Exploring interactive interfaces under sound and visual content

by
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Abstract

This paper researches the possibilities of using interactive interfaces to enhance audience participation in audio-visualization artwork. The research will be conducted with three interfaces: Arduino knob sensors, a web camera, and a leap-motion. Each input will trigger different visual parameters, giving the audience dynamic exploration through projects.

This work is inspired by a performance area called VJ'ing, in which live visuals and music are shared with audiences. I noticed most video jockeys (VJs) use MIDI Controllers and knobs to build visual content which can match the DJ set. This inspired my interest in exploring other interactive interfaces to manipulate visuals in new ways. I use Research-Creation, a methodology through making combined with my previous knowledge and practices, to build new approaches to sound visualization.

This work will be set up in an empty space; three different inputs will generate different visual effects based on a similar visual style. The audience participating in the interactive experience will see how different interfaces can create possibilities and inspire potential users. These explorations' possibilities can apply to various areas, such as live performances and digital art creations.

Acknowledgment

I would like to express my gratitude to the following individuals for their assistance with this research project. Firstly, I want to thank my primary research advisor, Dr. Adam Tindale, for his constant support and guidance in improving the concept and building up the work. I am grateful for the valuable lessons he taught me, as well as the numerous creative ideas he provided for the installation. His input has not only helped me with my thesis, but also influenced my future art exploration.

Secondly, I would like to express my appreciation to my secondary advisor, Prof. Nickolas Puckett, for his constructive advice and support in completing this research. He gave me many valuable suggestions for building the installation and taught me how to make the technology part more feasible. I am thankful for his guidance and contribution to this project.

I would like to thank the Digital Futures Program thesis directors, Dr. Cindy Poremba, and Dr. Emma Westecott, for their valuable feedback and constructive criticism throughout the development of my thesis and research. Their guidance and support have helped me to refine and enhance this project into a more comprehensive piece of work.

In the end, I am also thankful for the technical support from Aaron Latade. He provided me with various ideas/help through different software such as Ableton & Touch Designer.

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1.0 Introduction

Usually, people watch Vjing performers in the live show; however, the difference for this artwork is to engage the audience participation and explore the possibilities that the input can create in the generation of real-time audio-visual design. They may create their design by interacting with my works to connect with audio-visualization works.

1.1 Motivation

This idea grew out of my previous experiences and practices. My art practice began in 2016 as part of my undergraduate program in Technoetic Arts. During my studies, I gained knowledge in various fields, such as cybernetics, conceptual art, interactive installation, critical art, performance art, and sound visualization. However, I have not yet decided which field to specialize in. Through trial and error in creating digital art, I reflected on ways to improve in the future. As I entered the field of audio visualization, I began to discover what I wanted to achieve, and was drawn to the captivating visuals created by artists during live performance shows. It makes me excited and can help me understand their work. The person responsible for producing the visual output during live performances is called a video jockey (VJ). VJ has evolved to become someone who provides the live visual accompaniment to music performances, and they always play the primary role between audiences. The wonderful visuals inspired my curiosity about how visuals and sound can work together. Which programs and equipment can generate audio-visual displays? and how can I experiment with them? I also wondered if there were any audio-visual art installations that I could experience in person. This thought inspired me to consider if I could combine my previous interactive design knowledge and ideas to create an interactive installation that would offer a unique environment for the audience to experience sound visualization. I realized that not only could it attract audience

participation, but it could also serve as a quick reference for people who are curious about the functionalities of audio-visualization.

1.2 The function of sound visualization

Audio-visualization is creating visual representations of the sound of music, which involve manipulating and projecting visual content in real-time to accompany music or other live events, responding to specific musical elements, such as basslines or vocals. Audio-visualization is often used as a creative tool in music and multimedia production, as well as in interactive installations and visualizations for live performances. At the same time, Audio-visualization can help to create a more engaging and dynamic performance, as the visuals can respond and adapt to the changes in the music to enhance the audience's experience and overall atmosphere. Also, a powerful way to add a visual dimension to audio content and create engaging, immersive experiences for audiences.

1.3 The difference with participation

Interactive art, as artists seek to create more immersive and engaging experiences for their audiences, refers to art forms that invite the viewer's participation, blurring the line between the artwork and the observer. It is a form of art that encourages the audience to interact with the artwork physically or mentally, making it a more engaging and immersive experience. It can take many forms, including installations, performances, and digital media. There are three main types of interactive art:

1. Interactive installations: It responds to the viewer's movements or touch, such as a sculpture that changes color or shape when someone approaches it.

2. Performance art pieces: It is a form of art that emphasizes the audience's live experience and the performer's physical presence. It can encompass a wide range of creative

activities, including theater, dance, music, and visual arts, and is often characterized by using the performers as the primary medium of expression.

3. Digital media pieces allow viewers to interact with the artwork using a computer or mobile device, such as a virtual reality experience that puts the viewer inside a painting.

Based on the definition, interactive art includes performance art and installations, but the key difference lies in audience participation. Interactive installations are designed to respond to both input and output. In computing, Input/Output (I/O) systems enable communication between a computer or digital device and the outside world. Input refers to the data or instructions sent to the computer, which can include a variety of interfaces such as keyboards, mice, scanners, and microphones. Output, on the other hand, refers to the results or information that the computer sends back out, and the devices can include monitors, printers, speakers, and headphones. For example, Jeffrey S. Cook, Neha Gupta, and Richard Segall study found that:

'Programming may be considered a kind of visualization of what is programmed. Sound visualization with the use of sound recording systems and visual music; multimedia installations may also be considered forms of big data sets visualization.' (2018, p.588).

Compared with Audio-visualization in the live performance, it is the same logic as interactive installations: The artists use different inputs to create the interactive output to lead the audience in an immersive way. However, the most significant difference is the emphasis on interactivity and participation. The live performance usually is generated by the performer directly. The audience only can watch it. However, in interactive installations, rather than simply observing, viewers are invited to engage with it in a variety of ways in the installations,

often through physical interaction or the use of technology such as touchscreens, motion sensors, or voice recognition. There are many opportunities to let audiences participate.

John Shotter noted that "The aim of participatory research is 'to help participants attend to the spontaneous, dialogical involvements in which they originate and sustain their practices" (2000, p.130).

This led me to another question: Can audiences create their visuals in the audio-visualization environment instead of merely experiencing the performances? Allowing audiences to design their visuals in an audio-visualization environment can transform them from passive viewers into co-creators of the performance. It has the potential to enhance their engagement and create unforgettable experiences.

1.4 Research Summary

1.4.1 Problem Statement

As there is a gap of participation between audiences and performers, audiences only can watch the visualization work led by performers. That motivated me to create an environment based on the interactive design method, using different interfaces to set up an environment may enhance audience participants to create their visual works.

1.4.2 Research Questions

1. How can different interfaces be used to create an interactive artwork based on audio-visualization that provides quick examples and reduces the participation gap?

2. How can the previous practices in art exploration be combined into a methodological approach to building concepts and techniques through experiences?

2.0 Literature and Context Review

The literature review will help me to understand how to develop the concept of this artwork. It will consist of several sections. Firstly, it will define live visuals in live performances and discuss the relationship between audiences and VJ performers. Subsequently, it will review how audiences participate in interactive art installations and explore whether I can apply the same principles to set up an interactive environment for people to connect with each other.

2.1 Introducing the importance of Live Visuals

Léon McCarthy noted that "As a result, within Live Visual performance practice, aesthetics is profoundly coupled to technological processes and inventions. The term 'live' in Live Visual performance emphasizes that it is art created for and in the presence of an audience: the rendering of the artwork happens in real time as an ephemeral experience shared between performer and audience." (2022, p8)

The level of spontaneity that a performer strives for will vary, but in all cases, the audience's presence impacts the performance that is realized. The "live" aspect of live visual performance is also significant as it emphasizes the audience's importance in the artwork's creation and experience. The audience's presence creates a shared experience unique to each performance, making it a quick and dynamic art form. The performer's interaction with the audience can also impact the level of spontaneity in the performance, as the performer may respond to the audience's reactions and feedback.

The aesthetics of live visual performance can vary widely depending on the performer's style and approach, but the performers' technological tools are a fundamental part of the aesthetic. From projection mapping to real-time video manipulation, technology enables live visual

performers to create dynamic and immersive experiences for their audiences that are highly aesthetic.

Léon McCarthy's perspective on Live Visual performance highlights the importance of the audience and technological tools in creating the aesthetics of the performance. The "live" aspect emphasizes the audience's significance in the artwork's creation and experience, and the audience's presence impacts the performance that is realized. The use of technology is a fundamental part of the aesthetics of Live Visual performance. The technological tools used by performers enable them to create immersive experiences that are highly aesthetic. From projection mapping to real-time video manipulation, these tools allow performers to create dynamic visuals synchronized with other performance elements.

The level of spontaneity in the performance can vary depending on the performer's approach, and the interaction between the performer and the audience can also impact the performance. The shared experience between performer and audience is unique to each performance, making Live Visual performance an ephemeral and dynamic art form. Overall, the aesthetics of Live Visual performance are highly dependent on technological processes and inventions, as well as the interaction between performer and audience. The result is a highly immersive and dynamic art form that offers a unique experience to each audience member.

2.2 The relationship between Audience and Vj performer

Michael Betancourt noted that:

"A common concern when considering VJ (and video art generally) as an active practice, outside the confines of the gallery, is the issue of the relationship between the audience and the performance work: the question of what constitutes 'wallpaper' and what constitutes 'art.' This is an often contentious question; how- everitis also spurious-a

reflection of an established hierarchy between venues that has less to do with the performance itself and more with the status of the site where that performance happens. It is a question of whether (in extreme cases) the performer dominates the viewing situation, or the audience dominates." (2009, p.125)

This dynamic is particularly evident in the case of VJ practice, where video and visual effects can blur the lines between art and entertainment. Depending on the context in which it is presented and the audience's expectations, a VJ performance may be perceived as a work of art or simply a form of background decoration. The interchangeable concept of art and wallpaper highlights the subjectivity of the definition of "art." What one person may consider a work of art, another may view as mere decoration or wallpaper. This further emphasizes the importance of considering the audience's perspective when analyzing and interpreting works of art.

Michael Betancourt discusses the relationship between the audience and the performance work in the context of VJ (video jockey) and video art. He notes that what constitutes "art" versus "wallpaper" in this context is often contentious but ultimately reflects an established hierarchy between venues rather than the performance itself. Based on this point, we can know the dominant role that performers will bring, so how can the audience experience this play form and try with it?

Another author also has a similar view: Jonathan Hook and David Green (2011) noted that "VJing and other creative performance domains had been considered previously in an interaction design context. A primary concern of this research was the relationship between the performer and the audience. Interactive surfaces have been designed to make the audience aware of a VJ's actions using enhanced visibility and collaboration." Empirical studies have also explored aspects of this relationship and addressed issues, including the spectator experience and audience participation.

Furthermore, Engström et al. explored the integration of VJs' aesthetic, interface, and social preferences into a participatory scenario using mobile devices.

In this case, performers always play the role of the domain in the live performance, so my target is to let the audience feel the work and get more connection with the work.

2.3 Participation in the interactive artwork

Interactive art allows viewers to interact with the work, which means the interactive artwork is designed to empower the audience, allowing them to create, change, and influence the artwork itself and the institutions and events it reflects. In this way, interactive multimedia art becomes a platform for shared authorship and social exchange, where each voice is valued and contributes to the overall meaning of the artwork.

Kristine Stiles and Edward Shanken noted that "In digital art, participation in the processes of creative interaction becomes central to the content of a work, and to see one's volition materialized arguably heightens viewer involvement." (2000, p.45). When a viewer can actively participate in the creation or manipulation of digital artwork, it can create a more

profound sense of involvement and connection to the piece. This can lead to a more immersive experience and a greater appreciation for the work.

2.4 The Interface's role

Achintya K. Bhowmik noted that:

"How we interface and interact with computing, communications, and entertainment devices is going through revolutionary changes, with natural user inputs based on touch, voice, and vision replacing or augmenting the use of traditional interfaces based on the keyboard, mouse, joysticks, et cetera. As a result, displays are morphing from

one-way interface devices that merely show visual content to two-way interaction devices that provide more engaging and immersive experiences." (2014, p.1)

How we interface and interact with computing, communications, and entertainment devices is changing significantly. With the rise of touchscreens, voice recognition, and gesture-based interfaces, traditional input devices such as keyboards, mice, and joysticks are being replaced or augmented by more natural and intuitive methods. Moreover, the changes also give examples in interactive art.

Contextual Review

The Contextual Review I searched two artworks that influenced me for art creation, for example, the interactive and performance ways.

2.5 Contextual Review #1 *Sonic Water*

Sonic Water from the laboratory group KYMAT in Germany, this work gave me some references on how many possibilities of interactive interfaces the artist can bring to the exhibition.

This work is based on the experiment of Cymatics. The artists aesthetically express sound and transform it into attractive visual graphics and images. The exhibition set up an inverted camera to shoot a small cup filled with water in real-time and then projected the thing onto the screen so the audience could see the water image. Furthermore, after that, the various pulses are converted into sound, causing the sound film to vibrate, so the water surface in the bottle cap will produce corresponding watermarks. The water pattern will also change according to the frequency. Not only that, but it is also an interactive device. The exclusive underwater acoustic image will appear when the audience speaks into the microphone. The process of sound and vibration can be visualized by adding sand, water, fire, electricity, ferromagnetic fluid, plasma ball, and other media.

When it generates an incredible sound based on the influence of sound waves, the process of sound and vibration can be visualized.

Using cymatics and other interactive media to create visual representations of sound is an excellent example of how artists can use technology to enhance and transform the viewer's experience.

The interactive aspect of the *Sonic Water* exhibit, where the audience can speak into a microphone and create their own unique underwater acoustic image, adds an element of participation and engagement, making the exhibit more immersive and memorable. In addition, using various media, such as sand, water, fire, and electricity, to visualize sound and vibration adds to the overall aesthetic appeal of the exhibit, creating a multisensory experience for the viewer.

The *Sonic Water* exhibit is an excellent example of how artists can use technology to create interactive and immersive exhibits that engage the viewer's senses and enhance the overall experience.

