Akerselva

By

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Abstract

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Akerselva is a technologically mediated violin and viola performance, accompanied by audiovisual laser elements. This paper discusses the motivations for the creation of the piece, historical and contemporary precedent, the technical elements and challenges involved, the performance practices, and draws conclusions about the current state of improvisatory interdisciplinary art practices.

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INTRODUCTION

Akerselva is an improvisatory audiovisual performance, performed by the composer, on violin and viola. This paper *supports* the audio and video documentation for the piece. The piece uses non-traditional materials that are extensions of and departures from classical violin performance. It is a mediated extension of the performer's body. The performance incorporates a physical laser level device, a remote-controlled camera, a projector, a screen of fabric, a fan, a foot pedal, and a servo motor. Its goals are to draw audience and performer attention to the micro-inflections in drone-based music and the complexities that exist within slowly evolving visual and audio environments.

The title comes from the river Akerselva, which is located in the city of Oslo, Norway, where I spent one year in residence at the Center for Interdisciplinary Studies in Rhythm, Time, and Motion (RITMO). Akerselva weaves through the city and was the site of extended and regular walks throughout my time in Oslo. It has been described as the artery of the city, and is itself the site of many micro-environments that require careful attention to perceive their nuances. The piece is of variable duration, but on average lasts between 20 and 30 minutes.

CHAPTER 1:
Global Introduction
Motivation Summary

This work was created to explore and understand the creative use of scale and focal points in contemporary audiovisual installations, aiming to create a memorable, moving, and legible performance. Specifically, the work orients towards the technological enhancement of audio and visual materials that operate on a micro-scale, metaphorically akin to what one might observe under a microscope. The investigation of these micro-environments reveals creative potential that might otherwise be overlooked. In the effort to create a memorable performance, micro-environments play a key role. Audience members are placed in a minimal auditory and zoomed-in visual space, and therefore are required to make and hold meaning on their own terms. The creation of their own meanings, as opposed to more direct meanings or symbolic gestures given from the performer, contributes to a more localized, memorable, and personal experience. The minimal nature of the performance allows more room for audiences to engage with the piece as they see fit and as aligned with their personal experiences.

Embedded within this performance is a conceptual framework that looks to question, complicate, and obscure the lines between animacy and inanimacy. The piece employs a chain of hardware and software to create a machine-mediated extension of classical violin performance. This extension is important to place in the contemporary sound art discipline, as it is emblematic of a profound amount of history and work in similar styles. Furthermore, within the age of Artificial Intelligence, critically investigating and thinking about animacy and intelligence is relevant to predict the future of the field.

The conceptual framework for this performance is also rooted in literature – most notably feminist studies, fiction, and critical theory. Literature is particularly important to the motivations and background of the piece because it gives words to a discipline (music) which is most often non-verbal. It helps to localize a vocabulary within which I discuss the piece, both technically and in terms of its performance practice.

In the performance practice of the piece, improvisation is used as a counterpoint to the centuries of classical and contemporary notated violin music, and allows for a personal reclamation of the instrument as one that does not have to fit into classical performance practice, while also acknowledging its colonial history. The history of the development of the violin is one that dovetails with the rise of colonialism, particularly between Europe and North America, but is an international force spanning many centuries. In their book *Voices for Change in the Classical Music Profession,* editors Anna Bull and Christina Scharff pull in essays from a huge pool of classical musicians and practitioners, spanning topics from disability representation in opera, to class and gender disparities in conservatory recruitment, to conditions of equality before, during, and "after" the COVID-19 pandemic. [1] This book is a thorough examination of the current socio-political state of classical music, which very much extends to contemporary music. In today's musical landscape, the violin is often taught to children from a young age with the unspoken expectation of a classical soloistic or orchestral career, when the financial, social, and economic reality differs significantly from what is touted as the only "correct" way to become a professional musician. This piece examines and re-engages a personal relationship to classical violin performance and democratized technology.

In this piece, I perform silhouetted behind a curtain, which is used as a projection surface. The projector is connected to a camera which slowly pans across the changing diffraction of a laser level light. In this case, my symbiotic relationship with the slowly changing visual environment informs my playing, and through signal analysis, my playing changes the visual environment. In this case, the light becomes animate, and I respond to it not as if it were human, but as if it were a type of intelligence with complex reproductive structures in place. The conscious decision to perceive the light diffraction as a non-human, non-machine, ambi-animate (my word to describe the blurred space between animate and inanimate) being allows it to influence my playing, allows it to affect me, and allows me to approach the composition and performance from a place of humility, presence, and internalized musicality.

