assess emotional arousal, as the skin conductance response activity increases as the emotional arousal grows [1, 3, 10].

4 IMPLEMENTATION

This work is closely bound to our previous works in the performing arts [15]. One such work is the on-going *Boiling Mind* project. In

this work, we apply our physiological sensing setup to gather real-time data of the audience during contemporary dance performances. This data is then applied to elements of the staging including the music, lights, and projections. During the demo session, the artist, while being in Tokyo, Japan, will be wearing our physiological data acquisition device which will sample their blood volume pulse (12-bit, 200Hz) from a finger worn analog plethysmograph, and Electrodermal Activity (16-bit, 10Hz) measured from two fingers, and the respiration with a stretch sensitive chest strap (12-bit, 50Hz). The data will be processed in real time to derive their Heart Rate Variability (HRV). We are providing a sensing setup at the venue as well, so the visitors could see the installation react to their data as well as the artist's (see Fig.2).

For the representation of the artist's data we chose an egg-shaped inflatable silicone structure with programmable LEDs and haptic actuation. The led colors and haptic actuators inside the ball will change and undulate along with the artist's data.

The presented artifact is accompanied by an audio stream generated live from the artist's physiological data. We will assign five different kinds of sensing data to five different core elements of music as proposed by Russel Burton, which consist of pitch, duration, loudness, timbre, sonic texture, and spatial location [4]. Since we will have only two speakers in this installation, we will omit spatial location in our implementation. The assignments of sensing data to musical elements will be as follows:

(1) The pitches being used will be determined by the EDA.
(2) The duration of musical gestures will be determined by the heart beats.
(3) The loudness of certain musical gestures will be determined by the SD1/SD2.
(4) The timbre of the synthesized sounds will be determined by the artist's respiration.
(5) The sonic texture will be determined by the SDNN.

This artifact has two 8" speakers embedded inside the lower section which will allow us to project musical elements. All of the physiological data will be sent to a pc running Max/MSP software which will gather the data via OSC and then implement the data into the various musical parameters discussed above. Some minor scaling will be done within Max to ensure that the data stays within a usable range and prevent any undesired sonic characteristics.

5 CONCLUSIONS AND FUTURE WORK

To conclude, we present an installation featuring our custom physiological data acquisition platform. The artifact will reproduce the artist's heartbeat and respiration in an abstract way and sonify this data live in order to create a sense that the object is presenting a living being, while the human being who's data is used is not physically present at the venue.

We plan on exhibiting this artifact in multiple locations simultaneously (see Fig.3). One such installation would feature three artifacts located in Japan, the UK, and Los Angeles. Presenting these distantly located works which would all be fed the same artist's data would be a novel application for presenting the presence of the artist in multiple locations. Furthermore, we would like to use this opportunity to explore how distantly located objects can create a remote counterpoint between each other. In essence, this would be a sonic ensemble in which all three or more objects exist fully on their own while also existing as part of a unified ensemble.

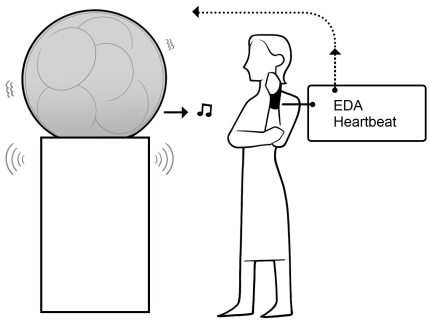

Figure 2: Diagram of Audience Interaction With the Artifact

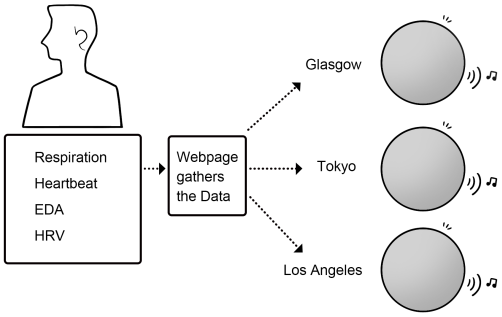

Figure 3: Diagram of Multiple Remote Artifacts

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