2.6 Contextual Review #2 *Trance*

I opened the door for the exploration of live performances by accident. At that time, I had planned to design an interactive dance installation, and my professor introduced me to many clubs that let me do reference work. She recommended a few famous local experimental underground clubs; the style of the performance groups has their type and very artistic way. I still remember that on March 29, 2019, it was hosted by the artist called Tianzhuo Chen (Asian Dope Boys). This is my first time entering a new world, which motivated me a lot during my artistic creation. Tianzhuo Chen is a famous modern artist known for his video performances and installations. His performance is always tied to his works, sometimes at a gallery after party. In this show, he works as a VJ to show his new works and the DJ followed the style of the visual to match the significance

behind the work. Under the environment he created, I learn how the artist creates his work, even to understand his character. His practice inspired me a lot: Visual combined with audio can be a way of explaining thoughts and creation, establishing a link with audiences and artists.

Not only in sound visual live performances, Tianzhuo Chen always combined emotion with the audience, allowing audience participation in the works to enhance immersive feelings. His live-performance works *Trance* at M WOOD Gallery, Beijing, gave me the reference about how artists create "participation," not only the approach of using interactive elements, such as inviting audiences to interact with the artwork physically but also can create a sense of immersion and emotional connection.

In *Trance's* work, Tianzhuo Chen invited the performer to do a live performance in the gallery, with each performance lasting 12 hours and taking place once per day. After many years of preparation, this marathon-like performance project is the artist's first trial. Unbound by traditional genres of theater, dance, or musical opera, *Trance* takes the entire museum as its stage and presents six stories related to human illusions and previous artworks. Rather than adhering to established conventions of narrative, chronology, or delineation between work and the environment it is situated in, Tianzhuo immerses audiences in a spatially and temporally de-centralized performance, where visitors are free to wander for the entire 12-hour duration as if in an aimless stream of consciousness. Eventually, Tianzhuo expects viewers will cross a threshold whereby they are no longer in control and enter a "state of trance" induced by their perceptions. After the first three days of live performances, a related video work will be created and exhibited in the museum's central hall during the exhibition.

As the artist mentioned, Taking *Trance* as the starting point, M WOODS invites audiences to immerse themselves in the world of Tianzhuo Chen: in his rebellion against cultural monotony and stereotypical interpretation and in his constant search for sincere, genuine modes of expression.

3.0 Research Methods and Methodologies

3.1 The approach of Research-Creation

Owen Chapman and Kim Sawchuk observed that "Research is not only part of developing art projects that then stand on their own; rather, performances, experiences, interactive art works, etc. can also be ways of generating research data that can then be used to understand different dynamics." (2012, p. 6). This research information is helpful in both considering how "effective" (2012, p. 81) the work is, and to develop "information on user-responses" (2012, p. 81) to iterate upon the project. There is a form of interactive design or testing. Individuals or groups who may be the intended audience are often involved in the design process. This allows designers to test and refine their interactive methods based on feedback from the audience. By involving the audience in the design process, designers can ensure that their interactive methods are engaging and effective, which can make any necessary changes to improve the audience's experience. This approach can be particularly effective in interactive performances, as it allows performers to refine their interactive elements to ensure that they effectively engage in creating an immersive experience. Ultimately, the goal is to create an engaging and enjoyable performance for the audience and involving them in the design process can help achieve this goal.

Research-Creation is an approach that combines artistic creation with research methodology, using the process of creating art to generate new knowledge and insights. It emphasizes the importance of incorporating research into the creative process and using the artistic output to generate data and understanding. This approach can be beneficial in fields like interactive media and live performance, where users can experience the creative works, and the audience response is critical to the success of a project. By involving users or

audiences in the creation and testing process, researchers and artists can gain valuable insight which can be used to refine and improve the work.

I selected seven experiments to show how I improved my thinking and technique skills and built the research field. For Experiment 1, I utilized a self-made interface consisting of a touch sensor in Arduino, which helped me to understand how to connect different interfaces in TouchDesigner. Experiment 2 allowed me to gain practical experience in planning a show and performing in a public gallery. In Experiment 3, I learned how to create sound visualization works using various software. Experiment 4 taught me how to use external techniques to construct a holder for a circuit board. Finally, in Experiments 5, 6, and 7, I gained experience in selecting appropriate contexts and leading audiences to participate in interactive works.

3.2 Experiment #1 Interface prototype

Interactive Arrival Lobby (2019)

This is a prototype for an interactive lobby (see Figure 1). It's my first attempt to use a touch sensor as an interface in Arduino, and to change the visual designs using TouchDesigner. In this experiment, my focus was on getting the basic demo to work by connecting Arduino to TouchDesigner. (See Figure 2).
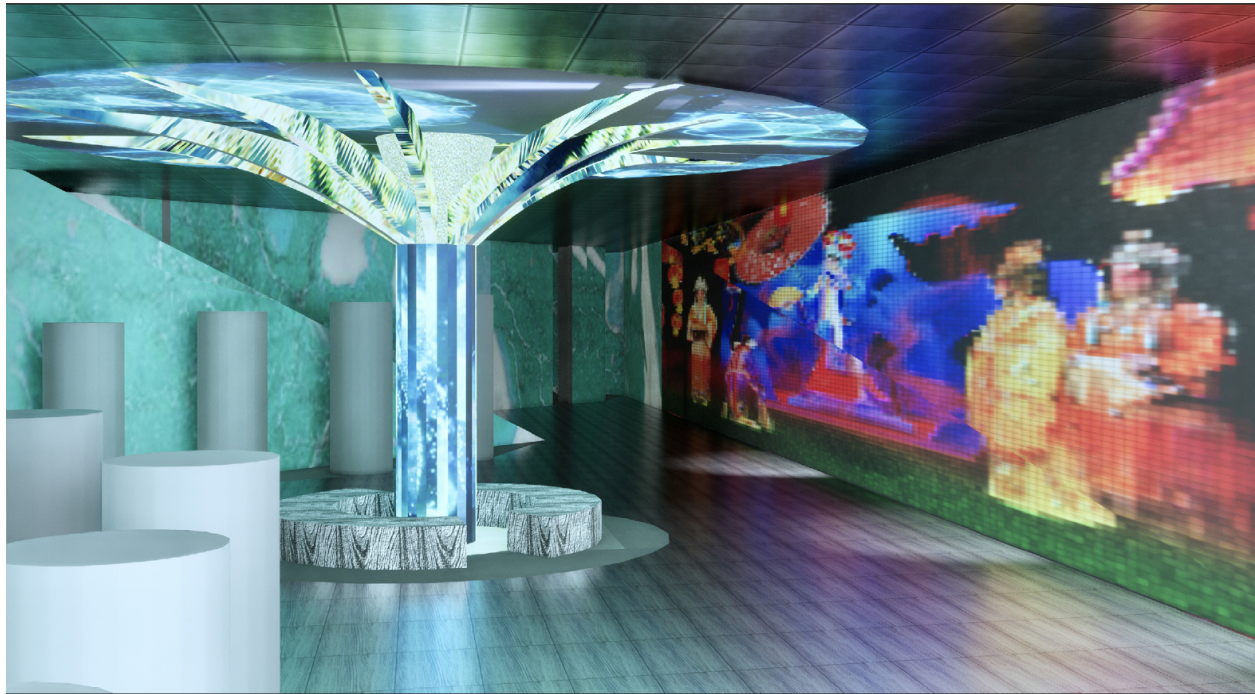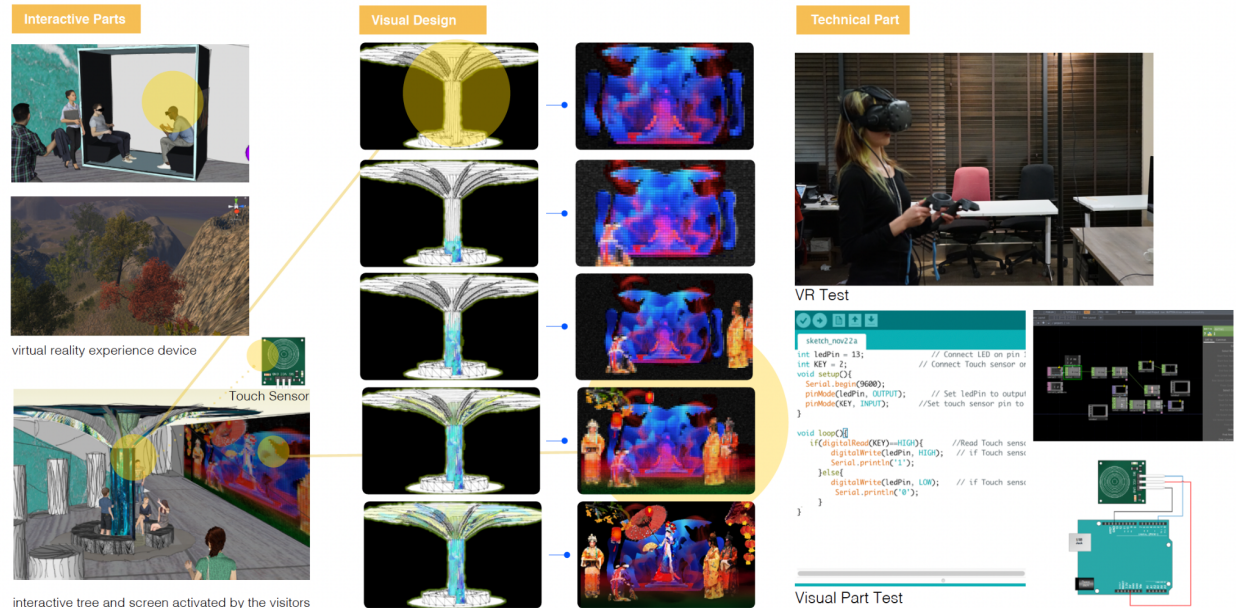
Figure 1. Design Draft.

Figure 2. Technology part demo.

Experience 1 Reflection: How to make the prototype more realistic?

— To do more research and be ready for plan different possibilities.

This project combines both imagination and technical skills that I have gained through my experiments with the demo. However, I am uncertain whether it would work with such large LEDs. Therefore, it is essential to consider the potential risks and limitations of any new technique or technology before implementing it on a larger scale. Before proceeding with the concept, it would be helpful to list the potential risks and limitations and explore alternative options that could be pursued if the current technique proves unsuitable for larger LEDs. These alternatives could involve experimenting with different controllers, modifying the design of the LED display, or exploring alternative interactive technologies.

Through considering these potential risks and alternatives up front, I can make a more informed decision about the feasibility and viability of the concept and ensure that I have a backup plan in case of any technical or logistical challenges that may arise.

3.3 Experiment #2 Live Performance practice: Sound input

Sun in Sunken Sea· Three Days (2019)

This work is my first time doing live performance art with Virtual Reality at Yard Gallery, M50 Art District, Shanghai. It was my first experience as a performer, so I got direct feedback from the audience (See Figure 3). I designed a virtual world in Unity and connected it to the Microphone. When the performer (me) constantly yells, the visuals will change. Through projection from the VR glass, audiences could see what was happening. I chose this form because live performance art with virtual Reality can offer a unique and immersive experience for the audience, blurring the line between the physical and digital worlds. The combination of live performance and virtual reality technology can create a fully immersive and interactive experience

for the audience, allowing them to engage with the performance in an interactive way (See Figure 4). This type of art can also offer new possibilities for storytelling and expression, as the performer can use the virtual environment to create a narrative or convey emotions uniquely and powerfully.
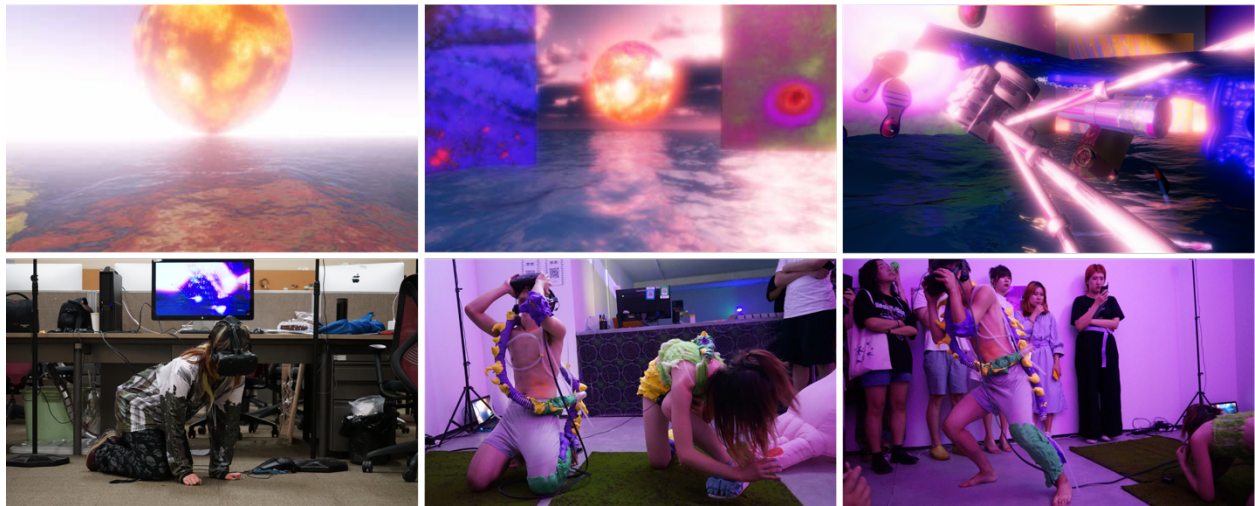

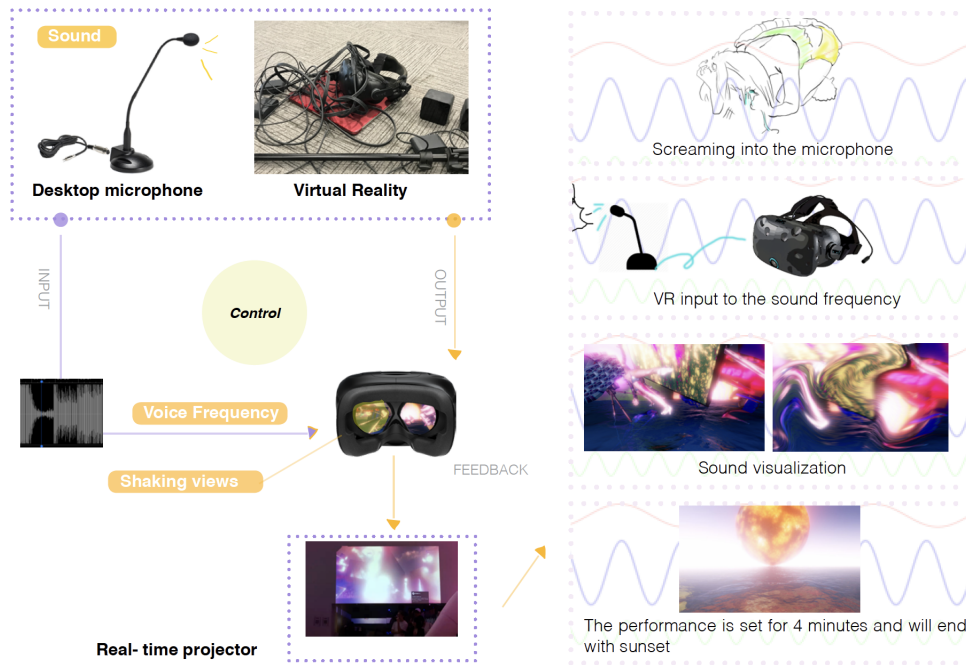*Figure 3*. Live Performance, M50 Art Zone, 2019.