Arts-based Research and Sound Art

This project is based on sound art and uses arts-based research as a starting point. Sound art, a term used to define art practices that use sound as their medium, originated in the late 1970s, but there are many pieces that predate the use of this term and can be considered precursors to the practice. Luigi Russolo, an Italian Futurist artist, composer, and instrument

[1] Bull, Anna, Christina Scharff, and Laudan Nooshin. 2023. *Voices for Change in the Classical Music Profession*.

builder, published a manifesto titled *The Art of Noises* in 1916. [2] This document detailed his predictions that the mechanized sonic space of the Industrial Revolution would push society towards the appreciation and acknowledgement of more complex sounds. His work with experimental musical instruments (*intonarumori)* was reported to have started a riot when first premiered in 1914. Though Russolo's instruments were acoustic in nature, they began a significant movement towards noise-based and sound-based art practices. Russolo's contributions to the field of sound as art and noise-based music were the acoustic predecessors of later composers such as Pierre Schaeffer, who pioneered a movement that concentrated on the manipulation of recorded, real-world sounds. This movement and others are discussed in more detail in Chapter 2. Importantly, sound-art in the 1960s and '70s also gave rise to more women composers entering the field, as it was emerging and not as dominated by men. Artists such as Maggi Payne, Connie Buckley, and Julia Heyward were all featured in the New York MoMA's 1979 exhibition titled "Sound Art", in which all three created innovative new works that prioritized sound. Though curator Barbara London did not explicitly state that her preferences were made in the name of feminism, her choices prioritized women in the emergent art form. [3] Additional artists working around this time include Marchel Duchamp, Bill Fontana, John Cage, and Max Neuhaus. Douglas Kahn's book, *Noise, Water, Meat* details even further the histories involved with interdisciplinary, sound-based art in the twentieth century, citing Fluxus, Yoko Ono, Jackson Pollock, and William Burroughs as subjects for investigation.

Arts-based research is useful in understanding and framing this project because it involves a methodology of *doing* and experimentation which is less formally linked to published research than in science and technology-related fields. The novelty with which I am combining physical and sonic materials makes crucial connections to other disciplines. The disciplines involved in this project (analog light and video art, music technology, improvisation) often appear as discrete silos with independent research trajectories, but a closer examination reveals their inherent interconnectedness. Within visual art practice, these connections abound – even within single-medium pieces. It is in keeping with the value systems of the project to instead amalgamate strands of art and sound-related research, which are frequently compartmentalized. In recent years, there has been a noticeable resurgence in DIY-based composer/performer practices that allow and welcome composers who also perform their own work. I see this trend as a nod to the community-oriented spaces that must continue to exist if sound art and experimental sound-based practices are to continue to survive and flourish. If composers perform and performers compose, there is more opportunity for interdisciplinary collaboration, which is essential for a creative practice of any kind. In their book *Arts Based Research,* authors Tom

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[2] Cox, Christoph, and Daniel Warner. *Audio Culture: Readings in Modern Music*, 2004. http://ci.nii.ac.jp/ncid/BA71171743.

[3] Judy Dunaway; The Forgotten 1979 MoMA Sound Art Exhibition. *Resonance* 7 May 2020; 1 (1): 25–46. doi: https://doi.org/10.1525/res.2020.1.1.25

Barone Jr. and Elliot W. Eisner report, "The primary aim of arts based research is to expand the variety of resources that researchers can use to understand the social world." [4] In this case, arts-based research allows me to anecdotally and subjectively understand how audiences respond psychosomatically to abstract, hypnotic, minimal visuals coupled with improvisation. I also learn how I respond to these visuals during repeated performances, and note their effects on my playing.

Fiction and Essay-based Literature Overview

The first key texts that have implications for this piece are Helen Oyeyemi's short story "is your blood as red as this?," and Kenneth Gross' essay *Puppet: An Essay on Uncanny Life.* The story, the third in the collection *What is Not Yours is Not Yours*, features a magical realist dissection of the relationship between animate and inanimate objects, and the blurred lines between these states. Oyeyemi's characters are all students at a prestigious puppet school, and the second half of the story is narrated from a puppet's perspective. [5] This story has served as particular inspiration for this piece, partially because of its genre, which, on a personal level, allows for an emotional response to both the writing style and the characters. As discussed above, the presence of such a response allows for the story to continue to hold weight, meaning, and value well into the future.

