Mynd Music: from brainwaves to music

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ABSTRACT

Technology has been an excellent tool to be in touch with people around the globe, but lately it has heavenly influenced our attention span and interactions towards the outside world. In this way, *Mynd Music* is a smell-enhanced virtual experience, along with real time EEG acquisition, that offers a nuanced understanding of our emotions and expression of them. During this art installation, the participant uses two EEG headsets -Muse 2, and Enophone- while being immersed in a virtual reality environment visiting different scenarios with their own scented stimuli -produced by Aroma Shooter®- to induce an emotional reaction. Meanwhile, the EEG signal is processed using frontal alpha asymmetry, along with relative beta and alpha power to correlate the readings with emotional states such as concentration, relaxation, and approach/avoidance oriented behaviors. The music is selected with machine learning algorithms to resemble the emotional state. Thus, the final melody is unique in every interaction with the VR environment, as our brain has different reactions. This diversity allows for exploration, communication, and understanding of our emotions in a way words can not express, but can be captured by a melody. *Mynd Music* is an acoustic re-interpretation of the physiological manifestation of an emotional state.

Author Keywords

BCI [1], EEG [2], affective computing, emotion recognition, melody, composition, interactive brain-computer interface installation, alpha and beta brainwaves

[1]Brain Computer Interface
[2]Electroencephalogram

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CCS Concepts

•**Human-centered computing** → **Mixed / augmented reality; Sound-based input / output;** •**Computing methodologies** → *Feature selection;*

1. PROJECT DESCRIPTION

Even though XXI century technology has let us experienced a globally connected world, it has also brought a lack of connection with each other and ourselves. Hence, *Mynd Music* offers a new experience with the use of technology and the help of bodily expressions. With these, we created an introspective connection with our emotions by translating them into music.

1.1 Motivation

We consider that in the Engineering and Science School, the work methodology tends to be narrow-minded. Therefore, we decided to think out of the box by merging art and science, like the Aguahoja project, where the MIT Media Lab succeeded in combining art, science, engineering, and design. Each term has its meaning [4]. One problem that we noticed, was that technology is a double-edged sword that can be used for good or bad; for example, during a pandemic of mental health issues that has had repercussions on how people express themselves, making them apathetic. Art is the ultimate way of expression, and engineering is the best path to create new things. These two areas combined make a powerful combination that results in an innovative form of expression, specifically using music as a vessel for the most profound human emotions.

Lately, this approach linking science and art has gained attention in neuroscience to analyze brain patterns associated with viewing art like Muller, K. proposes [1] and projects such as Your Brain on Art [2] or Tender Rythms [3].

However, the translation of EEG signals into music has rarely been implemented directly with the use of different stimuli. Therefore, we developed an experience where we could discover how raw emotions are translated from different reactions in the brain as the result of visual, auditory, and olfactory stimuli. Allowing us to explore the mind through the unique language of music.

1.2 Proposal

The project aims to interpret emotion and intent throughout a VR experience –aided by the scent diffuser, the Aroma Shooter®, to provide a more immersive environment introducing aroma according to the VR scene–that cycles through multiple scenes with brief transitions to generate a vague narrative. EEG readings are constantly taken throughout the experience and polled as the scene changes. This is done with two devices, the Muse 2 which is placed on the front of the head, and the Enophone headphones with three EEG sensors set on the sensorimotor area. Different metrics are extrapolated from the data, each one correlated with a particular human affect. Thereafter, a song is assigned to that state. The music was composed by choosing a special key for each original song produced by one of the authors of this project, María F. Velázquez-Vergara, and a musical engineering major Andrés Ortiz Trejo. The principal emotions classified with the machine learning algorithm, were sadness, happiness, anger, fear, and surprise. The workflow used for the coding algorithm is summarized in Figure 1.

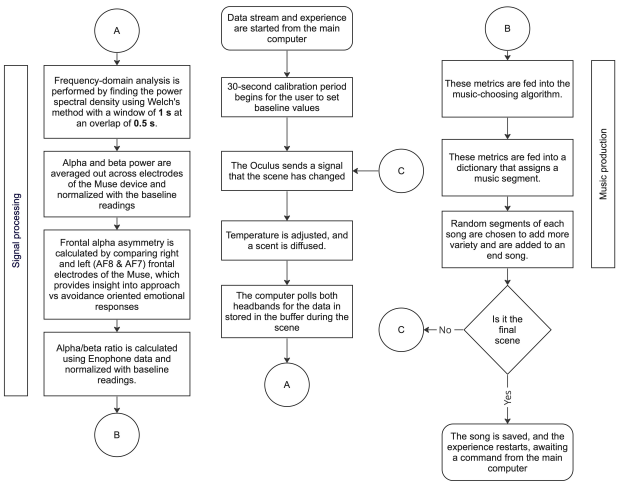

Figure 1: Flowchart for the data processing algorithm

2. INSTALLATION

2.1 Space requirements

The installation requires minimum a clear space of 2 m × 2 m with access to an electrical outlet.

2.2 Logistical Requirements

This art installation does not take longer than 30 minutes to set up. The chair must be placed in position, along with the Raspberry Pi, followed by a small table where all the devices are displayed until a new user comes along (Figure 3). There must be always at least 2 outlets available for the router and Raspberry Pi, with an extra outlet available for charging the other devices if necessary. Access to a wired Ethernet connection is preferred, but not required.

The set-up before using it requires at least 5 minutes. We must ensure all devices are properly connected and calibrated in order to commence the experience for a particular user.

Appendix A shows the floor plan for the project.

