You Are the Ocean: Interactive Art Installation

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Abstract
This paper explores "You Are the Ocean," an interactive art installation where a participant's brainwaves control a projected ocean simulation. Using an EEG headset, the approximate attention and meditation levels of the participant are measured. As the participant increases her attention and focus, the ocean and sky become stormier. When the participant calms her mind, the ocean too becomes calm. This paper describes the concept, implementation, and participant interaction surrounding the installation. While many existing artworks have used EEG headsets, "You Are the Ocean" is novel in its use of interactive, photorealistic real-time rendering to communicate the intrinsic connection between humans and the planet.

Author Keywords
Interactive art; environment; oceans; EEG; brainwaves; projection art.

CSS Concepts
• Human-centered computing~Participatory Design

Demo Video of the Installation
https://vimeo.com/232792092

Figure 1: Views from "You Are the Ocean".

Project Description

This interactive installation allows participants to control a digitally simulated ocean using only their brainwaves. Calm seas and storms alike are powered by the viewer's thoughts; the sheer act of concentration can conjure a squall or sunshine.

Participants intentionally control their thinking while surrounded by the magnified consequence of their thoughts. A participant wears an EEG (electroencephalography) headset that measures her approximate attention and meditation levels via brainwaves. Attention level affects storminess: with higher concentration, the waves get higher and the clouds thicken. By calming her mind, the subject can create a calm ocean.

Humanity evolved from the oceans. The vastness of the ocean prevents us from perceiving the impact of our actions. The human impact is a collective consequence. The industrial revolution and the direction that technology evolved have contributed to the increase of human population, exploited the ecosystems, and destroyed the balance. Our analytical, problem solving, positivist mind leads us to seek profit, speed and conformist solutions, creating major environmental problems.

"You Are the Ocean" is a reminder that our presence and thinking have a direct impact on the planet. If we stop seeing oceans as a resource and feel that we are an extension of the oceans, then we may begin internalizing Donna Haraway's insight: humans are not superior to any ecosystem and they exist in the intertwined web of all ecosystems as an extension of the planet [1].

Related Works

EEG-based artworks have common trends such as operating with live or recorded data, creating music, activating physical objects, generating projections, offering meditation, integrating multiple brainwave data, creating an artistic metaphor or functioning as a pragmatic tool.

The majority of EEG-based art pieces use live EEG input such as the most well-known Brain Ball [3]. In contrast, Melting Memories [4] operates with recorded data. In the majority of EEG art examples, the participants are stationary. They sit on a chair or stand in front of the piece or sometimes they lie down. Ascent [7] makes a clever twist on this trend by elevating the participant with her thinking activity. Ascent activates a human body and Brain Ball activates a ball while Melting Memories and Wave UFO [6] generate massless projections. In Eunoia [2], the performer's thinking activity creates music and actual ripples on the surface of the water. Mutual Wave Machine [5] creates music by integrating two different participant's brainwave data. Similarly, Brain Ball creates a competitive relationship between two participants by using their brain wave activity. While all these pieces serve as art installations, Agent Unicorn [8] aims to make a pragmatic contribution to the lives of children experiencing Attention Deficit Hyperactivity Disorder. Ascent, Wave UFO, Melting Memories, Brain Ball, and Eunoia all invite the participant to a mindful presence by integrating meditation.

Our piece "You Are the Ocean" adapts some of these trends. The participant is stationary. She can be mobile but her physical actions don't have a consequence for the output. The piece generates projected ocean waves. While the sound of the waves and wind is not musical, its minimalistic and repetitive nature serve as a noise machine for calming people. The participants who have tried the piece remain around it for a while, watching the ocean and enjoying its meditative nature. The novelty of "You Are the Ocean" is in its realistic visualizations. The majority of projection-based EEG art uses abstract visuals, while "You Are the Ocean" shows a realistic representation of clouds, light, and ocean waves and their smooth transitions.