The presence of sentience and conscience in puppets is of particular personal resonance given my relationship with narrative and storytelling as a child, during which my storytelling and make believe sessions frequently switched points of view, tone, and narration styles. As I have worked on this project, I have found a nascent impulse toward animation still alive within me, and it is this kind of animacy that I respond to as a performer, even if, for all intents and purposes, the objects themselves are inanimate and controlled by me. Of the story, Oyeyemi cites Kenneth Gross's essay as having contributed majorly to her work, in which puppets are regarded as fully sentient beings that can even control their owners' actions. Of puppeteering, Gross writes that puppeteering lies in

> the curious impulse and skill by which a person's hand can make itself into the animating impulse, the intelligence or soul, of an inanimate object—it is an extension of that more basic wonder by which we can let this one part of our body become a separate, articulate whole, capable of surprising its owner with its movements, the stories it tells.[6]

Gross's use of the word "intelligence" implies an intelligence separate, or within a perforated layer from the human intelligence that governs the owner of the puppet. The human

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[4] Barone, Tom Eisner Elliot W., *Arts Based Research* (Thousand Oaks, USA: SAGE Publications, Incorporated, 2012).

[5] Oyeyemi, Helen. 2017. *What Is Not Yours Is Not Yours : Stories*. New York, New York: Riverhead Books.

[6] Gross, K. (2012) *The madness of puppets, from puppet: An essay on uncanny life by Kenneth Gross*, *University of Chicago Press*. Available at: https://press.uchicago.edu/books/excerpt/2012/gross_puppet.html (Accessed: 09 June 2024).

hand *takes* and *makes* itself into an animating impulse – its anthropomorphism is relegated to a new, ambi-animate plane. The impetus towards the blurring of boundaries between animate and inanimate is at the core of the creative research questions that govern *Akerselva.* In this case, an almost animate quality is given to laser light diffraction. The peculiarities, imperfections, and unpredictability of the diffraction are built into the system itself, so that the movement of the light begins to take on its own form, and contribute to the meaning-making to which the audience and performer respond.

Non-Fiction Literature Overview

Non-fiction literature-based inspiration for the piece comes from Laura Tripaldi's recent book *Parallel Minds: Discovering the Intelligence of Materials.* In this book, Tripaldi, who has a background in chemistry and materials science, writes that the word "interface" is often used to describe the way humans connect with technology, and the ways in which communication between two surfaces or metaphorical bodies is often much more complex than it may appear. She elaborates:

> The interface is not an imaginary line that divides bodies from each other, but rather a *material region,* a marginal area with its own mass and thickness, characterized by properties that make it radically different from the bodies whose encounter produces it. Anyone who is confronted with a new material soon realizes that what determines its behavior often has nothing to do with its internal composition or structure…but with what happens on its surface. [7]

This piece is conceptually and literally constructed around surfaces, around the changing composition of surface tension and density of audio and visual materials. One of Tripaldi's main calls throughout her book is that users of technology, scientists, and artists consider the types of non-human and ambi-animate (not exactly animate, not inanimate) intelligence that make up the seemingly innocuous materials that construct our lives. Her chapters each concentrate on either mythical creatures (the Hydra, for instance) or an intelligent material/being (polycephalous slime, spider webs) and discuss its implications for expanding the commonly understood definition of intelligence, instead, arguing that the definition should include the chemical construction and thinking that occurs in materials, surfaces, and interfaces. This piece aims to allow the audience to concentrate on the intricacies of the interface itself, as well as the intelligence of the materials that lie beneath; to break open the metaphorical shell and enter the minutiae of the ever-changing underbelly.

The second conceptual reference point is the work of Sofian Audry, who describes a relationship between humans and Artificial Intelligence as based on *The Little Prince's* concept of *apprivoiser,* which means "to tame" in French. Within the text and for Audry, taming is not a unidirectional relationship, unlike the meaning of the word in English. For Audry and for the Little Prince and the Fox in the story, taming requires a position of empathy; it is a patient,

[7] Tripaldi, Laura. 2022. *Parallel Minds*. MIT Press.

iterative building of trust. It is not about control, but relationship, and getting to know the other.[8] Audry's framing of *apprivoiser* is particularly applicable in the way that I approach the physical and sonic materials in this piece–not as variables that I manage, regulate, or contain, but as potential energy that can be shaped and that shapes my performance. Holding this particular relationship to materials, whether they are animate or not, provides a necessary sense of internal stillness, slowness, and groundedness that is crucial to the personal sense of success in a performance.