Figure 4. Interactive Method.

The concept is: The fantasy brought by desire dissipates while the alienated products and a shattered body make up the vision for the future. When the invasion of technology is inevitable and the substantial world perishes, illusion and awareness only emerge in different dimensions.

This practice is making me realize that if I decide to do a live performance, I will need to carefully consider the amount of content I provide and take into account the emotions and reactions of the audience.

Experiment 2 Reflection: How do people feel excited during the whole live show?

— Design a variety of performance forms.

The show lasted for 10 minutes, but I had only designed one interactive part. At the beginning, the audience was very excited, but after the interactive part of the performance was repeated several times, they started to feel tired. This experience taught me that variety is crucial in keeping the audience engaged during an interactive performance. Using a single interactive method throughout the show can become repetitive and dull for the audience. It is important to consider incorporating different interactive elements or surprises throughout the performance to keep the audience engaged and excited. It could include changing up the type of interaction, introducing unexpected twists, or incorporating audience feedback in real-time. By varying the interactive elements, the audience will likely stay engaged and interested in the performance and other artworks.

3.4 Experiment #3 Alternate software options

Visualization of Gossip (2021)

The inspiration for this work (see Figure 5) comes from the multi-disciplinary studio NOTA BENE Visual and their interactive typographic installation *'IN ORDER TO CONTROL.'* For this study, I used p5.js to connect the microphone, which detects sound amplitude to visualize

sound waves, and the camera on the laptop to capture people's movements. As part of the design, I created a page where people could write sentences containing praise, criticism, or insults. Users can speak into the microphone and observe the sound waves changing on the screen. At the same time, they can move their bodies to see the profile follow their movements.

"You tried very hard."
"You're beautiful. "
"Stop complaining!"
"Don't talk to me like that!"
"You're a good helper. "
"You're a jerk! "
" You are out of your mind."
"Nothing can stop you now. "
"I can see the progress."
"Don't bother me. "
"It's none of your business."
" You make my life complete.   "
"You're a treasure "
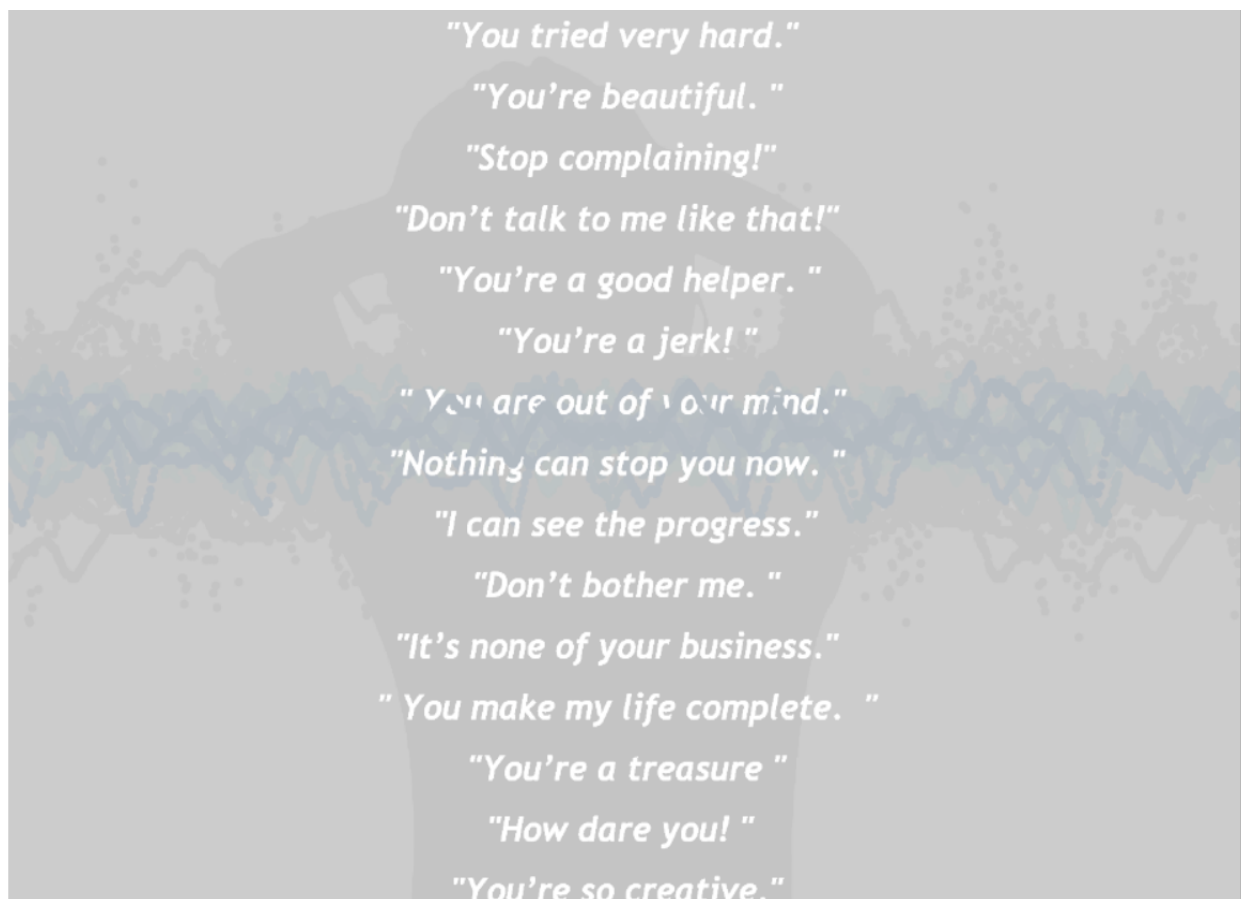"How dare you! "
"You're so creative."

Figure 5. Sound Visualization design in P5.js.

Experiment 3 Reflection: How to use different software to achieve a similar effect?

— Identify the desired effect and search about the potential software which can be realized.

Experiment 3 allowed me to explore different approaches to achieve a similar outcome, which can be helpful in developing a more diverse and nuanced creative process. When approaching a creative project, it can be helpful to consider multiple solutions and approaches to achieve the desired outcome. Furthermore, exploring different approaches allows me to discover new tools and techniques I might not have considered. This exploration can help me to expand my skill set and develop a more diverse range of creative solutions.

In the end, exploring different approaches and solutions can help me to develop a more adaptable and nuanced creative process. It is essential to approach the process with an open mind and to embrace the learning opportunities that arise along the way.

3.5 Experiment #4 Choosing the material and approach

Brains Talking (2021)

Brains Talking (2021) is an interactive group artwork that explores the concept of consciousness in the human mind (see Figure 6). We used various techniques to create the installation. Consciousness encompasses experience, cognition, feeling, imagination, and volition. Our brain is the most important tool that enables us to perceive and receive information from the world around us. There are numerous nerve systems in our brain that allow us to communicate through our senses, such as touch, taste, and smell, and to interact with the world. By contrast, unconsciousness is much easier to understand, as we cannot interact with the world without self-thoughts or awareness. For example, stones, sculptures, installations, and even our technological world lack consciousness. The artwork explores what happens when consciousness becomes unconscious and how humans can cope with this transition.

To better align with the concept, we utilized acrylic material and laser cutting techniques to replicate the shape of human brains. This practice allowed me to develop a greater understanding of how to construct designs that better fit the concept and accommodate the Arduino board.
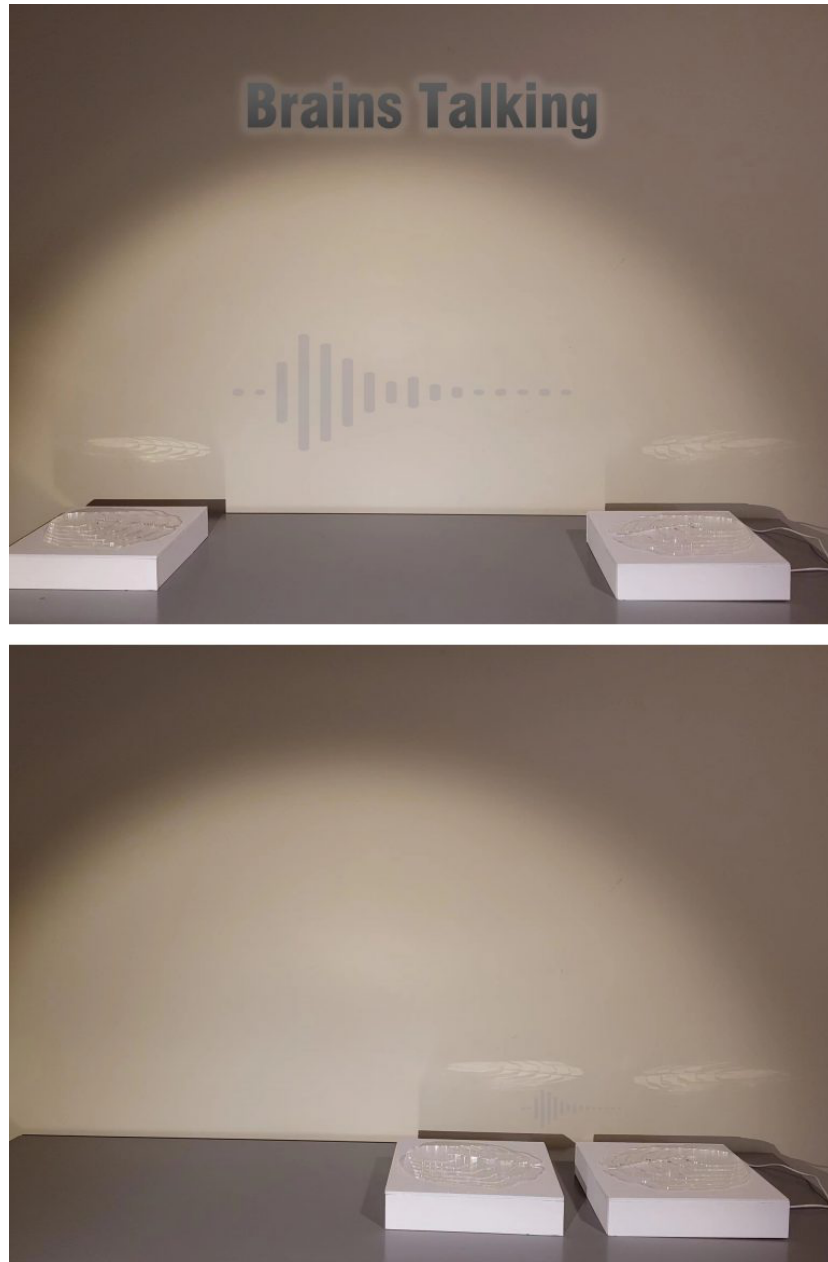

Figure 6. Brains Talking (2019).

Experiment 4 Reflection: How to design a housing that can hide circuits and devices?

— Determine the appropriate size and select suitable materials.

It is a creative approach to make the design more suitable for hiding circuits in interactive art, such as Arduino boards and other devices. From the experiment 4, I learned about the importance of adjusting the size or shape of the design components to accommodate the board's dimensions and adding holes or notches in the acrylic pieces to provide easy access to the board's inputs and outputs. Another strategy to consider is designing a separate enclosure or housing for the Arduino board that can be integrated into the overall design. This case design can help protect the board and securely attach it to the design. It can be helpful to create sketches or mock-ups to visualize how the components will fit together. I should consider testing different materials and fabrication techniques to see what works best for my project.

3.6 Experiment #5 Audience participation

A Hundred &4 Keys (2022)

It is the group work from 2022, which attempts to let the audience participate in the sound-visualization work. Audiences can first experience the project when they enter the room and witness the piano music and the projected design—the sound and video work harmoniously to provide the viewer an immersive, calming experience (See Figure 7). The abstract nature of the performance leaves viewers to their interpretation of the project. Conceptually, the display is meant to represent a new way of playing an instrument that combines sound and visuals that speak to each other. In a larger context, this technology can be used by a band or a live performance with more instruments involved.

Experiment 5 Reflection: How can I enhance the interactive aspect of my project to make it more exciting for the audience?

— Create an immersive experience.

From the feedback on this artwork, I can see that people are very curious and excited about being able to interact with it and see changes in the visuals. However, the current interactive method is simple, with only one output If I want to continue developing my artwork, I need to consider how to enhance the interactivity and engagement further. The question would be: Is there any way I can encourage people to interact more with my artwork? Can I incorporate additional visual elements or effects that respond to user input?
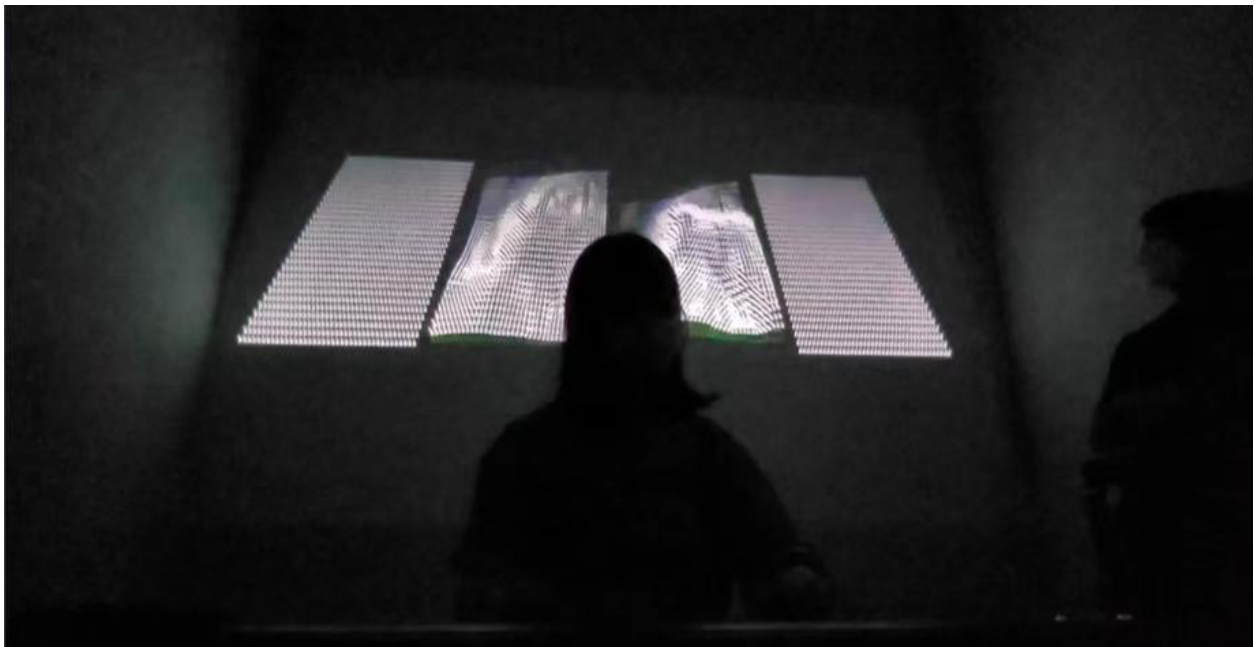

Figure 7. Audience Participation.