Setup

"You Are the Ocean" is a flexible installation, designed to fit a wide variety of exhibition spaces. At its core, it is a standalone Windows application that runs on a powerful PC capable of generating the installation's real-time graphics. The EEG headset it supports is the NeuroSky MindWave Mobile, an inexpensive, consumer-oriented neuroheadset that connects to the PC through Bluetooth.

The installation is designed to be projected onto a wall, creating an immersive environment for the participant and spectators. Across its many exhibitions, the installation has varied from small projections generated by a single projector, to projections up to 30 feet long, such as at FILE in São Paulo, generated by multiple projectors (Figure 5).

The installation is usually accompanied by a guide who helps participants adjust the neuroheadset to achieve an optimal reading. This involves adjusting the position of the recording electrode, which rests on the forehead, and the reference electrode, which clips onto the ear. At the bottom right corner of the projection, a small icon appears to let the guide know the neuroheadset's

connection status. This icon disappears when the headset is connected and properly reading the participant's brainwaves.

While the wireless nature of the headset encourages the participant to move around the installation space, a seat is often placed in the center to provide a resting place. Encouraging the participant to sit at the beginning of the experience also facilitates the guide's assistance in adjusting the headset.

Implementation

"You Are the Ocean" was built using the Unity game engine and programmed in C#. The NeuroSky MindWave connects to the PC using its own proprietary application, which then interfaces with our application through a TCP connection.

Our code does not interpret raw EEG data. Rather, we use two basic metrics outputted by NeuroSky's proprietary algorithm, known as eSense. The "attention" metric, which supports the primary mode of interaction with the installation, is largely based on Beta waves, while the "meditation" metric emphasizes Alpha waves. Both of these metrics are returned as integers varying from 0 to 100, where a higher reading indicates more brainwave activity.

Because the MindWave only contains one recording electrode, its readings of brainwaves are approximate at best. However, it provides an easy setup experience for participants, and it still manifests the meaningful connection that exists between brain and ocean waves in "You Are the Ocean."

Within Unity, "You Are the Ocean" was built from a combination of pre-existing and custom-built assets. Both the sky and water are generated in real-time. The installation transitions between 20 pre-defined "profiles" of the sky and ocean, varying from placid water and blue skies to a turbulent ocean and thunderstorm. These profiles set the many attributes that define the dynamically generated environment, such as water and sky colors, wave intensity, and cloud cover. While the profiles ensure general consistency in these attributes, the constant movement of the waves and clouds in the scene ensures that no two instances of the same profile appear exactly the same.

The neuroheadset sends new readings to the application once every second. The "attention" readings from the headset are averaged over a few seconds, and then the proper sky and water profiles are chosen based on this average, correlating high levels of attention with a stormy scene and low levels with a calm one. Every few seconds, linear interpolation is used to smoothly transition between the old and newly selected profiles. The "meditation" readings are also used; they affect the speed of the camera as it flies over the water. Higher levels of meditation result in a faster speed, adding a transcendental quality to the piece.

When no one wears the headset, the ocean is in a default calm state with a cloudless sky. Several seconds after a participant removes the headset, the ocean will once again reset itself to this calm position.

The installation's audio comes from a combination of real-world recordings and computer-generated sounds. Once again, multiple pre-defined profiles are used,

consisting of sound files which are mixed together at varying volumes. A calm ocean is paired with the sounds of gentle waves, while a more turbulent ocean includes the sounds of crashing waves, howling winds, and intermittent thunder.

Participant Interaction

While "You Are the Ocean" was designed for a single participant, we also noticed active participation from spectators throughout our observations of participant interaction. Often this involved a dialogue between those waiting to try on the headset and the current active participant. Conversations centered around the participant's thoughts—when a storm would arise, an excited crowd often inquired about what exactly the participant was thinking in that moment. At other times, spectators would share their own thoughts on the impact of mindful presence on nature, or they would offer advice for what brings calm or concentration to their own minds. Most visitors wanted their turn at becoming the ocean, but many also simply enjoyed watching the dynamic, photorealistic visuals for long periods of time. Meanwhile, active participants often became engrossed in the piece, requiring a time limit when long lines would form.