Curtain-Based Literature

This piece uses a curtain as a projection surface – the performer behind, silhouetted, and the audience in front. It is therefore important to discuss *some* of the crucial developments in literature that tie into themes of perception, invisibility, and the obscuring of oneself. One of the most relevant of these is Bonnie Honig's 2023 essay "The Epistemology of the Curtain: Sex, Sound, and Solidarity in *Singin' in the Rain and Sorry to Bother You."* Honig's discussion centers around a pivotal scene in *Singin' in the Rain* (dir. Gene Kelly and Stanley Donen, 1952), in which Lina Lamont (Jean Hagen) lip syncs in front of an audience with a curtain behind her, while Kathy Selden (Debbie Reynolds) voices the song from behind the curtain. Honig also discusses the importance of Pythagoras' use of a curtain during his lectures so that his students could concentrate on his voice, and how French composer and musicologist Pierre Schaeffer referred to his musical creations as "acousmatic music" in a later nod to Pythagoras. Honig writes

> In the case of both Pythagoras's curtain and Singin's, the tether to the visual is occluded but not severed, suggesting therefore not just detachment but also a possible (re)attachment. The voice that floats past the curtain is resecured to its source when the curtain opens, as it famously does in Singin's denouement, revealing the truth for all to see. This puts the curtain into epistemic accord with the [sexual] closet, which makes of diverse sexual practices a singular secret and then constitutes as truth that which can now be exposed for all to see or know. My claim here is that the curtain's reveal constitutes forensic knowing as epistemic activity as such and this promotes a skepticism- inducing distinction between inner and outer (where only the latter is assumed to be knowable, and the former is a "secret" perhaps even to the self). That distinction, readable as philosophy's mind- body problem, belongs, like Sedgwick's epistemology of the closet, also to a politics of sexuality.[9]

Honig contrasts this scene in *Singin'* with a similar scene in *Sorry To Bother You* (dir Boots Riley, 2018), one in which the curtain is a men's room stall door from which an equi-sapien is eventually revealed after the main character hears cries of despair (or pleasure, it is unclear which). She discusses the ways in which the hetero-normative and raced nature of the reveal in *Singin'* (the scene is the beginning of the coupling of the film's love interests)

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[8] Audry, Sofian. 2022. "Aesthetics of Machine Learning Art and Music in Embodied Agents." Keynote Speech. Presented at the Embodied Perspectives on Musical AI, November 22.

[9] Honig, Bonnie. 2023. "Epistemology of the Curtain: Sex, Sound, and Solidarity in Singin' in the Rain and Sorry to Bother You." *Cultural Critique* 121 (1): 1–41. https://doi.org/10.1353/cul.2023.a905073.

reinforces the binary of the closet–one is either in or out. It is here I think of comic Hannah Gadsby's assertion in her 2018 special *Nanette*, in which she says, "Let me explain to you what a joke is…It is essentially a question with a surprise answer, right? But in this context, what a joke is, is a question that I have artificially inseminated. Tension, I do that, that's my job. I make you all feel tense and then I make you laugh and you're like 'oh thanks for that, I was feeling a bit tense'. I made you tense. This is an abusive relationship." [10] Though of course Gadsby's assertion is hyperbole, it points at something important and relevant to this context. A "question with a surprise answer" is not dissimilar to the scene in *Singin'* which Honig references. *Singin'* provides an answer to the anxiety inherent in a voice visually detached from its subject, makes itself (the film) the source of the problem and the solution to the problem. It is not a coincidence that this answer just so happens to be a heteronormative coupling of the film's two white protagonists. *Sorry* only complicates this relationship, and from the beginning of the film things go from bad, but tolerable, to bad, and completely dystopian on every level. It is this kind of formal construction that *Akerselva* makes use of – it does not have a reveal, it does not have a holistic truth, it centers, as Honig describes, the mythical goat-human creature Pan: "Pan is famous for his random, piercing, acousmatic screams in the woods (Pan is heard more than seen) and for his randy, indiscriminate encounters." [11] *Akerselva* is certainly the site of these types of indiscriminate encounters, and it certainly combines the epistemology of the curtain with Tripaldi, Audry, and Honig's mythical creature and surface-based intelligence thinking.

There are many other pieces of literature that have given much needed critical consideration to the metaphor of the curtain – Maurice Merleau-Ponty's *The Visible and the Invisible* discusses the phenomenology and interplay between what is seen and unseen. Feminist scholar Sara Ahmed uses Merlau-Ponty's work as a starting point extensively in her book *Queer Phenomenology,* in which she writes, "As I have suggested, phenomenology reminds us that spaces are not exterior to bodies; instead spaces are like a second skin that unfolds in the folds of the body…the different 'impressions' of a new landscape, the air, the smells, the sounds, which accumulate like points, to create lines, or which accumulate like lines, to create new textures on the surface of the skin." [12] Ahmed's insistence on skin, surfaces, and impressions is not unlike the visual environment of *Akerselva*, in which laser light diffraction and zoomed-in camera angles create patterns, hold rhythm, and take form, shape, and substance differently in each performance. To be present for *Akerselva* requires attention to detail, orientation to the minutiae of spaces, and acceptance of their inevitable change. In her book *Living a Feminist Life,* Ahmed writes, "to get ready often means being prepared to be undone." [13] To perform this piece is a

