International Journal of Advanced Smart Convergence Vol.13 No.1 77-84 (2024)
http://dx.doi.org/10.7236/IJASC.2024.13.1.77

IJASC 24-1-8

Data Visualization of Site-Specific Underground Sounds

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Abstract

This study delves into the subtle sounds emanating from beneath the earth's surface to unveil hidden messages and the movements of life. It transforms these acoustic phenomena into digital data and reimagines them as visual elements. By employing Sismophone microphones and utilizing the FFT function in p5.js, it analyzes the intricate frequency components of subterranean sounds and translates them into various visual elements, including 3D geometric shapes, flowing lines, and moving particles. This project is grounded in the sounds recorded in diverse 'spaces of death,' ranging from the tombs of Joseon Dynasty officials to abandoned areas in modern cities. We leverage the power of sound to transcend space and time, conveying the concealed narratives and messages of forgotten places .Through the visualization of these sounds, this research blurs the boundaries between 'death' and 'life,' 'past' and 'present,' aiming to explore new forms of artistic expression and broaden perceptions through the sensory connection between sound and vision.

Keywords: *Underground Sound, Messages of Life, Digital Data, Transformation , FFT Function, Audio Visualixation.*

1. Introduction

This research, conducted through the 'Data Lifeform' project, explores the subtle sounds emanating from the Earth's depths in an effort to uncover hidden messages and the movements of life. These subterranean sounds, often associated with the realm of death, can be seen as the breath of nature itself. Despite the visual obscurity of the underground, it conceals the hidden messages and life's intricate rhythms. This project conceptualizes the sounds originating from these depths, which represent an alternate facet of life, as seeds. It then reincarnates them within a metaspace, investigating the reception of messages from entities concealed beneath the ground and converting these messages into data to cultivate new life forms. This research transcends conventional approaches to audio-visual programs, utilizing Sismophone microphones to capture and analyze the sounds emanating from diverse subterranean environments. The aim is to comprehend the unique characteristics and vitality of sounds originating from various underground settings.

This selection is deeply rooted in the unique historical, social backgrounds, and physical characteristics of each location. It serves as an expression of attention and respect for spaces, as well as the concealed narratives within them, which have been forgotten or marginalized in modern society [1]. These abandoned spaces themselves provoke subtle philosophical inquiries about societal transformation, cultural adaptability, and the

Manuscript Received: January. 22, 2024 / Revised: January. 28 , 2024 / Accepted: February. 5, 2024
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essence of human existence and worth. The artist endeavors to convey the hidden stories and messages of these spaces to us through the sounds emanating from their grounds. Furthermore, by employing the FFT function in p5.js to analyze the frequency data of the music, this project transmutes sounds into diverse visual elements. It explores the profound connection between sound and image, striving to introduce novel forms of artistic expression and broaden our perceptions.

The underground spaces documented by the researchers carry a wide range of social implications, spanning from historical sites of the Joseon Dynasty to contemporary spaces marked by significant events. These abandoned spaces, in themselves, pose intricate philosophical questions about societal evolution, cultural fluidity, and the significance of human existence. The artist's objective is to communicate the concealed narratives and messages of these spaces to us through the sounds emerging from their depths.

2. The Relationship Between Underground Sounds and Life, and the Significance of Sound Data Conversion

2.1 Theoretical Approach to the Association Between Underground Sounds and Life

Visualizing the sounds emerging from beneath the earth, symbolized as 'spaces of death,' in the form of life forms blurs the boundaries between 'death' and 'life.' By representing these sounds from 'spaces of death' as 'life forms,' the distinctions between life and death, past and present, and material and spirit become indistinct [2]. This theme, frequently explored in contemporary art, encourages profound reflection on our existence, the meaning of life, and the passage of time. Recording the subterranean sounds of these places is a process of sensing the unique meanings or messages they hold and transforming them into another medium [3]. By expressing these sounds as 'life forms,' the artist delves into the boundary between 'death' and 'life' associated with these spaces.