2.3 Feasibility

The first iteration of this installation was presented at INC Monterrey Festival 2022, as one of the four winning exhibits of the 2021 Fund of the Art, Science, and Technology Laboratory of the Art Institute CSO and Tecnológico de Monterrey (Figure 2). Entering a 3 m × 3 m space, viewers were able to sit down and get connected to all devices (VR headset, Muse 2, and Enophone). Then, the user is registered, introducing his/her name into the GUI. One of the artists made sure all devices were properly connected to the GUI and triggered the experience from the Raspberry Pi. In the VR environment, different scenarios, scents, and sounds were displayed for the viewer, while their brainwaves were being processed and analyzed in real time.

Figure 2: *Mynd Music* at INC Monterrey

When the journey ended, their unique melody was stored in our database and was later emailed to them due to lack of Wi-Fi connection. The interesting part of this piece is that each experience can be completely different from the last even if it is the same person doing a re-run, making it truly mindful each time.

2.4 Equipment requirements

This work requires one Raspberry Pi with Linux and an attached display, one Muse 2 Headband, one Enophone headset, one Oculus Quest 2 headset, one Aroma Shooter diffuser with the respective aroma cartridges, one router for the connection of all devices, and a comfortable seat.

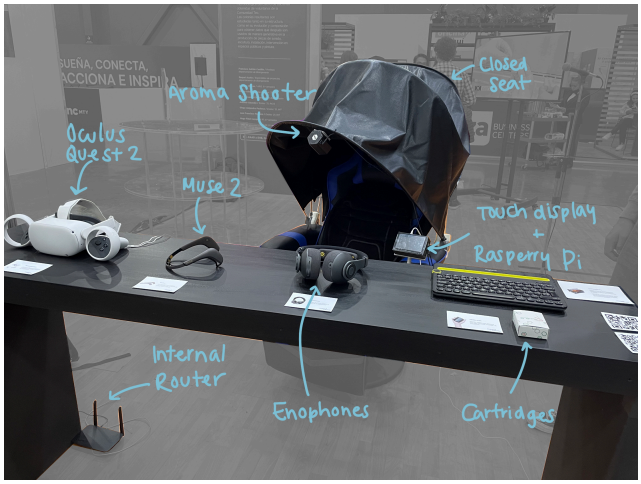

Figure 3: All the equipment required for the installation displayed in a single exhibition.

3. MEDIA

For more photos, videos and information, please visit our Instagram and Website

4. ACKNOWLEDGMENTS

This work was sponsored by the Arts, Science, and Technology Laboratory of the Art Institute CSO and Tecnológico de Monterrey.

In the present case, the authors would like to thank Fabian de Jesús Nuño Orozco for his help in designing the code for real-time frontal alpha symmetry processing using Python. We also recognize and thank Andrés Ortiz Trejo for his mentoring in music theory to represent emotions, and composing individualized pieces of the repertoire from which we are able to extract fragments to create each unique melody. Special thanks to María Fernanda González Espinoza for managing our Instagram and Website.

5. ETHICAL STANDARDS

This project received its funding by the *Arts, Science, and Technology Laboratory of the Art Institute CSO and Tecnologico de Monterrey.*

During this research, all experimental procedures were conducted with informed consent by the human participants through an official consent letter.

6. REFERENCES

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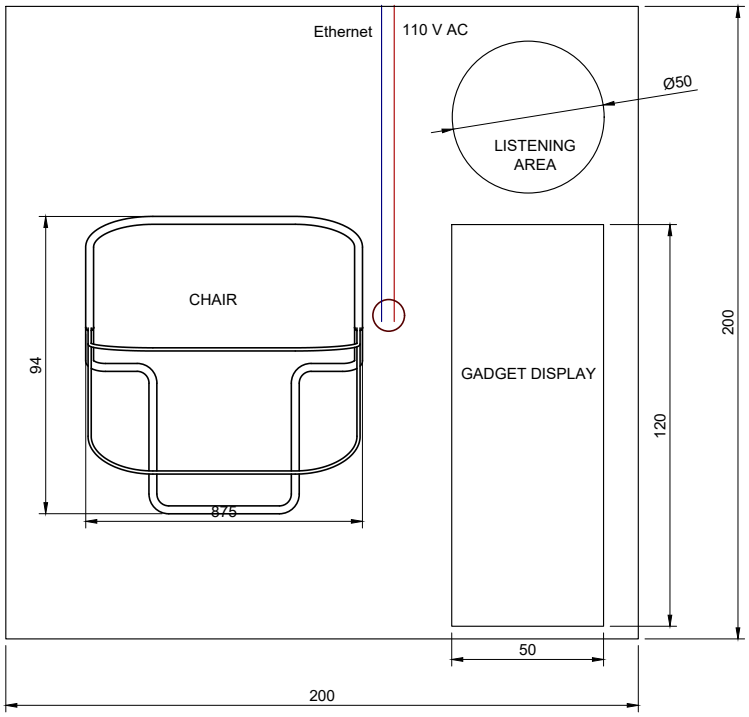
[2] K. Kontson, M. Megjhani, J. Brantley, J. Cruz-Garza, S. Nakagome, D. Robleto, M. White, E. Civillico, and J. Contreras-Vidal. 'your brain on art': Emergent cortical dynamics during aesthetic experiences. *Frontiers in Human Neuroscience*, 9, 2015.

[3] S. Koziej. Tender rhythms, Jan 2023.

[4] N. Oxman. Aguahoja, 2014.

APPENDIX

A. FLOOR PLANS



NOTES:

The instalation is meant to be in a closed space, such as a classroom, a gallery, etc. The minimum space requitements is a square of at least 2x2 mts so all the components of the instalation can fit properly.

Also, the technical requirements are at least 3 electrical outlets for charging the devices, the chair and the router. And it is also necessary a wired Ethernet connection.