3.7 Experiment #6 Enhancing interactive participation

The Heavens (2022)

This was a group project that utilized Kinect, a projector, and TouchDesigner to set up. After brainstorming, we decided to create and execute visible lights in TouchDesigner and

implement our idea using projection-mapping techniques. We carefully considered all aspects of the project, including the lighting, space, and aesthetic style. Our goal was to encourage the audience to move around the room and experience the lights on their body, observe their shadows on the ground, and create new patterns and shadows by moving. To achieve this, we projected the light from above onto the ground using a projector. The dark atmosphere of the room increased the audience's interaction with the lights and minimized any distractions (see Figure 8).
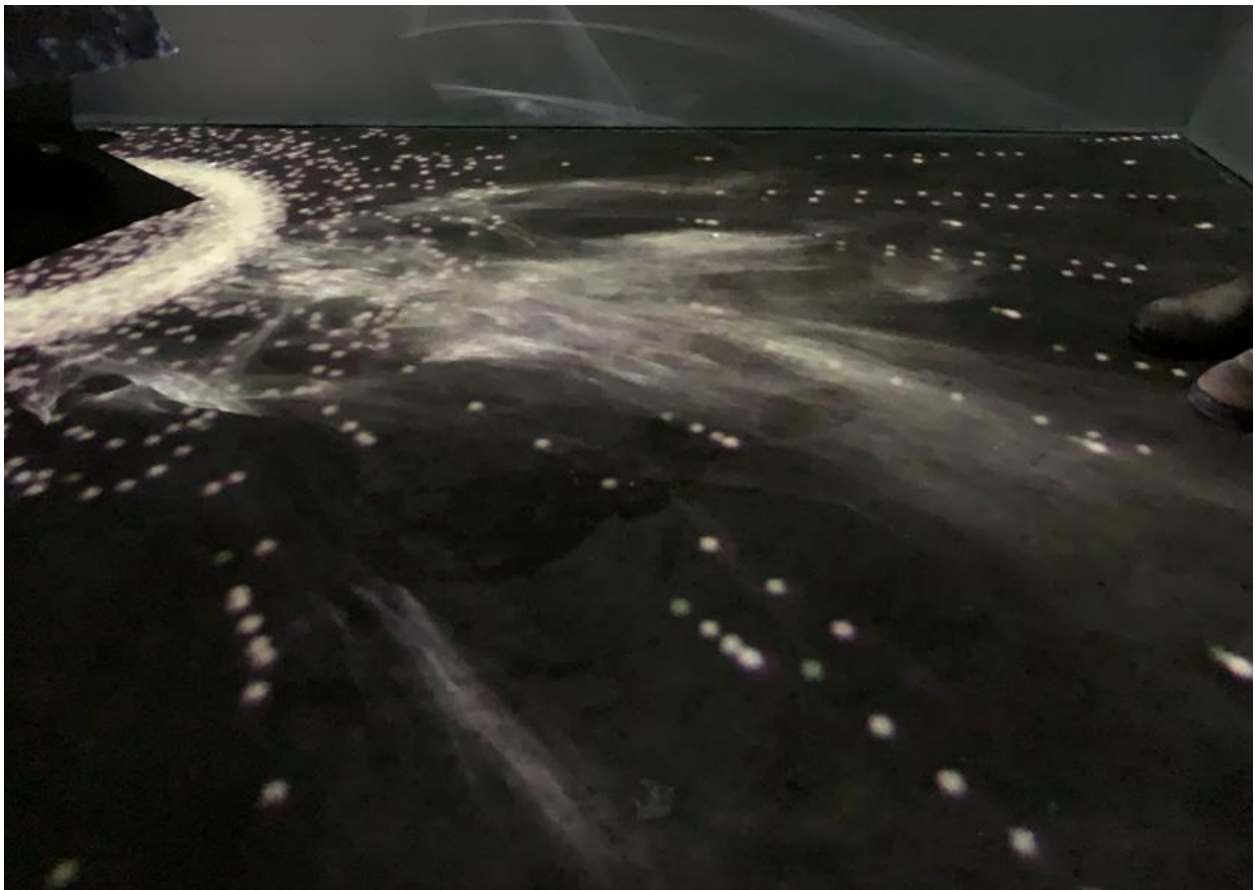

Figure 8. The Heavens (2022).

Experiment 6 Reflection: How to plan the capacity and organize the participants?

— Evaluate the size of the space and establish a schedule.

Based on the results of the exhibit, many audience members expressed interest in interacting with the artwork, but only one person could participate at a time, causing others to wait and making the space feel more crowded. This led to feelings of frustration and discomfort among the audience. To prevent overcrowding, determining the maximum capacity of the space would be the best approach. Additionally, testing how long each person spends interacting with the artwork can help estimate the number of people who can enter the room at the same time.

3.8 Experiment #7 Real-time Interaction

Through continued practice and studying visual generation, I had the opportunity to collaborate with DJs in live performances. Instead of being a spectator, I became the performer, using various software such as TouchDesigner (See Figure 9) and Resolume Arena (See Figure 10). I could feel the excitement of the audience as they danced and cheered during the shows. After the performances, many people asked me how to generate the visuals and which software I used. Most people were curious about how the visuals functioned, which motivated me to create an interactive live-visual environment that would allow them to experience the mystery behind the technique.

Figure 9. VJ Performance used TouchDesigner by Siyu Sun.

Figure 10. VJ Performance used Resolume Arena by Siyu Sun.

4.0 Prototyping & Evaluation

4.1 Prototype #1 Sound visualization first attempt

For the first experiment, *Sound visualization first attempt,* I learned how to connect external interactive devices to change the data values in TouchDesigner to enhance participation. Kinect can catch people's movement, and it sparked the idea of building a concept of critical art. However, there is a lack of research on this idea, and the visual works cannot fit the concept. From this experience, I knew it was essential to consider concepts and visuals when creating artwork. The key to creating great artwork is approaching it with creativity and discipline, balancing a solid concept with effective production.

Rumors (2019)

It is the first attempt to use TouchDesigner connected to external interactive devices such as Kinect and camera to change visualization (See Figure 11). This project explores the theme of "rumors" in our daily lives using TouchDesigner to create an interactive artwork. The installation incorporates a laptop camera as a Video Device In TOP, and a Kinect sensor, which are connected to TouchDesigner to capture people's shadows and movements. The visuals including a ball and images of voice frequency, respond to people's movements, creating a dynamic and immersive experience. Ultimately, I uploaded music as an Audio Device In CHOP and connected it to the microphone, which can change people's voice frequency.

The concept is: Our daily life is full of different sounds that can shape our experiences and perceptions. These sounds can be positive or negative, and they can have a profound impact on our well-being and happiness. Sometimes, negative sounds can feel like a heavy burden that weighs us down and makes us feel stuck. In such situations, it's essential to have the right attitude and tools to face these challenges and find a way forward. To address this issue, I want to create a

project that raises awareness of the importance of facing problems and overcoming challenges. The project will use multimedia and interactive elements to engage and inspire audiences to think about their own experiences and attitudes towards difficulties. By encouraging people to face problems with courage and creativity, the project aims to empower individuals to take control of their lives and achieve their goals.
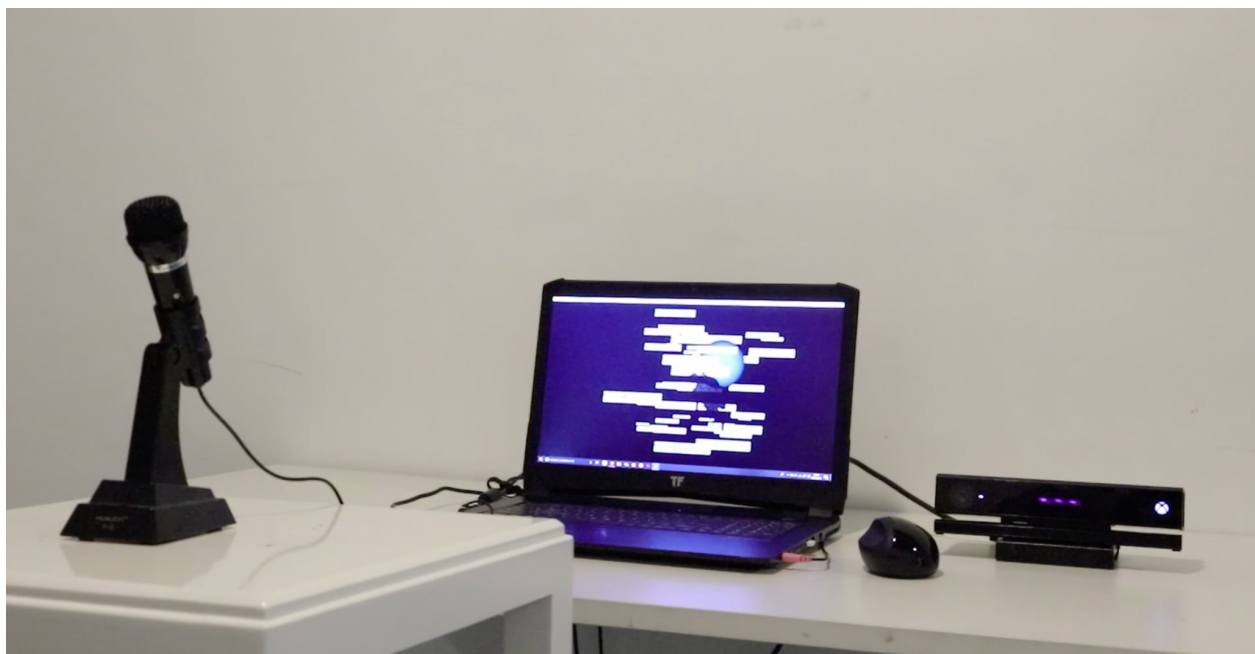

Figure 11. External Devices: Microphone and Kinect.

Reflection: How to connect the achievement and match the concept?

— Identify the achievement and consider technology support.

The concept behind my project is to confront the problematic environment of rumors and empower people to overcome the difficulties. I designed heavy ball and noise images to surround people but encountered many technical difficulties in TouchDesigner. Although the concept was for people to push the ball away, it remained attached to their bodies no matter where they went

(See Figure 12). This experience taught me the importance of considering both the concept and technique simultaneously. Through iterative testing and adjustment, I learned how to effectively communicate the message while being mindful of practical considerations, such as whether the technology could support the idea. If necessary, I sought technical support, changed the implementation method, or adjusted the concept itself.
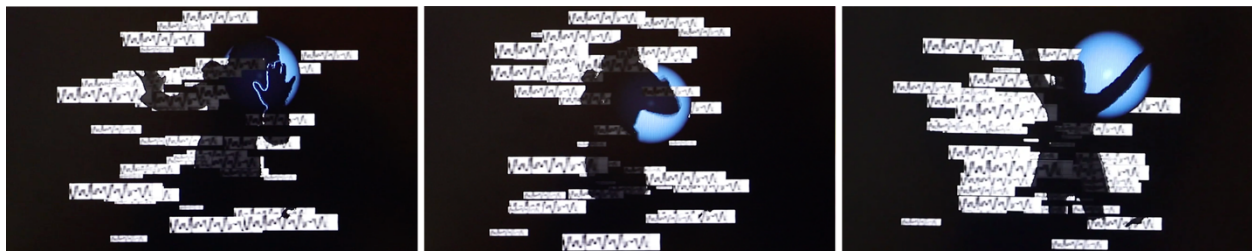

Figure 12. Objects surrounding.

4.2 Prototype #2 Initial Concept

I started exploring the concept of social relationships during my undergraduate studies, and initially, I wanted to create an immersive experience that would allow the audience to feel like they are in a space full of negative comments. I planned to use harsh noise and visuals to make the audience empathize with the pain caused by hurtful words, which can help reduce the likelihood of hurting others in the future. My research question was to explore how sound can affect the nervous system and provide feedback on emotions, thereby creating evidence of controlling human emotion.

To design the environment, I used SketchUp to create a demo. The visual will be generated on the wall, while the speakers in the corner would create a surround sound effect. The sound would trigger the other two walls to play the visualizations, forming a circulation system. A

keyboard would be integrated into this setup, leading to a sense of disorientation and 'lost feeling.' With the 3D printing generated by sound visualization, the installation would be displayed in the middle of the environment. Additionally, two LEDs would be connected to a touch sensor, installed on the surface of the installation. When the audience touched the sensor, the video would start to change or play, creating an immersive circulation system using sensory experiences such as sound, light, and touch.
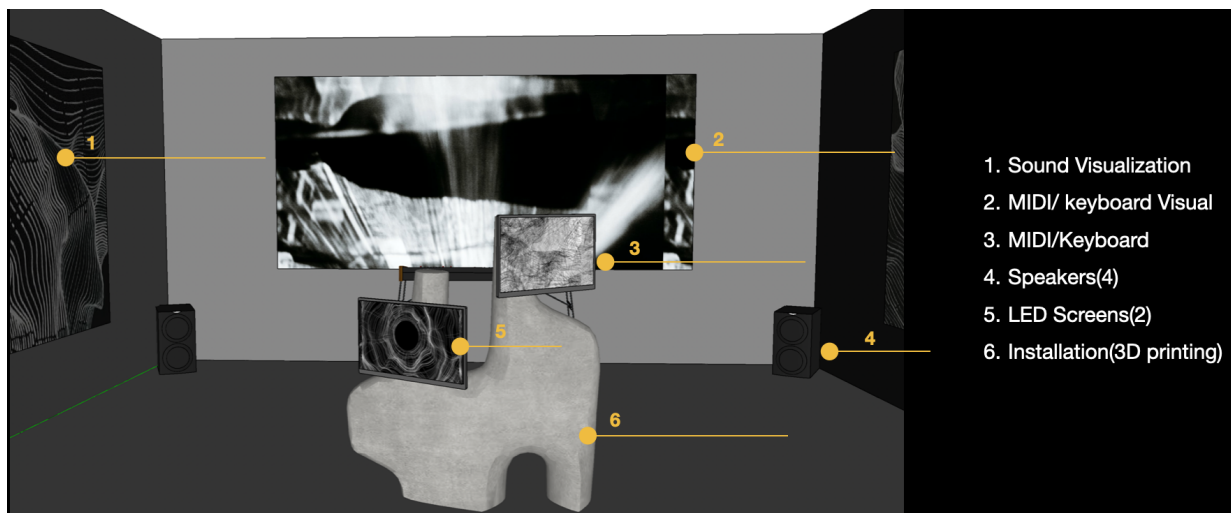

Figure 13. Initial Concept Environment Design.