[10] Gadsby, Hannah. 2018. Review of *Nannette* Video. Edited by Aleck Morton. *Netflix*.
[11] Honig, Bonnie. 2023. "Epistemology of the Curtain: Sex, Sound, and Solidarity in Singin' in the Rain and Sorry to Bother You." *Cultural Critique* 121 (1): 1–41. https://doi.org/10.1353/cul.2023.a905073.
[12] Ahmed, Sara. 2006. *Queer Phenomenology: Orientations, Objects, Others*. Durham: Duke University Press.
[13] Ahmed, Sara. 2017. *Living a Feminist Life*. Durham, NC: Duke University Press.

gradual undoing, (a practice in vulnerability) and the physical nature of the setup is a grounding practice that speaks to the getting ready.

Judith Butler's *Gender Trouble: Feminism and the Subversion of Identity* gives voice to the complicated and nuanced relationship between gender, sex, and performance. Arguably, in this piece, I am subverting some aspects of my identity, which I speak to in more technical detail in Chapters 2 and 3. In any case, the fact that I am silhouetted is an important distinction in the Honigian sense of the curtain. The boundary between complete obfuscation behind a curtain (as in *Singin' in the Rain)* and complete visibility is at the threshold of the silhouette, and it is this threshold that the piece traverses through the material visual choices to use fabric as a projection surface and a fan to billow the fabric. Sonically speaking, there are many different thresholds at play, but the one that is most often blurred is the distinction between harmonicity and inharmonicity, or sounds that have whole number multiples of their fundamental pitch versus sounds that don't. The gray area between these types of sounds is one of the crucial guiding formal principles of the piece (discussed further in Chapter 3).

Precedent

The first visual precedent point is Thomas Wilfred's Clavilux, a manual machine that allowed users to create lumia (Wilfred's term for light art) by depressing certain pedals in combination with one another. Though the device was not widely manufactured, it is reputed to be the first device of its kind, and played a significant role in light art's scholarly and public acknowledgement.[14] One element of Wilfred's lumia that is particularly inspiring for this project is the three-dimensional quality of the images it produces and its analog nature; it could occupy a large amount of space and almost appear aura-like, hazy, and slow moving (Figure 1). The piece relies on artistic practices that are improvisatory and may contain drone-based music and visuals – that involve subtle and slow changes over time. There are too many practices of this vein to name in this paper; however, some noted musicians and artists whose work provides a basis for this project include: Tony Conrad (*Ten Years Alive on the Infinite Plain)*, Giacinto Scelsi (*Anahit)*, Ellen Fullman's Long string Instrument, Iancu Dumitrescu (*Hyperspectres)*, Pauline Oliveros' deep listening, and Alvin Lucier's work. More contemporary performance based reference points include violinist and improviser C. Spencer Yeh, violinist Carla Kihlstedt, composer and improviser Sakoto Fuiji, trombonist and improviser Mattie Barbier as well as the duo RAGE Thormbones, experimental cellists Okkyung Lee and Tomeka Reid, composer and improviser Miya Masaoka, and composer and improviser Myra Melford. Video art practices which have influenced the project include American Experimental Film artists Anthony McCall, Michael Snow, P. Adams Sitney, and Maya Deren. Further, some laser light work precedent

[14] Thomas Wilfred et al., *Lumia: Thomas Wilfred and the Art of Light* (New Haven, CT: Yale University Art Gallery, 2017), 21.

comes from the laser harp, first introduced by Jean Michael Jarre in the 1980s.[15] Though these composers and artists span a wide variety of timelines and practices, their attention to the lived circumstances of their work and process-oriented approach remains a substantial contribution to the field, and has been invaluable in positioning the work of *Akerselva.*