2.2 Technical Methods for Converting Sounds into Data and Their Artistic Applications

The act of nurturing data existing as sound into life forms serves as a bridge connecting space, time, history, and culture through the medium of 'sound.' Sound, though invisible, possesses the power to convey messages and emotions with great intensity. Through the expressive potential of sound, the artist unveils the hidden narratives of abandoned spaces and their historical, social, and cultural significance [4]. Furthermore, a fundamental aspect of site-specific art lies in the interaction between the audience, the artwork, and the location. By sharing the concealed stories and messages of a place through recorded sounds, the artist enables the audience to form new perceptions and emotional connections with that location. This transformation in the audience's relationship with the place prompts a reevaluation of its value and meaning [5]. Ultimately, the artist's creative act becomes a pivotal process that prevents 'abandoned spaces' from fading into oblivion. Instead, it rediscovers and accentuates the inherent life and value of these spaces. This aligns with one of the primary objectives of site-specific art: to redefine and underscore the value and significance of a location.

3. Research Methodology

3-1. Sound Recording

This research utilized Sismophone microphones to collect underground sounds. The chosen locations for sound collection are site-specific and hold significant social implications. They include Joseon Dynasty tombs, areas near the U.S. military base in Dongducheon, the cultural heritage site of Igansumun Water Gate

in Dongdaemun, and the vicinity of the Cheonggyecheon Overpass, covering places in Seoul and Gyeonggi that span from the Joseon Dynasty to modern and contemporary times. The sounds from these locations were collected and transformed into data.. Figure 1 depicts scenes illustrating the process of recording sounds from underground.

Figure1. Sound recording equipment

3-2. Sound Analysis

The transformed data underwent an initial visualization through the audio spectrum, where the analysis of sound spectra unveiled the conditions within the earth and variations in sound vibrations. After mixing the audio files, they were converted into computer-readable audio signals, enabling the analysis and visualization of sound data using p5.js and the FFT (Fast Fourier Transform) function. Figure 2 represents the primary visualization of the audio spectrum.

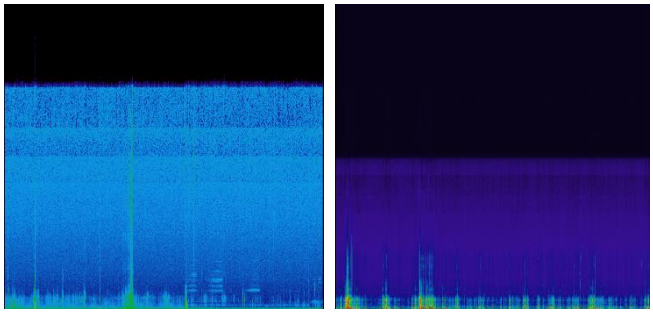


Figure2. Audio spectrum measurements

4. Data Analysis and Results

4.1 Analysis and Comparison of Sound Data by Location

In this study, we investigated where and what sounds would be recorded for the purpose of visualizing sound as data. In Table 1, we summarized the process and methods of sound recording along with introductions to each location and their significance.