The visual and noise are based on the experiment of interviewing people. So, I requested them to imagine they were in that situation, drawing related images and writing the keywords (See Figure 14).
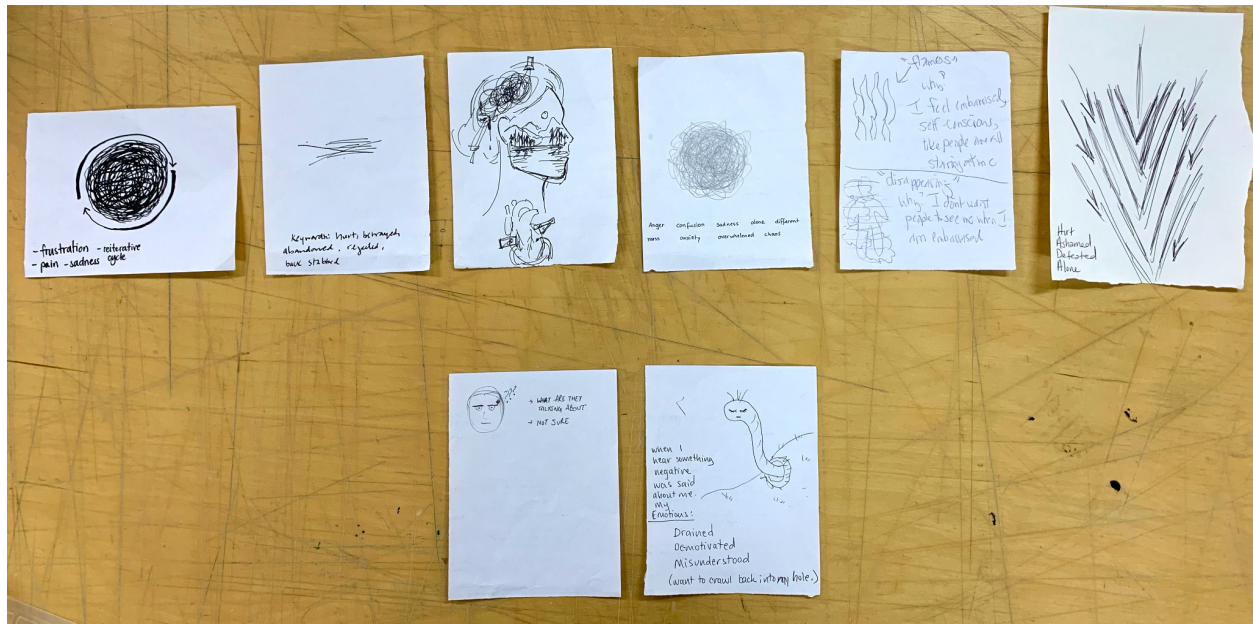
Figure 14. Emotion Experiment.

After analyzing the information provided by the participants, I found most people think "rumor" or "judgment" can bring a lot of hurt feelings in people. At that time, I thought I found evidence that irrelevant comments would influence people. To create a visual representation of this concept, I extracted the shape from the participants' drawings and generated a corresponding visual using TouchDesigner. For the soundtrack, I created a depressing sound using Ableton, which was then transmitted to TouchDesigner via keyboard input (See Figure 15). When people press the keyboard, they can hear the change in the sound, at the same time, the visual will be changed (See Figure 16).
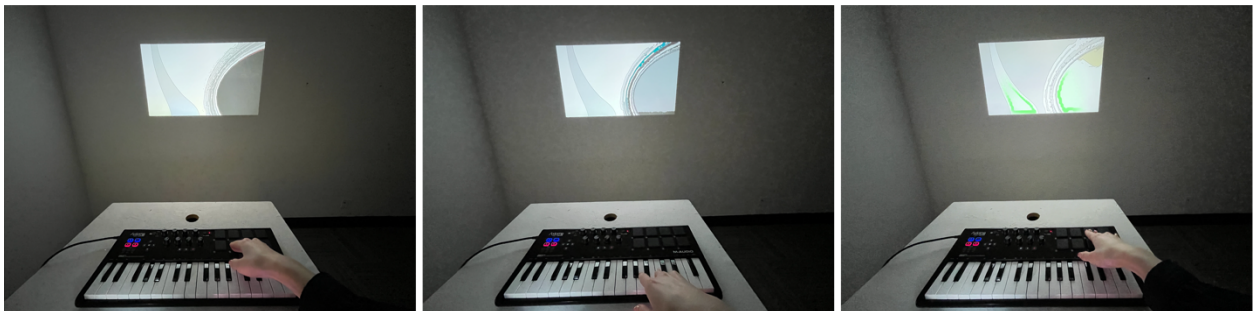
Figure 15. Keyboard with Touchdeisgner.

Figure 16. Keyboard activated visuals.

This was my first attempt in the keyboard controlled visual, and then I got a lot of feedback:

4.2.1 Limitation

1. Narrow topic: Why do I want to test people and let people empathize with their feelings? My target is to let people know the bad feelings and rethink their behavior in the future, however, I cannot control people's thoughts. Everyone has their own life experiences, and the attitude towards the objects is different, it is so difficult to let people emphasize the same feelings.

2. Lack of evidence-based research: How can I define people's emotions when they hear rumors from outside? How can I say people will get bad feelings when they face this situation? And what is the meaning of this research?

Based on these critiques, I recognized this topic's limitations and potential challenges, especially in relation to human emotions and behavior. Controlling people's thoughts and attitudes is complex, and evidence-based research is lacking to support my hypothesis. From this experience, I should consider more details. After that, I had to calm down and continue to think of another concept. From this experience, I must remain open-minded and flexible as I develop my project. Although, as I have found, live empathy exercises are not practical or feasible, I should consider alternative approaches to achieving my goals. This could involve incorporating new research methods, changing my project scope or goals, or seeking input and feedback from others in my field.

4.3 Prototype #3 Concept improvement

After the feedback on the first concept, I continued trying different possibilities in sound visualization. Then, as practiced in Prototype 1, I connected Keyboard to TouchDesigner and triggered the sound and the visuals, which gave me another way of thinking: Based on my previous experimentation in Experiment 1 (p.22), where I used interfaces as inputs to control the output, I

am considering whether I can use the Arduino method to build physical knobs. This leads me to a

hypothesis: can I create an interactive installation that allows audiences to interact and observe

how the interfaces change the visual output in response to their actions? Through the critiques and

reflection, my way of thinking was improved, and the concept is clearer. I started exploring from

a traditional keyboard. By connecting potentiometers to Arduino and uploading the Firmata code

(See Figure 17), I created a physical interface for audiences to control the visual parameters of the
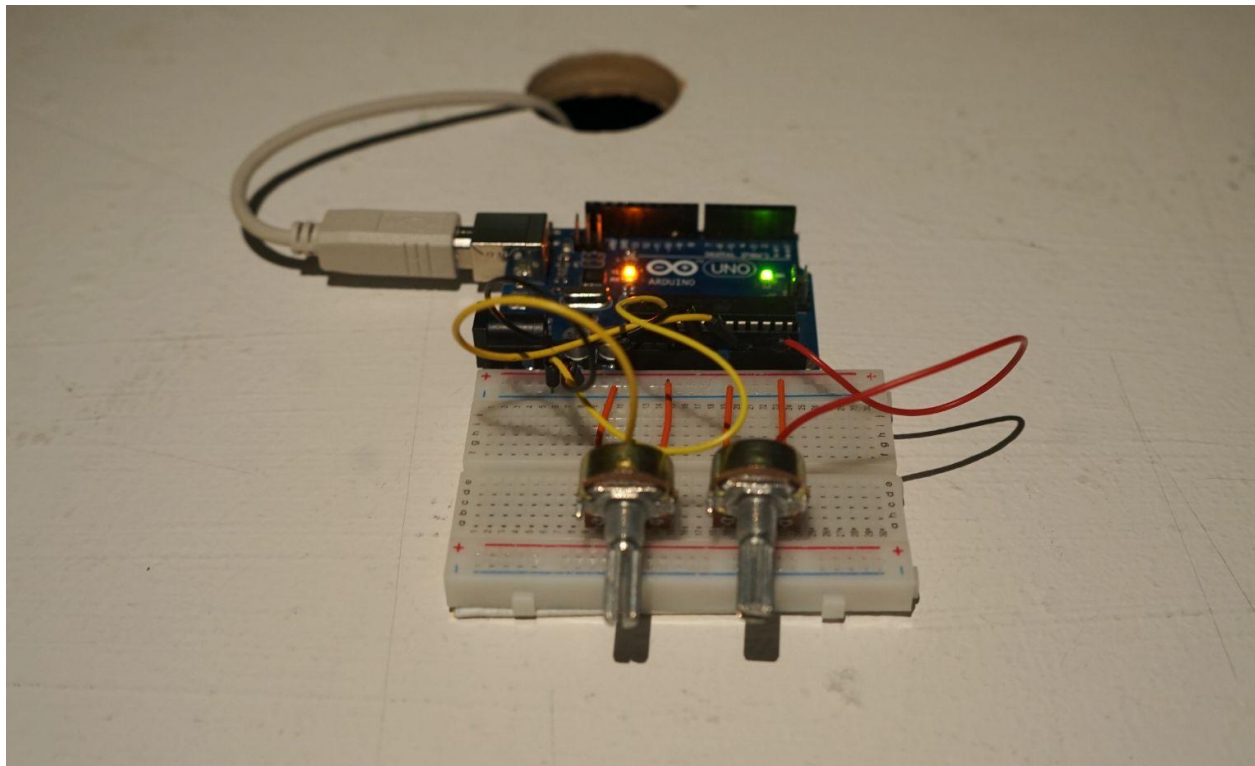
sound visualization.

Figure 17. Arduino Connection.

Firstly, I uploaded the soundtrack as an Audio File In CHOP at TouchDesigner to generate

the shape of the sound. Then, to let the potentiometers change the visual parameters, I created

Firmata chop in TouchDesigner to change the Anchor and Strength (See Figure 18). Audiences