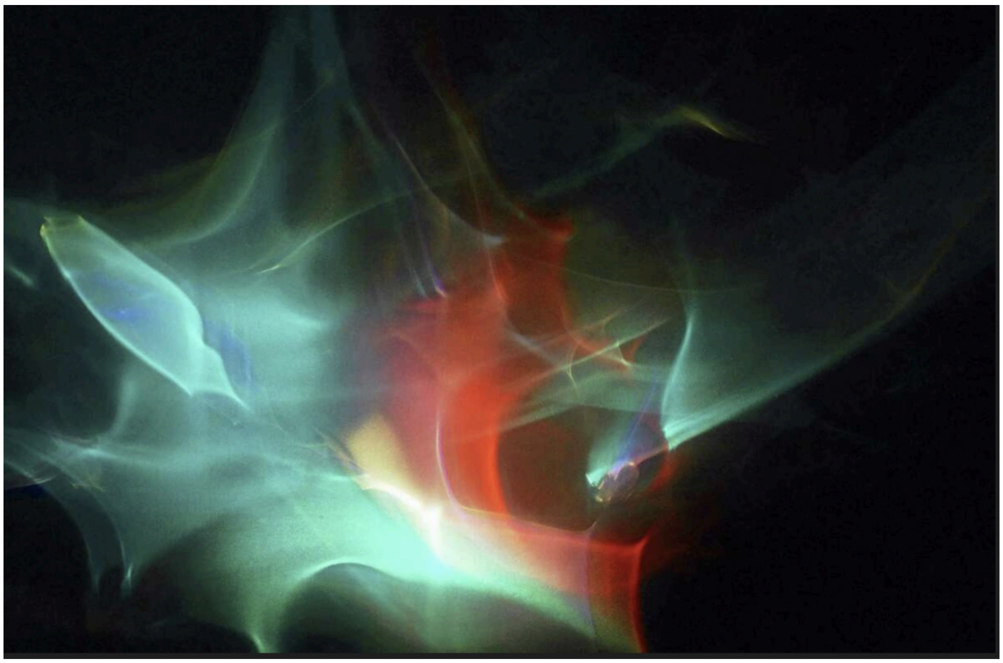

Figure 1. *Visual Output from Thomas Wilfred's Clavilux at Yale Art Gallery, 2017*

CHAPTER 2:

Technology in *Akerselva*

Technological History

The technological workflow of this piece is indirectly influenced and impacted by the technological developments in music beginning in the 1870s, when the phonograph was formally introduced as a machine that could play music. These technological developments, largely driven by the commercialization of equipment and machines, continued over the next century, and are still changing today. For the purposes of this paper, I will concentrate on the developments in digital recording and music production technology, as well as discuss the seminal figures within the discipline of avant-garde music, sound art, and electro-acoustical art music.

In 1948, experimental musician and French composer Pierre Schaeffer and his colleagues at the Studio d'Essai (Experimental Studio) developed a technique of musical composition known as *Musique Concrète* (concrete music), in which recordings of natural real-world sounds

[15] G. Ferenc and J. Popović-Božović, "An infinite beam laser harp with external MIDI I/O functionality," 2014 22nd Telecommunications Forum Telfor (TELFOR), Belgrade, Serbia, 2014, pp. 877-880, doi: 10.1109/TELFOR.2014.7034545. keywords: {Laser beams;Structural beams;Instruments;Universal Serial Bus;Hardware;Laser modes;Electronic musical instruments;laser harp;MIDI controllers;USB audio}

are modified and combined to create an assemblage of sound. Schaeffer is credited with developing one of the first experimental electronic music techniques, and a number of other composers followed suit. One of the most well-known pieces by Edgard Varèse, a French-American composer, is *Poème électronique,* which was composed for the 1958 Brussels World's Fair and performed through 400 loudspeakers. [16] *Musique Concrète* complicated the relationship between composer and performer, and introduced the notion that a performer did not need to be physically present or even part of the musical process for a piece of music to have artistic meaning and value. The resulting implications of this style of music and technology led to the founding of multiple centers of musical research across the United States and Europe. While not all centers of musical research concentrated on *Musique Concrète*, its impact remains a crucial part of the research discipline.

The Institute for Research and Coordination in Acoustics/Music (IRCAM) is a computer music research center that, like Studio d'Essai, is dedicated to the research of music and sound. Based in Paris, it is the site of innumerable developments within the field of computer music research. One of the most important of these contributions is the development of Max/MSP, a visual programming language and software for music and multimedia. Miller Puckette, the main developer of Max, began working on it at IRCAM.[17] Since then, the software has been purchased by Cycling '74 and has become one of the main tools used and taught in undergraduate and graduate music programs internationally. It has undergone many revisions since its inception, with the integration of Musical Instrument Digital Interfaces (MIDI) being one of the most important developments. Max/MSP is used extensively in this project, and one of its strengths is that it can parse a variety of data types and function as a space where many different hardware and software protocols can communicate effectively.

Technological Methodology

Below is a list of critical points, methodologies, and concepts that I carefully considered when constructing the technical environment for the piece. It is important to note that this chapter details *the entire* process of technical development, which began in August/September 2022 and ended in May/June 2024. There were *many* versions of the piece, using many different workflows. The current state of the project is described under the heading "Phase Four".