Participants were often solely interested in creating a stormy ocean by increasing their focus and attention. Their tactics varied; sometimes it was thinking in another language, trying to recall a distant memory, or attempting mental arithmetic. Other times it involved an intense focus on something tangible, such as the waves of the ocean in front of them. When a participant was able to create a turbulent storm, there was often collective excitement among the spectators. Few participants were interested in clearing their minds to create a calm ocean.

While the piece was intended to evoke in participants a feeling that they are an extension of the world's oceans, the interactive nature of the piece sometimes resulted in an opposite reaction: participants felt god-like in their ability to directly control the ocean. Lastly, we found that the piece had universal accessibility across age groups. Children greatly enjoyed the installation—at Stanford's BrainMind Summit, for example, even an infant found joy as an active participant in the piece (Figure 3).

Images from Exhibitions

Figure 2: A crowd watches "You Are the Ocean" at Currents New Media Festival, Santa Fe.

Figure 3: The brainwaves of a very young participant, Max, generate the ocean waves at the Digital Consciousness Exhibit during the BrainMind Summit at Stanford University.

Figure 4: A volunteer adjusts the headset at SBCAST, Santa Barbara. Photo Credit: Kristen Weiss

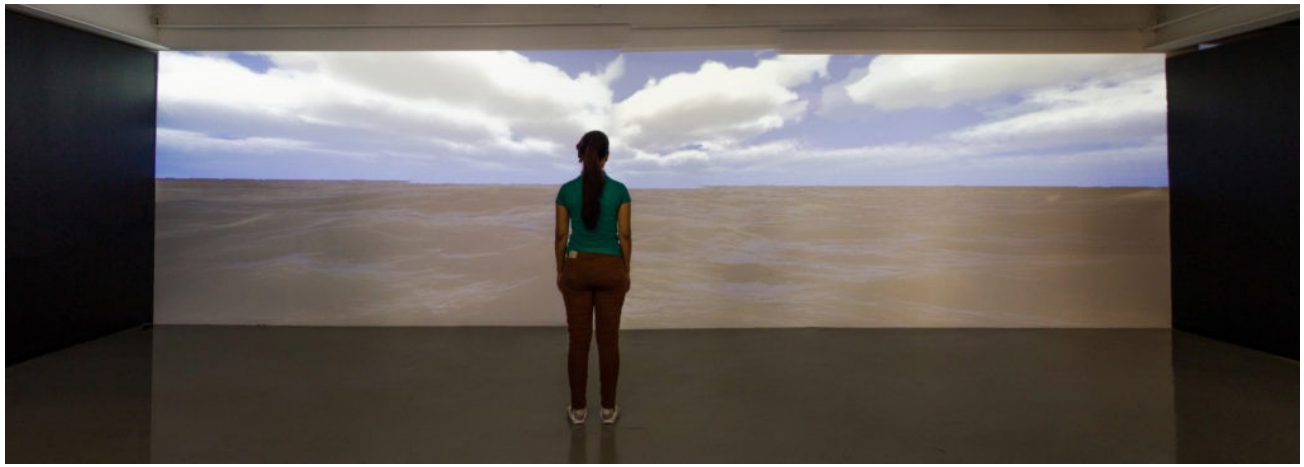

Figure 5: A participant engages with the installation at FILE festival, São Paulo, Brazil. Photo Credit: Camila Picolo

Figure 6: Visitors line up to try "You Are the Ocean" at the 2018 SIGGRAPH Art Gallery, Vancouver.

Figure 7: A dancer's brain activity creates the ocean waves during a dance performance at CommFest 2018, Northwestern University.

Acknowledgements

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