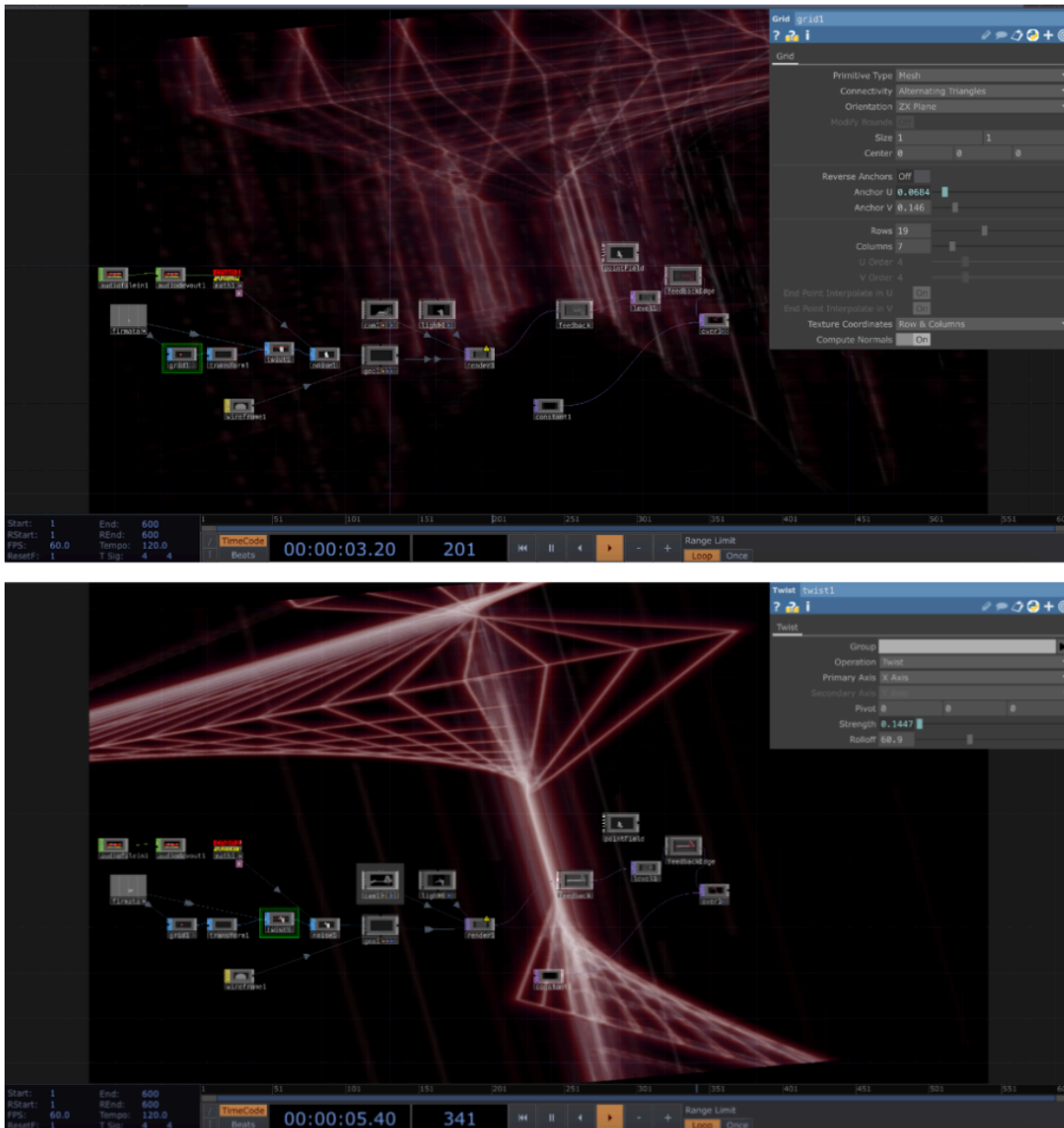can see the visual change when they control the two parameters (See Figure 19).
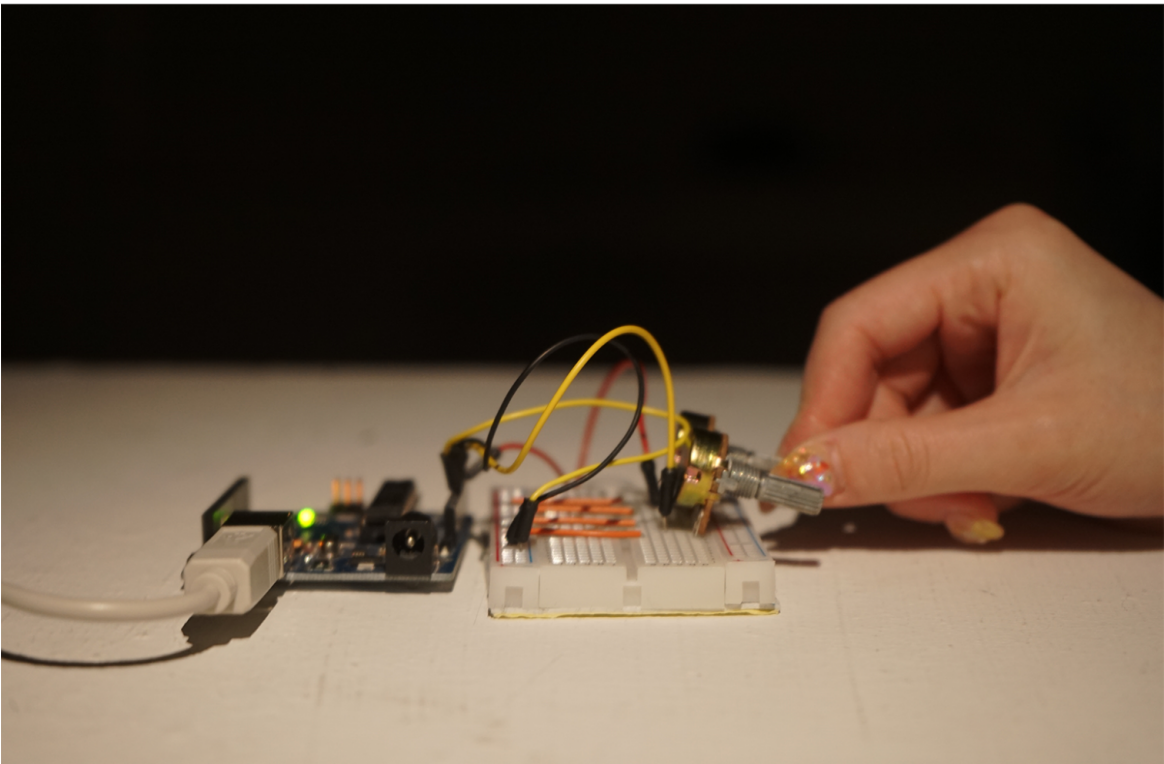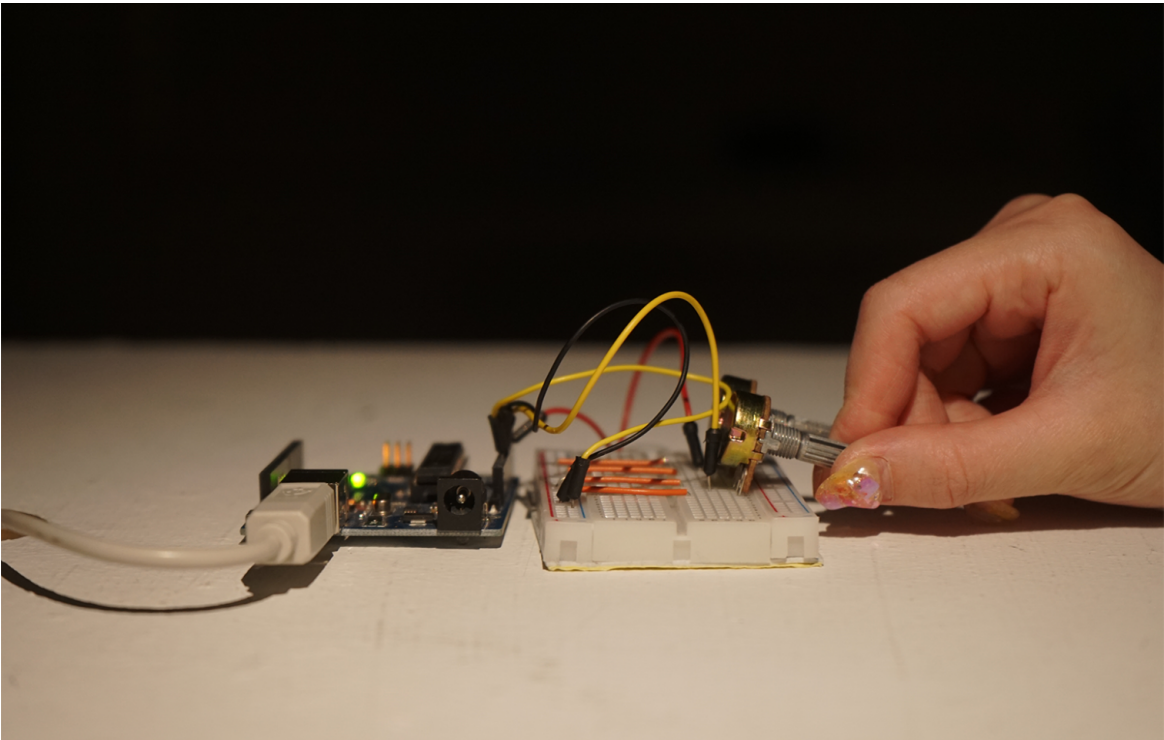

Figure 18. Firmata methods prototype.

Figure 19. The function of potentiometers.

After this experiment, I found this interesting and want to go deep with the interface topic. So, for project production, I opted to design three different inputs and generate visuals in a similar style using TouchDesigner as the visual creation software and Arduino as the interactive input. I combined with the interactive installation design, as my previous practices, allow audience participation in the live-visual environment.

4.3.1 Process #1 Installation Design

The exploration in this project involves designing an interactive installation, and therefore, building a visible installation is necessary. The aim is to create a shape of sound that can enhance the relationship between the audience and the topic, while also promoting participation. To achieve this goal, I have incorporated various technologies and tools into my project. Firstly, I used Noise CHOP to make an irregular wave that never repeats, and it should be an excellent example of daily life's voice. After that, I generated the shape in Touchdesigner (See Figure 20) and got the irregular shape. Then I took this shape into Rhino to create a 3D model of it (See Figure 21). Initially, I could use this installation to build the instructions to help audiences understand how to use the interface effectively and raise their interest in my works (See Figure 22). Finally, I designed a space on the top that could put the devices, such as a Phone, web cameras, or other devices which can catch people's movement.
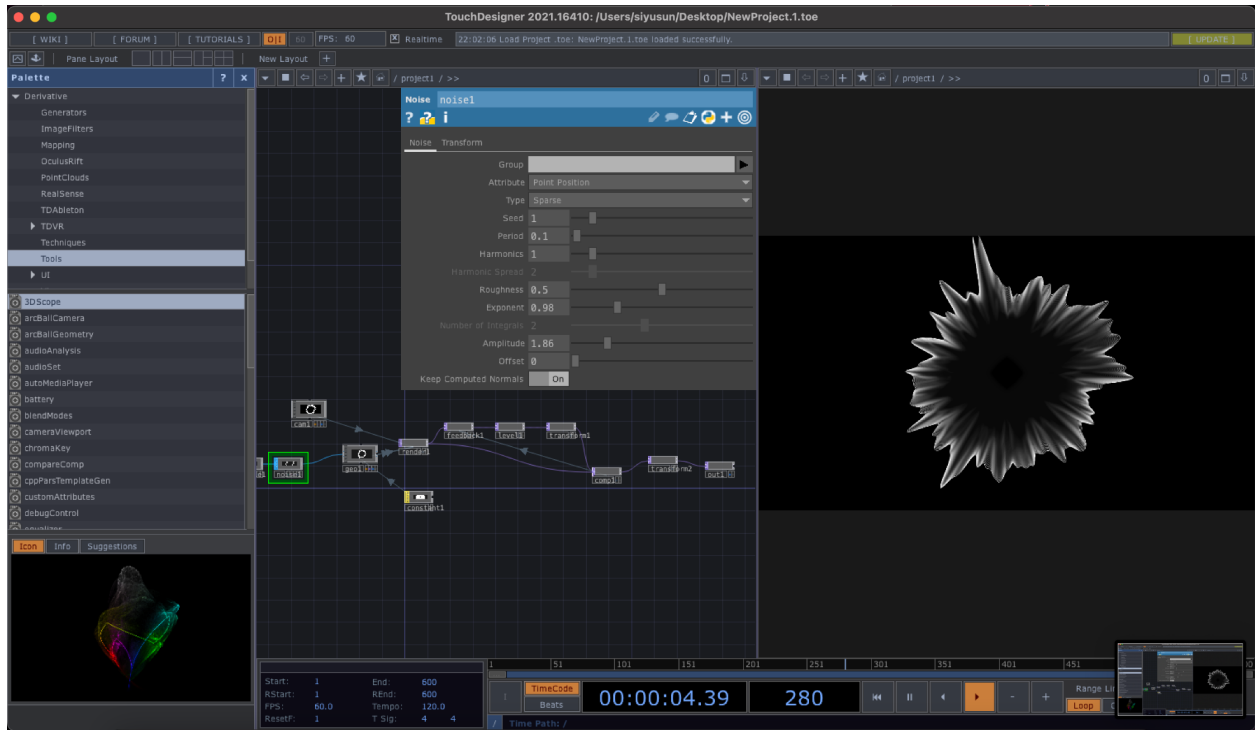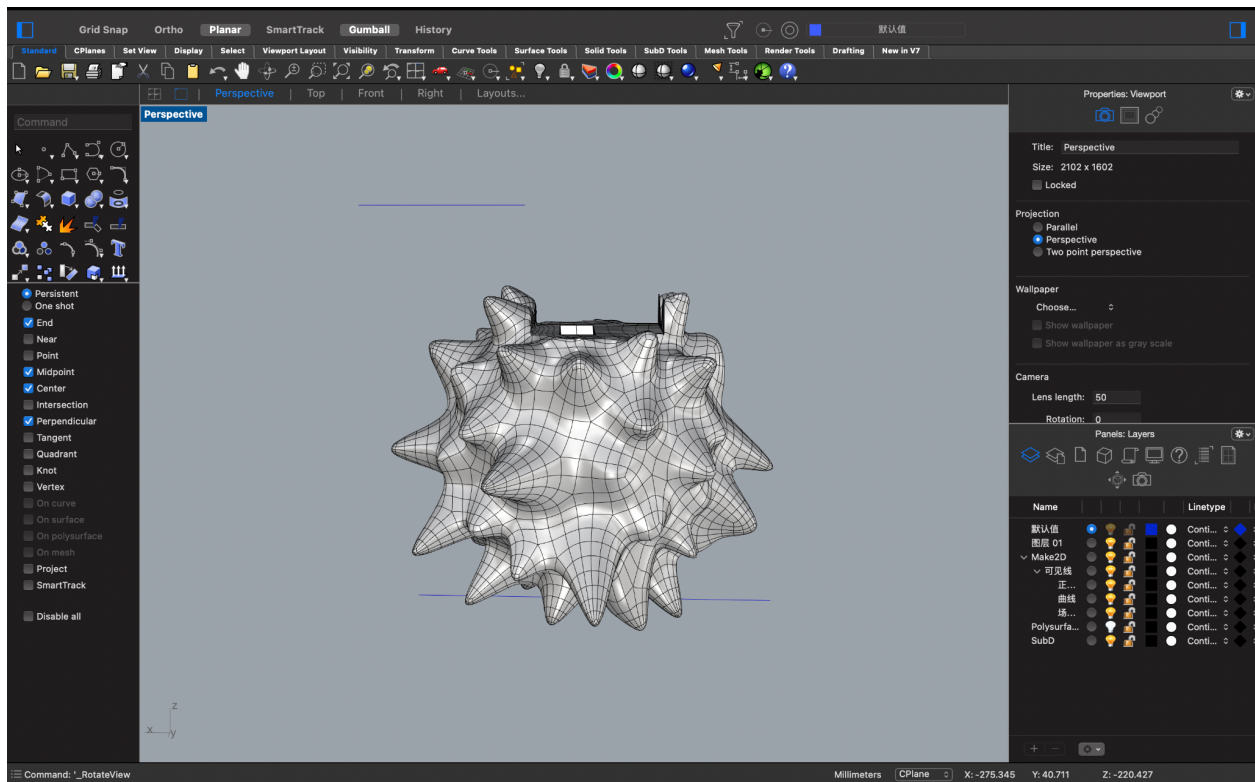
Figure 20. Generate the shape of sound.

Figure 21. The shape of sound in Rhino.

Figure 22. 3D Print of Sound.