1. I emphasized physical robustness in the circuit design and connections between devices. This involved using solid state electronics and easily replicable circuits with common motors and components. This decision allows performances to take place with little troubleshooting disruption and with more ability to experiment sonically. Furthermore, it leaves room to build in complexity in further iterations as one becomes fully competent and fluent with the technologies. Prioritizing time and space for creativity, rather than troubleshooting or extensive technological research, is a key element of my workflow. If needed, I revisit the technology after addressing the creative goals, for example, to

[16] The Editors of Encyclopaedia Britannica. 2019. "Musique Concrète | Musical Composition Technique | Britannica." In *Encyclopædia Britannica*. https://www.britannica.com/art/musique-concrete.
[17] Puckette, Miller, and David Zicarelli. "MAX-An interactive graphic programming environment." *Opcode Systems, Menlo Park, CA* (1990).

minimize latency or ensure a more efficient system. Robustness means that the system must be flexible enough to travel internationally and adapt to different venues and spaces. This involves not only a responsibility for keeping track of its discrete elements, but also being able to communicate tech rider needs to various people. I have now performed the piece in a variety of spaces: small classrooms and lecture halls, in small performance spaces, and in large performance spaces both in the United States and abroad. Given the performance constraints, the entire technological set up can be contained on one small table offstage.

2. An important conceptual framework of the piece is democratic design, which flattens and expands hierarchies of control into a more horizontal framework. As such, I orient to the system as though no one element is more important than the others, because they must work together and communicate with one another properly in order for the piece to function. The visual aspect of the piece must complement the sonic output, which involves incredibly slow and detailed change over time. I further develop this framework and its larger cultural and performance implications further in Chapter 3.
3. The system incorporates both discrete and continuous mapping of hardware to software using real-time audio analysis as one of the main control parameters. These cyborg hardware and software have a variety of communication protocols, each with a learning curve. Challenging myself in terms of understanding such protocols and to personally explore technologies I had not previously worked with is a major part of this piece.
4. The audio production space of the project must address the precedence effect, a phenomenon related to spatial hearing in which listeners localize sounds closest to them as arriving first. [18] Therefore, since the piece involves amplified instruments, it is crucial that the speakers have an appropriate amount of delay built into the sound check for live performances, and that the audience is a certain distance. To check the sound from the audience's perspective, I use a clip-on microphone (a Neumann MCM 114) and walk to the center of the space while playing.

Laser Needs

The inspiration behind using laser light as a visual tool for the project came from an awareness of my own sensitivity to light and shadow "touch." In scenarios where laser light beams cross paths with my body, there is a phantom physical response triggered from watching the light, regardless of the quality or situation surrounding the contact (e.g. laser tag or art installation). This phantom response is something that not only triggers an emotion in me, but also animates the laser or light source, making me feel as though I am interacting with a kind of spirit. A crude example: in most amateur

[18] Wallach, Hans; Newman, Edwin B.; Rosenzweig, Mark R.; 1973; The Precedence Effect in Sound Localization (Tutorial Reprint) [PDF]; Swarthmore College, Swarthmore, PA; Paper ; Available from: https://aes2.org/publications/elibrary-page/?id=10299

productions of the musical Peter Pan, Tinkerbell is a moving flashlight. The physical response remains a crucial part of the project. The light and diffraction themselves are components that I wanted to use as an interface between the margins of animate and inanimate, and as something that moves unpredictably in response to me, as though we are taming each other.

Current Signal Flow Development Summary: May 2024

The first stage of technical development, from August 2022 to April 2023, was accomplished at the University of Oslo's Center for Interdisciplinary Research in Rhythm, Time, and Motion (RTIMO) under the supervision of Dr. Alexander Jensenius. The devices used were as follows: A 5-volt servo motor with a bar arm with a small piece of bubble wrap taped to the top of the bar (Figure 2, below), a physical laser level device (Figure 3), and an Arduino Uno. The motor was connected to the 5v power supply, ground, and analog pin 9 of the Arduino (Figure 4). The motor was placed on top of the laser level, so that the bubble wrap hung down over the light emitter (Figure 5). The laser level device has two modes: one in which a green horizontal light beam is emitted, and one in which a vertical light beam is emitted. I worked exclusively with the vertical light beam, because the bubble wrap nor the motor could not physically reach the horizontal beam. During the time from September 2022 to April 2023, there were two main phases of experimentation: one in which I used the motion of my body to diffract the laser light, and the second in which I used the incoming audio signal of my violin to diffract the laser light. The details of each of these phases are below under separate headings.

