Visum: beyond the physical eye

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ABSTRACT

Visum is a data-driven screen-based audio-visual art projection/performance that that externalizes visual perception through visual evoked potentials (VEPs) created by optical illusions. A VEP is an electrical potential, that is, a specific brainwave pattern captured from a specific area of the human brain following the presentation of a visual stimulus. The VEP data retrieved some time ago, through a subject experiment has its own aural and visual information, which serves as building blocks for an audio/visual experience or composition. These VEPs are brought into an environment as three-dimensional sound and visual objects. The VEP objects is played as an instrument via a user-controlled interface such as mixing and parameter control creating an evolving, dynamic, sounds and visuals.

1. INTRODUCTION

A Visual Evoked Potential (VEP) is a change or spike in brainwave electrical activity that is created when a visual stimulus is presented to an observer. It is typically seen in the background Electroencephalogram (EEG) recorded from the occipital scalp following a flash of light [1]. Optical illusions give us insight into how the brain works, by using patterns, light and color that create images, which can be deceptive to our brains and such reveal the mechanisms of perception [2]. Optical illusions occur, because our brain is trying to interpret what we see and make sense of the world around us.

The VEP data are used as objects in an immersive audio/visual space. In Mathew et al, a 3D sound installation was created where, a multivariate event-based sonification was proposed using 3D spatial location to provide cues about these particular events [3] occurring in the brain. This research also creates a 3D sound environment using brainwave data.

Here, illusion based VEP components (e.g. peaks/spectral density) are used to provide sound cues. These cues represent the different areas of the brain and what happens when someone observes a visual stimulus. Emphasis is placed on the experience of creating soundscapes from visual perception.

2. METHODOLOGY

Participants of an experiment were presented with four optical illusions shown in Figure 1, while their brainwaves were being recorded from an 8-sensor EEG device.

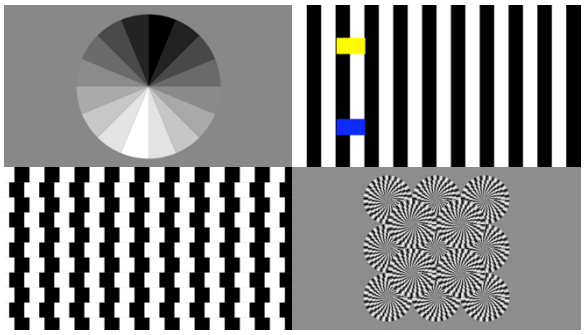

Figure 1 Four illusions used in this research (clockwise from top left); Reverse Spoke Wheel, Stepping Feet, Rotating Snakes and Café Wall.

Digital filtering, segmentation, trial averaging and analysis are performed on each subject's brainwaves to extract the VEP information, which is embedded in the EEG data. The VEP data is considered an object with its own aural and visual representation within this space.

3. SONIFICATION AND VISUALIZATION

The multimodal design of *Visum* (the interface) involves VEP data and user interaction. The sonification is created out of data manipulation of visual regions in the human brain by the granular synthesis method. The data is broken up into grains and

spatialized, representing the neuronal firings in the human brain. The sound is outputted through 8 channels representing the 8 EEG device sensors placed on the experiment subject's head in binaural listening format. This could be heard via headphones for an immersive 3D sound experience.

The visualization just like the sonification is controlled by the VEP data only it is based on an optical illusion thematic experience, i.e. the optical illusions images used in the experiment is manipulated by the VEP data itself. The visual output is shown on the screen where the user can see the visual objects in 3D space (Fig. 2). The morphing, warping and other effects of the visuals will depend on the amount of the visual evoked potential, that is, electrical activity picked up by the EEG device sensors of a subject during the experiment. The visualization includes several visual effects such as noise, blurring, rotation, and shape deformation. The visualization is also synced with the audio spatialization, showing the prominence of each audio channel.

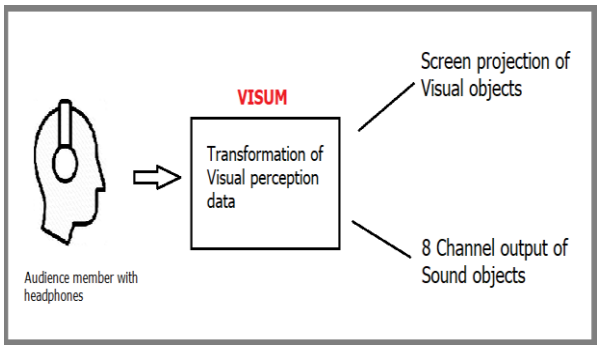

Figure 2 Visum A/V output design

4. CONCERT PERFORMANCE

Title: Visum: beyond the physical eye (2020)
Medium: Video (mp4)
Duration: 7:01
Artist: Lena Mathew

In this composition the artist interacts with the interface (Fig. 3) controlling the VEP objects of four subjects to create soundscapes which are synced to the visuals and spatialized in 3D space. The interface was designed in designed in Max/MSP/Jitter [4] a visual programming language. VEP data for each sensor are used as control voltages, which are mapped to the sonification granular synthesis parameters such as grain size, pitch shift, pan etc. These parameters are mapped to the visualization parameters chosen and controlled by the artist.

There is constant change, reflecting neuronal mechanisms and processes, thus affecting perception. The realization of these changes is projected via an 8 audio channel output (binaural) and a visual projection. The visualization loops through the optical illusion images while VEP data of experiment participants warps the images. The sonification and visualization of this scientific data create sound and visual objects as a representation of integrated cognitive visual processes.

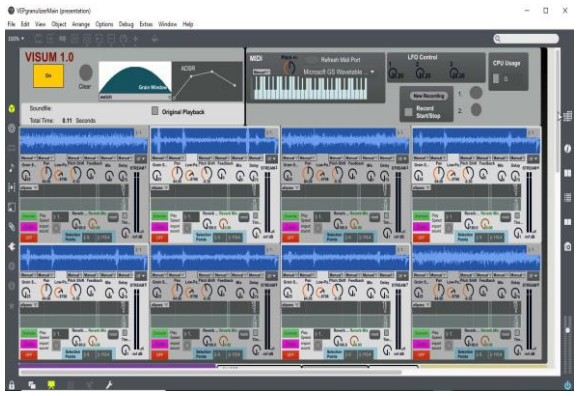

Figure 3 Visum Interface

The audience members will have a 3D immersive experience, by listening, engaging, and learning about visual perception. They will hear and see spatialized audio-visual allowing them to experience these visual perception processes.

5. REFERENCES

[1] Creel, Donnell. "Visually evoked potentials." *Webvision: The Organization of the Retina and Visual System [Internet]*. University of Utah Health Sciences Center, 2012.

[2] Bach, Michael, and Ch M. Poloschek. "Optical illusions." *Adv Clin Neurosci Rehabil* 6.2 (2006): 20-21.

[3] Mathew, Marlene, Mert Cetinkaya, and Agnieszka Roginska. "BSONIQ: A 3-D EEG Sound Installation." Georgia Institute of Technology, 2017.

[4] Max/MSP/Jitter < https://cycling74.com/>. Retrieved April 21, 2021.