After 3D printing, I touched the surface and noticed a unique, harsh texture. This reminded me that I could create a casing to hide the potentiometer's raw form (see Figure 23). Drawing from my experiences in Experiment 4 (p.28), rather than directly touching the potentiometer, I realized there are many artistic ways to showcase it and raise the audience's curiosity. They may be compelled to touch it and see how everything works.
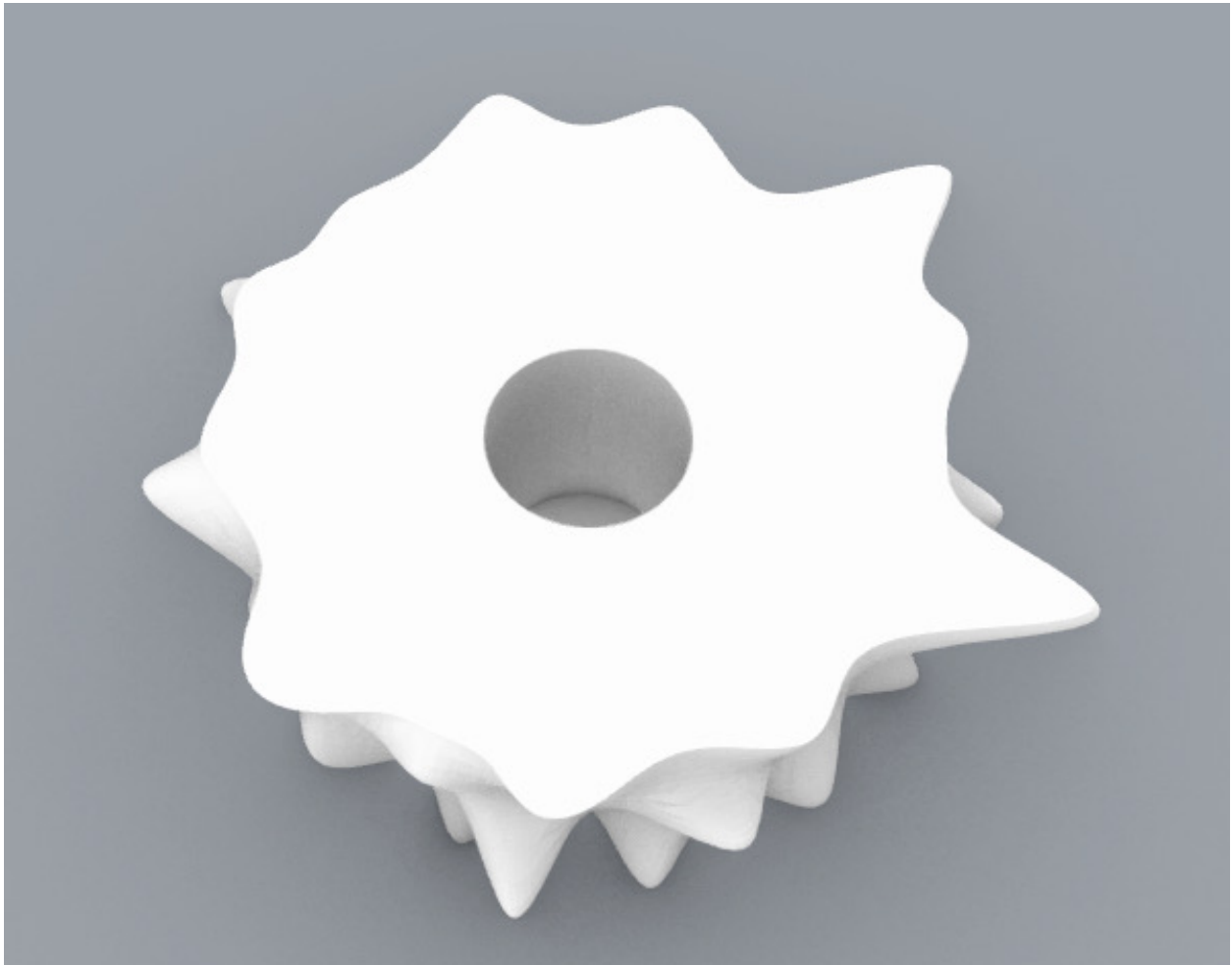
Figure 23. Potentiometer Case Design.

4.3.2 Process #2 Derived Interactive Surface Ideas

Based on the potentiometers' first attempt, I started thinking about how to set up the environment. Through reflecting on my experience from Experiment 2 (p.24), I know how to improve to design more interactive participation in the environment, which can bring more exciting feelings. I set up three different interactive interfaces to help make it more engaging for the audience, allowing them to participate in this artwork.

1. Potentiometer in Arduino- **Controlling**

This interactive method is derived from the use of MIDI controllers, which is a popular technique for VJs during live shows. I utilized a potentiometer as an interface to control the visuals in Touchdesigner through an Arduino board (See Figure 24). By uploading the track, I created in Touchdesigner as Audio Device In CHOP, the visuals can be generated automatically, making the experience more dynamic and engaging for the audience. During the interactive part, the audience can only control the visuals by spinning the potentiometer and observing the changes in the parameters (See Figure 25). The design purpose here has two reasons. First, it restores the participation relationship between the audience and the performer. Second, it talks about control in the context of Interactive art. Yusuf Pisan noted, "There was a continuing connection between the response and control states. When participants became bored with the current possibilities of the system as they understood it, they would return to the response state to discover new ones." (2005, p.55) Even if it is already generated automatically, it can still create other possibilities through interaction. It gives the audience a sense of empowerment and agency, allowing them to change the visual based on their behavior as they try different combinations and see how the artwork responds. The interactive process can be a method to keep the audience interested and actively involved in the work I created.

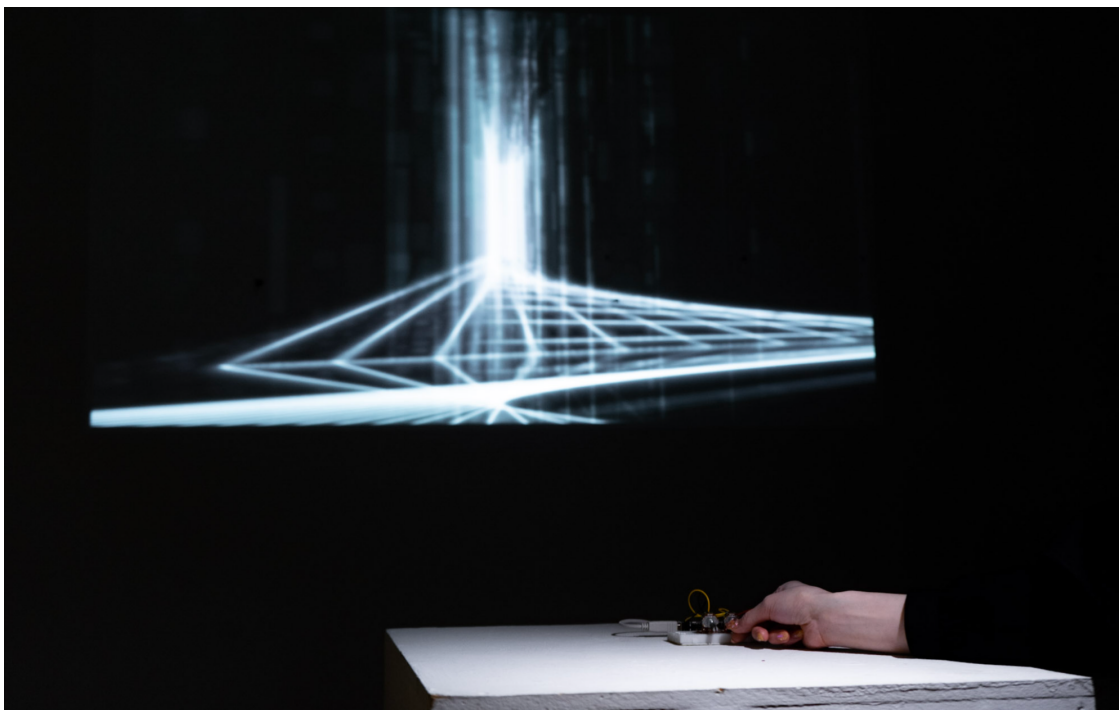*Figure 24*. Potentiometer Interfaces design.

Figure 25. Interaction way.

2. Web-camera **Following**

For the 3D print of the shape of sound, I want to encourage people to interact with the installation themselves. By creating a unique shape for the audience to touch, I think it will be a good opportunity for them to explore the installation and discover the different changes in visuals. The visual will reflect the 3D object's shape (See Figure 26), and the audience can observe the noise's shape through the camera. This can also attract people to come closer and interact with the installation. For the interaction part, people have two choices for it. First, they can touch the shape of the spikes to enhance their relationship with the sound visualization content. Second, they can move under the camera to make more changes, there is no limit to how much they can move their hands or body (See Figure 27).
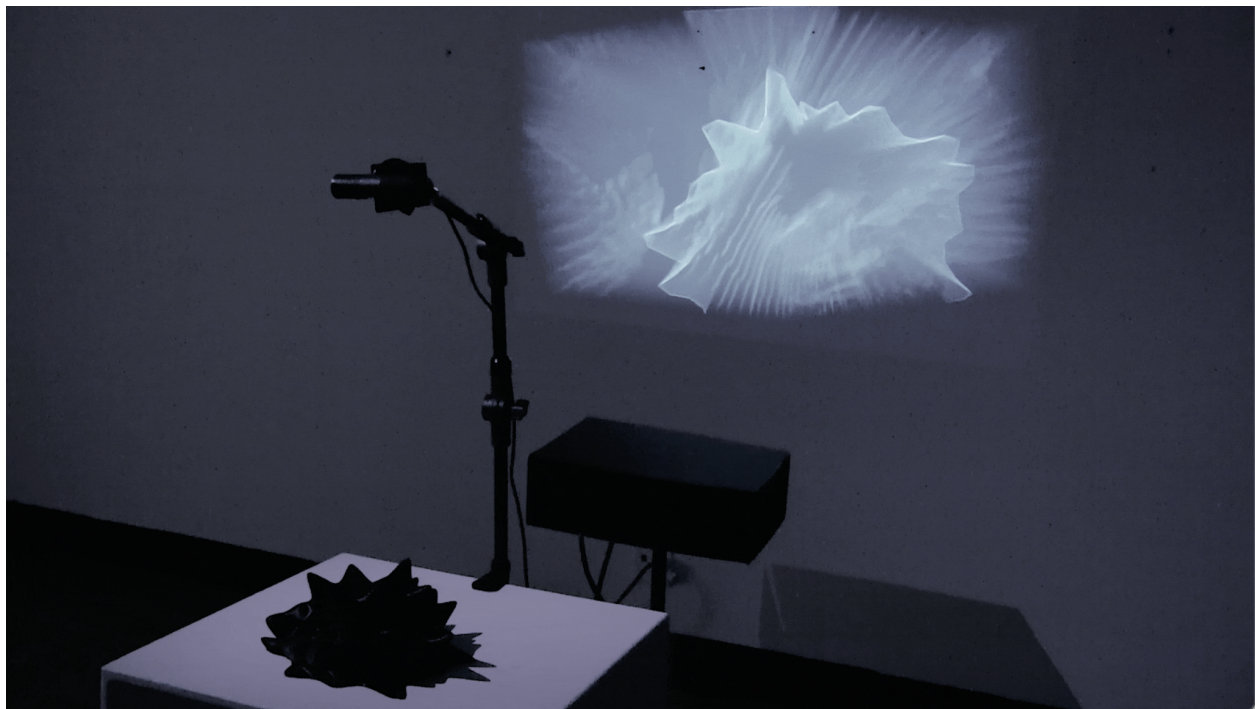

Figure 26. Web- Camera catches up.

The function of a webcam reminds me of the method of visual feedback. It can provide immediate feedback to the audience's actions, making the interaction more compelling and rewarding. Therefore, interfaces have become a way for them to follow each other.

Figure 27. Two-way interaction.

3. Leap Motion **Communication**

By using Web-camera as an interface, I start to think about how to enhance the relationship with the interfaces? Another possibility is that I can talk about communication in the context of interactive art. In order to achieve the goal, I finally selected to use Leap Motion to express this to choose hand-based gestures as an input to design some movement which the audience can interact with using their gesture (See Figure 28). Hand-based gestures can provide a unique way for the artist to communicate their ideas and emotions to the audience. The gestures can be choreographed to create a narrative or tell a story, and the audience can participate in the performance by interacting with the gestures. People have the freedom to make various choices during the interaction. Additionally, participants do not need to physically touch the interface; instead, they can use gestures in the air to control the parameters (See Figure 29).
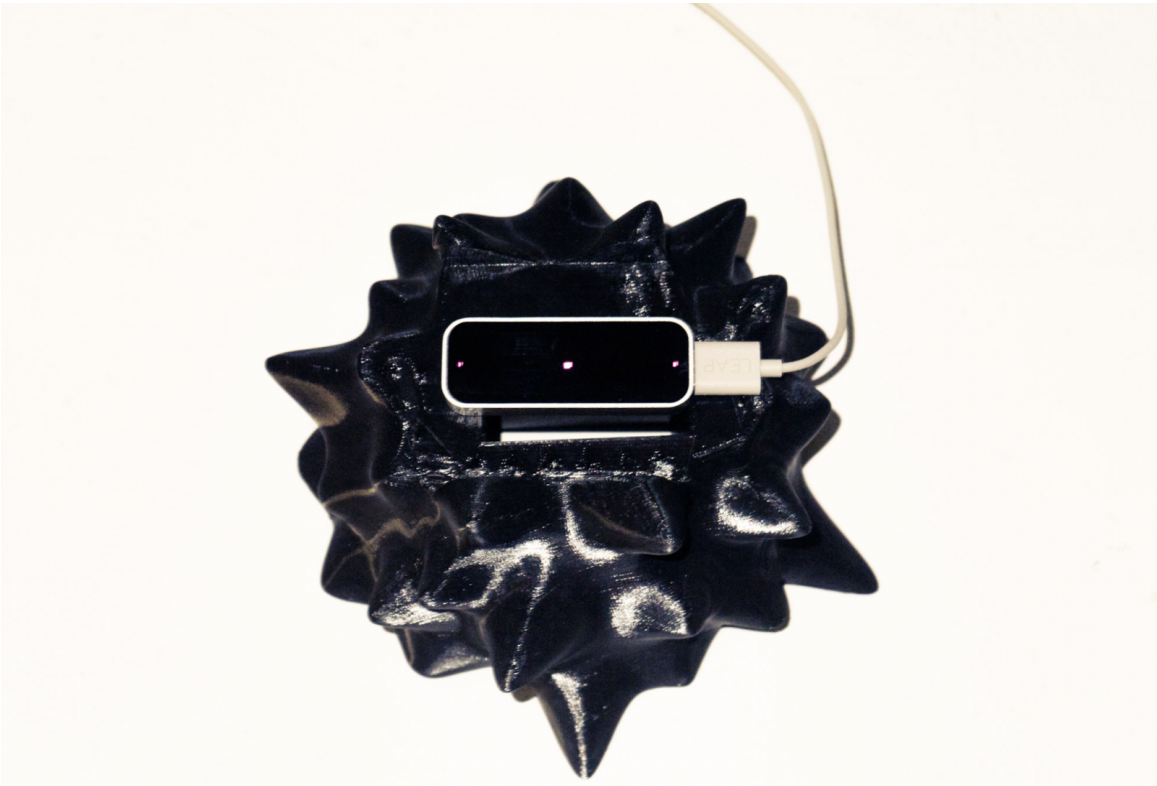
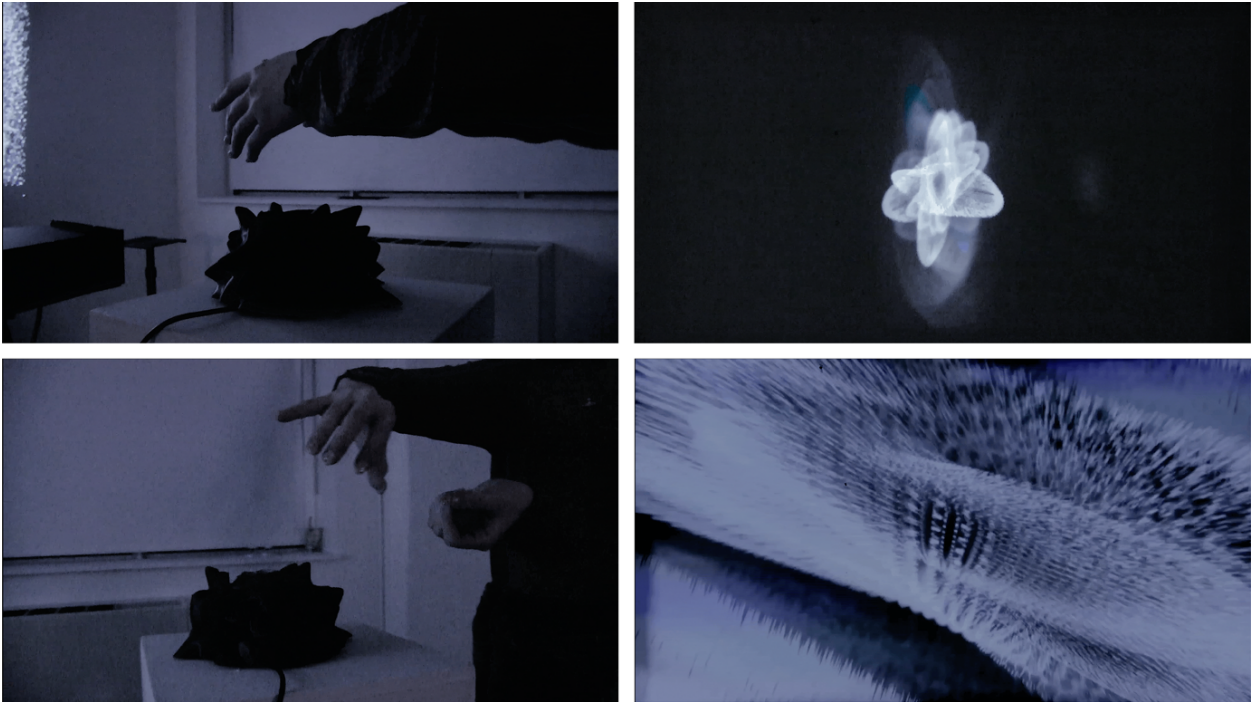*Figure 28*. Leap Motion Setup.