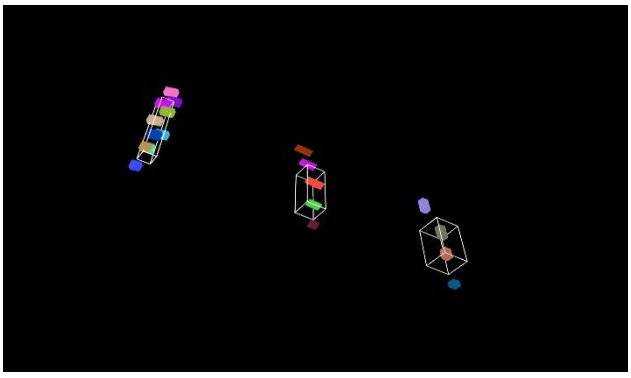
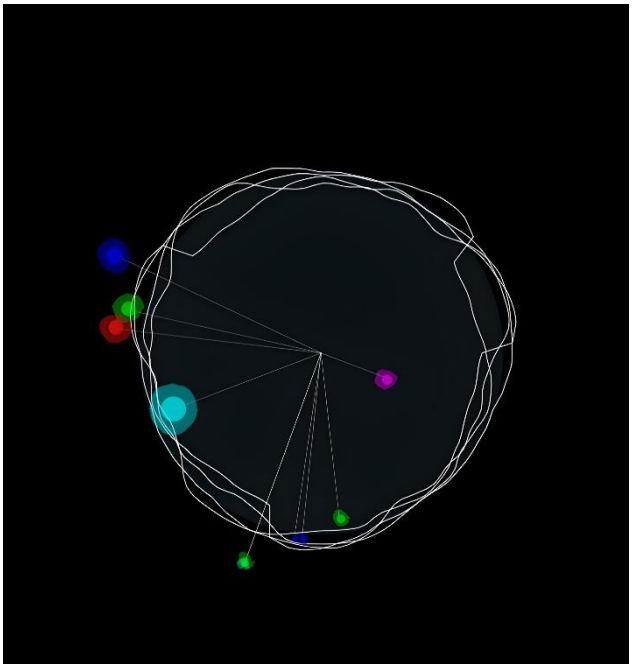
Table 1. Analysis and comparison of sound data for each location

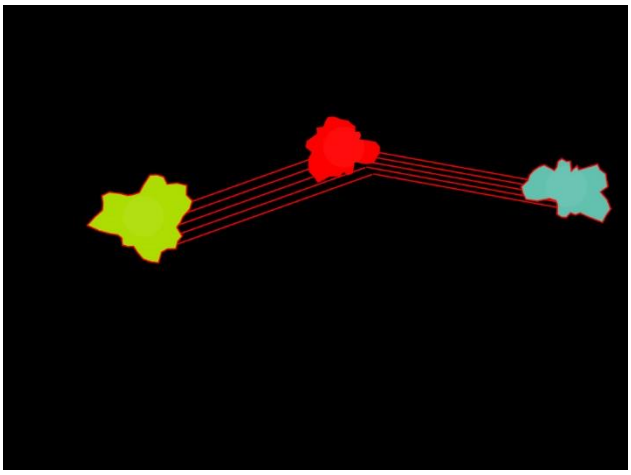
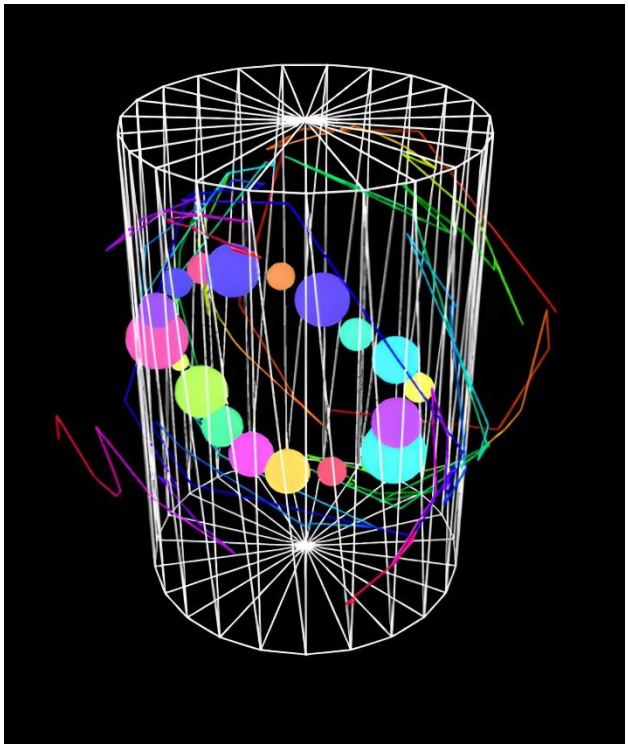
Location	Title	Background	Key Findings	Shift in Meaning
 #. Joseon Dynasty Graveyard	Exploration of Sounds connected to the historical and social context of cemeteries.	For centuries, graves have been silently guarded by their surroundings, including large and majestic trees.	The soil of the cemetery is densely active with subtle movements and sounds.	An awareness of the change in the meaning of sounds after understanding the cemetery's history, atmosphere, and social context.
 #. Bosandong, Dongducheon	Exploration of Sounds Related to the Shocking Incident Site in Bosandong, Dongducheon.	In 1994, a tragic event occurred where a young female employee was murdered by U.S. soldiers. Even after 30 years, the scars and memories of the incident still linger.	To capture the invisible sounds within the building that was the site of the incident.	Although the interior of the building has become a lifeless space of death, mechanical and repetitive sounds still emanate from within.
 #. Dongdaemun	Exploration of Historical and Cultural Traces and Their Sounds in Dongdaemun and Hanyang (Now Seoul), Centered Around Igansumun.	Dongdaemun, the heart of Hanyang and a place where historical events coexist, especially Igansumun, which has been the endpoint for various life forms and waters.	Igansumun stands as a testament to Hanyang's history, where the sounds of nature and the city, the past and the present, intermingle at the juncture of different eras.	Igansumun is not merely a conduit for water but a meeting place of epochs, people, life, and death, with its sounds conveying vital messages of history and culture.
 #. Cheonggye Overpass	The Importance of 'Dead Spaces' like Under the Cheonggye Overpass and the Exploration of Sounds from Beneath the Ground	Once the center of Seoul, the area beneath the Cheonggye Overpass has become a forgotten space over time, now permeated with a quiet and serene presence.	The ground beneath the Cheonggye Overpass is filled with various noises, yet amidst this noise, one can hear the evolving story of Seoul and the lives and tales of its people from different eras.	These spaces offer profound reflections on the past, present, and future, highlighting the importance of 'dead spaces' that have become the victims of urban development and where the memories of those who once inhabited them are buried.