Figure 29. Leap motion function.

Compared with the setup in the web camera, using Leap Motion to enable hand-based gestures, such as making a fist, or waving, can provide a natural and intuitive way for the audience to interact with interactive art and enhance their relationship with the interface.

4.4 Evaluation

Another objective is to make use of the final installation environment and create a narrative route that engages people as they move through the space, breaking down the distance between them and the artwork. When evaluating the artwork, the most critical factor is to ensure that it functions well and effectively utilizes the environment. To achieve the goal of allowing participants to interact with three different interfaces and comprehend what is happening, I have chosen to showcase them on three white plinths with the same height, accompanied by a projection of equal size on the wall. This will enable participants to observe changes in the interfaces directly (See Figure 30).
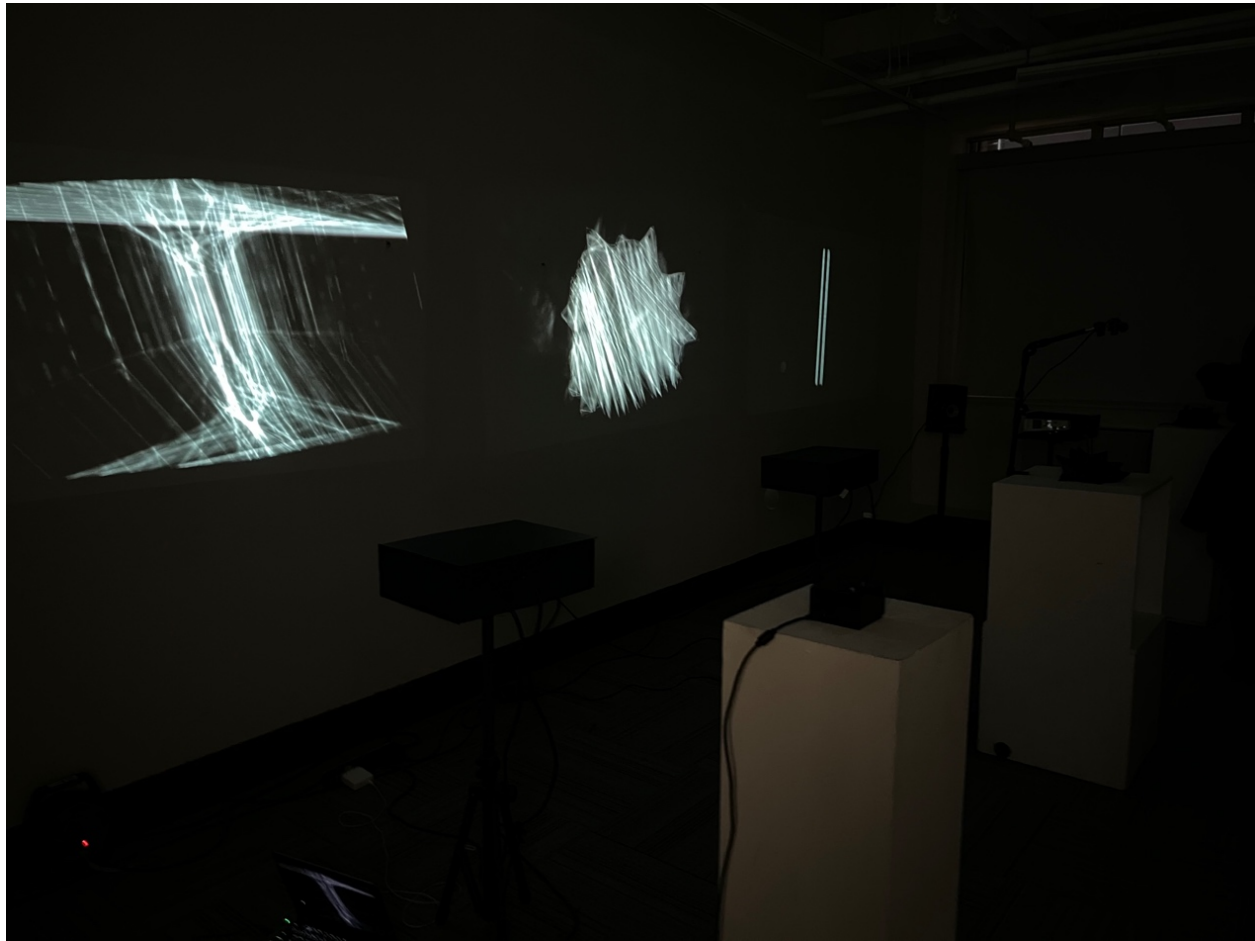
Figure 30. Standard projection.

This setup proved to be effective in achieving the goal of enabling participants to interact with three different interfaces and understand the changes happening in real-time. The use of three white plinths with equal height and a projection of equal size on the wall allowed for clear visibility and ease of access for participants to interact with the interfaces (See Figure 31). Another benefit is participants were able to more easily compare the differences between them. However, the visibility of the projectors impacts the overall aesthetic of the installation (See Figure 32). So, one of the questions I will consider is how to hide the appearance of the projectors.

Figure 31. Audience participation.

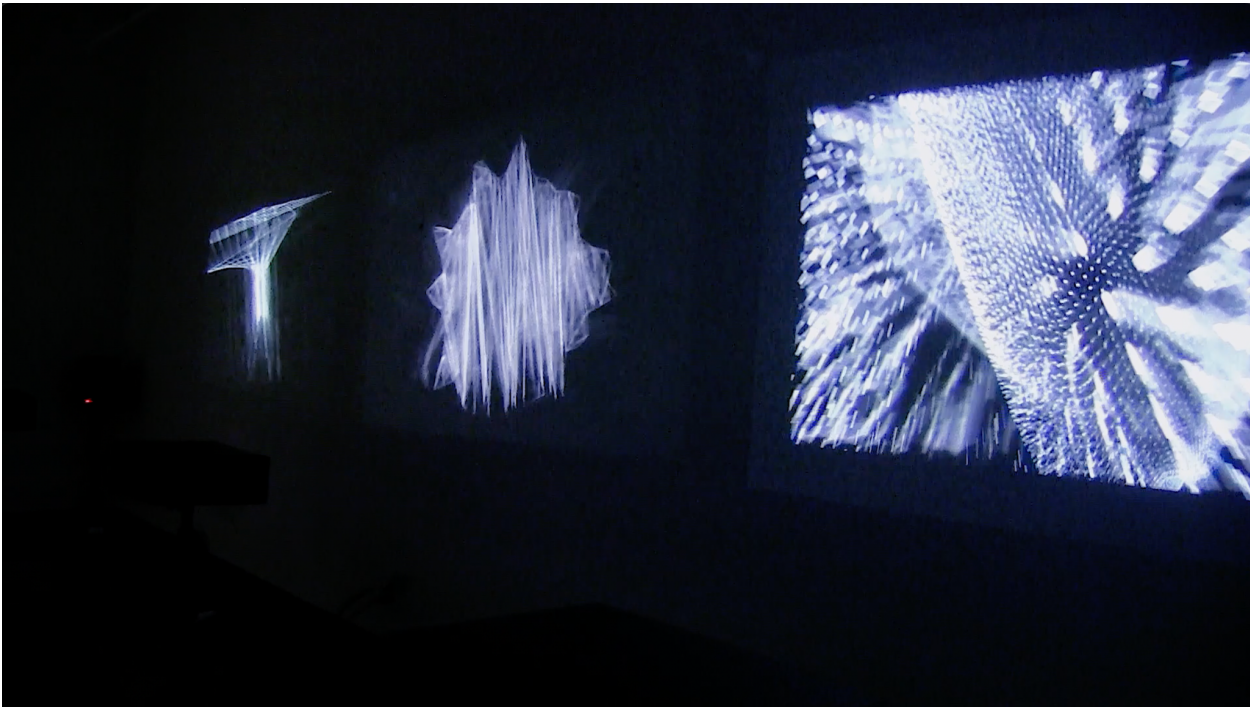*Figure 32*. Visual difference.

5.0 Conclusions and Future Work

5.1 Revising Goals and Projects

The goal of this research is to use audio-visualization techniques with the design methods of interactive installation. The goal in this research is successfully, I used the terms of participation to design the three different interfaces then create an environment contented with three different parameter projections, each input has their own narrative structure, and provides a sense of progression and direction for the participants. This can be crucial for the audience exploring the space in their own way and at their own pace. Through previous research, the way to create interactive artwork is to create an experience that is engaging, immersive, and memorable. In order to achieve the point of review to use the method in the interactive installation, it is an excellent way to create a unique and dynamic experience that encourages active participation and exchange between the audience and the art. These practices can be crucial for the audience exploring the space in their own way and at their own pace.

During the final exhibition, there was evidence that the participants were engaged with the artworks. They stayed for a long time at each interface and moved their bodies. Some of them even returned with their friends. Additionally, some performers were surprised and commented that this method could be utilized in their shows and even inspired them.

5.2 Personal Reflection

This research came from my long-time survey in the Art & Technology, and based on what I learned from the studio, it set up my thinking and aesthetic and built my research area. This research taught me how methodologies function in my art exploration and how to combine each experience and reflection on the previous practices. This research recorded my artistic development and helped me understand my artistic practice and identify areas of growth and

improvement. The research topic starts from my interest in audio visualization and using previous experiences in interactive art installations. I learned how to organize the critique from the outside, continue to verify and improve concepts. As an artwork, the critique can be the most critical and valuable for artists looking to improve their work. From the initial research topic, I attended many presentations even normal conversation to receive feedback on my work. These experiences taught me how to consider the source and evaluate its value. I also need to apply the feedback and act on the suggestions that benefit my work. If the topic cannot keep going, don't be afraid to do other experiments and try new techniques or approaches.

5.3 Outcomes and Contribution

The key contributions of this project include the introduction of how interfaces can be used to create engaging and interactive art experiences and how sound can be visualized in different ways. From the prototypes of the experiments, the project shows how interfaces can be used to allow audiences to engage with and influence an art piece. By providing a way for audiences to interact with an artwork, interfaces can make art more accessible to a broader range of people.

Another significant contribution of the project is the exploration of audio visualization. I selected three ways to trigger that allow audiences to experience the different possibilities in interactive art directly, it can bring quick examples to show the audiences how the different devices will bring the content.

This project demonstrates the potential of interfaces and audio visualization in interactive art. Furthermore, by exploring these concepts through prototypes and experiments, I would inspire people who are looking to create engaging and interactive art experiences.

5.4 Limitation

This project has several limitations which should be acknowledged. Based on the research question, three inputs should generate different visuals, to provide the interaction. However, through my previous Experiments in the set-up exhibition, I gained much experience from the final installation. These include environmental limitations, installation protection, and capacity limitation.

1. **Environment limitation:** Depending on the environment in which the interactive art is displayed, there may be limitations on the devices installed and how to organize the whole space. Suppose this artwork moves to another place; I should reconsider the factors such as the size and shape of the new space, the lighting conditions, the placement of the audience, and any potential obstacles or hazards in the area.

2. **Installation protection:** The installation will be up for display for over one day, so errors and faults should all be corrected prior. This goes for every device, such as interactive devices, projectors, speakers, and laptops. Every part is crucial. It is also essential to have a contingency plan in place in case any issues arise during the display period. This can include having spare equipment available, technical support on standby, or backup procedures to address any problems quickly.

3. **Capacity Limitation:** The limitation of capacity is also a crucial thing to think about. This project should consider how many people can attend at one time, considering the flow of people. Because the space is limited and if so many people attend at the same time, it may cause many mistakes.

Through acknowledging these limitations and taking steps to address them can help ensure a successful and safe display of the final setup.

5.5 Future Work

Conducting profound research in audio visualization through this paper is an excellent opportunity for me to develop a strong foundation of knowledge and skills in this area. Also, this knowledge can be used to create more innovative and sophisticated works. I will first continue to experiment with different software and hardware tools for creating audio visualization, such as Max/MSP and Processing. Then, I will further explore the relationship between performers and audiences to create more interesting interfaces that match different themes and encourage more engaging interactions.

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