4.2 Dynamic Changes in Visual Elements Based on Sound Data

Through the p5.js program, sounds imbued with symbolic meanings from various locations were processed to classify the characteristics of sound data. Different expressive elements were applied to each sound, creating organisms that move and evolve according to the sound. In Table 2, we have summarized the representation methods of each organism and the principles of their response to sound.

Table 2. Dynamic changes in visual elements based on sound data

	**-Dynamic Movement:** Using translate and rotateX/rotateY, the central 3D structure dynamically moves in response to the amplitude of the music. That is, the volume of the music dictates the magnitude of its movement.
	-Three Pillars: The screen displays three pillars, each moving at different speeds and sizes. These pillars are drawn based on the music's spectrum data.
	-Random Colors and Positions: Small boxes within each pillar are filled with random colors, and their positions also change somewhat randomly.
	-Outlines: White cubic outlines surrounding each pillar represent the total height of the pillar and dynamically change in size based on the music's spectrum data.
	**-Music and Visualization Synchronization:** The bass (low frequencies) of the music is analyzed to influence the size and movement of various visual elements. The central large circle changes size according to the intensity of the bass, and small circles or squares are generated around the large circle whenever a certain bass threshold is reached.
	-Particle System: Small circular particles appear, move, and disappear at random positions across the screen. The quantity of these particles is determined by the intensity of the music's bass.
	-The Central Large Circle: There are circular lines drawn around the large circle using a noise function. The noise function generates continuous and smooth random values, making the lines around the circle continuously and smoothly transform.
	-The Central Small Circles and Squares: The small circles have interesting appearances using shadow effects and noise. With a 10% probability, small squares are generated and rotate around the screen's center. Colors: Bright primary colors with an emphasis on fluorescent hues are used to give a lively and dynamic feel.

<table>
<tr>
<td rowspan="3">  </td>
<td>-LifeForm Class: This class represents objects within the screen that move and transform individually. Each object possesses variables for its x, y position, size, color, and a shapeVariation variable that determines the transformation of its shape. The grow function adjusts the object's size and color based on the music's volume and bass, also generating changes in position. The network function creates connection lines through interactions with other LifeForm objects and applies a fluorescent twinkling effect. The display function draws the current visual representation of the LifeForm object.</td>
</tr>
<tr>
<td>-Interaction with Music: The code calculates the music's volume and bass to reflect it in the visualization. The LifeForm objects move, and their size and color change according to these musical characteristics.</td>
</tr>
<tr>
<td>-Screen Elements: The LifeForm objects move periodically, forming networks of lines that twinkle in fluorescent colors. Each LifeForm object has an outline and core that transform using a noise function, mimicking the complex forms and movements of life forms in the real world.</td>
</tr>
<tr>
<td rowspan="6">  </td>
<td>-Initial Setup and Music Playback: The preload() and setup() functions are used to load and play the music file. WEBGL is utilized for rendering 3D graphics.</td>
</tr>
<tr>
<td>-Wireframe Cylinder: A wireframe of a rotating cylinder is drawn at the center of the screen.</td>
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<tr>
<td>-DNA-like Lines: DNA-like lines are drawn inside and outside the wireframe cylinder, moving based on the noise function and the average volume of the sound. The color of the lines changes with their height.</td>
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<tr>
<td>-Spheres within the Cylinder: Several small spheres are drawn inside the cylinder. The number, color, and position of these spheres change according to the music's volume and Perlin noise function.</td>
</tr>
<tr>
<td>-Color Mode: Setting the color mode to HSB with colorMode(HSB) makes it easier to adjust colors.</td>
</tr>
<tr>
<td>-Display and Responsiveness: The windowResized function automatically adjusts the size of the canvas when the browser window is resized, ensuring that the graphics remain centered.</td>
</tr>
</table>

5. Conclusion

In this era, the rise of digital art is erasing the boundaries between visual and auditory experiences. Beyond traditional art forms, the conversion of sound into physical and visual phenomena through code represents a contemporary art trend. The codes we have reviewed provide clear examples of this shift, offering insight into how the artist intended to visualize recorded sounds and the methods they employed.

One key aspect to highlight is the artist's use of the FFT function in p5.js for analyzing the frequency data of music. This function dissects complex frequency components, breaking them down into individual elements and associating them with various visual elements. This allows the artist to monitor sound volume and amplitude in real-time, enabling dynamic adjustments to the movement and form of visual elements. Furthermore, the code introduces diverse visual expressions based on volume and frequency data, including 3D geometric shapes like toruses or spheres, fluid lines generated using noise functions, and moving particles. Notably, the size, position, rotation, and color of these elements dynamically change in response to the pitch and intensity of specific sounds.

These evolving visual elements establish a sensory link between sound and vision. Notably, the artist has diligently worked to enhance this connection by governing the movement of visual elements based on specific sound components. This method enables viewers to discern subtle shifts in sound through visual phenomena. Such an approach can be viewed as the artist's endeavor to delve into the profound connection between sound and vision. Yet, it transcends mere creation of visually pleasing effects. At a deeper level within the code, the artist seeks to explore the essence of sound and its influence on our visual perception.

This work offers fresh perspectives on the interplay between sound, imagery, and technology. It dismantles the boundaries separating music from visual art and extends the potential of code as a medium for investigating the interaction between these two senses. In summary, the codes discussed provide valuable insights into visually representing the intricate qualities of sound within the realm of digital media. They delve into the dynamic interplay among sight, sound, and code, demonstrating that such interactions usher in new frontiers in contemporary art.

Acknowledgement

This paper has been studied with the support of the academic research support project of Dongyang University in 2021.

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