Figure 2. *Servo Motor with Bubble Wrap*

Figure 3. *Laser Level with Vertical Line*

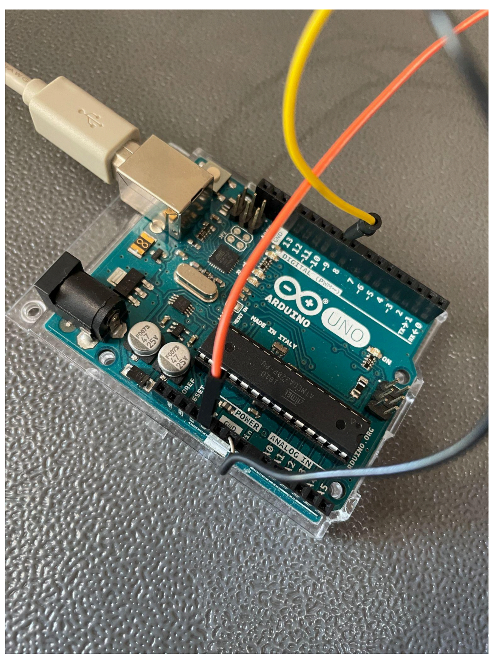

Figure 4. *Arduino Connections*

Figure 5. *Laser Level with Servo Motor*

In September of 2023, the technological setup expanded to include a camera which captures a close up angle of the light diffraction and projects this angle onto four panels of 9’ x 3’ fabric. This fabric is hung carefully from an extendable metal stand and billows gently from the force of a DMX-controlled oscillating fan. In April of 2024, I substituted the previous Unifi G4 camera for a PTZOptics Move 4K camera, which allows remote control of pan, tilt, zoom, and focus using http commands and presets triggered by a MIDI foot pedal. Figure 6 below shows the staging of the piece.

Space left blank to accommodate Figure 6.

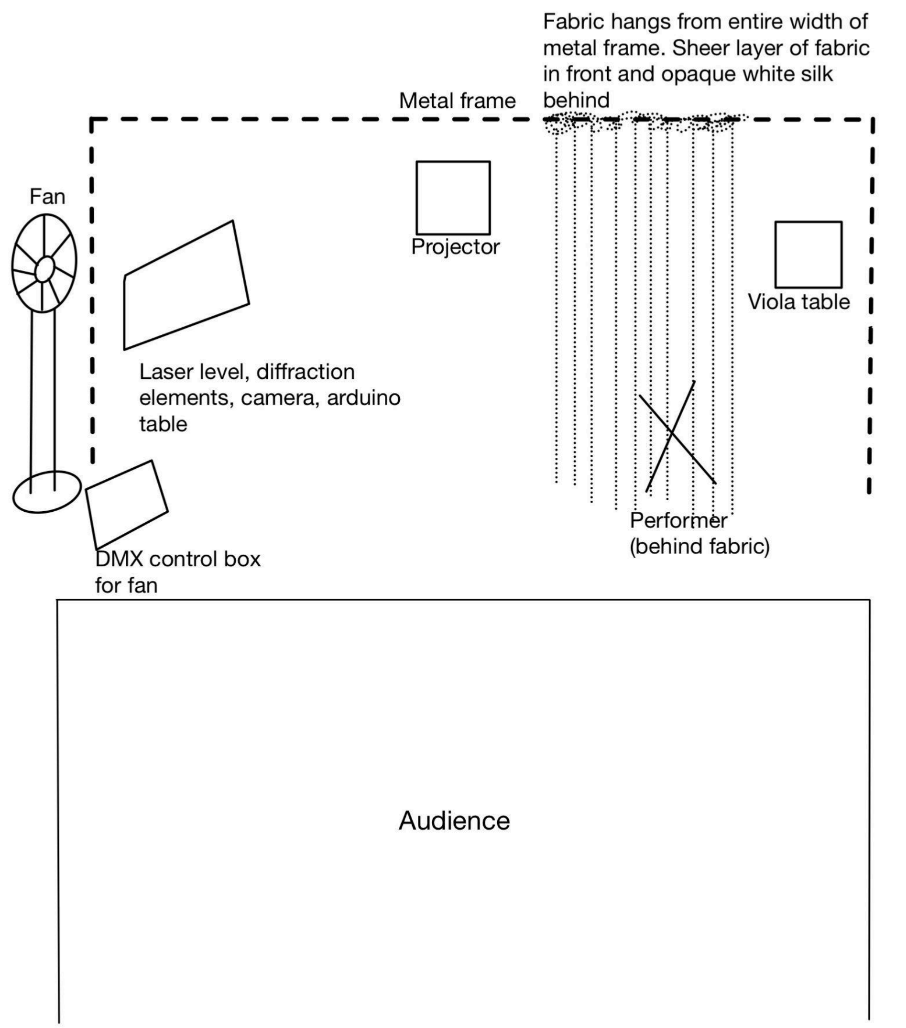

Figure 6. *Staging as of June 2024.*

Research Plan

During my time in Norway, I set out with specific technical research goals for this piece. The broadest of these goals was to challenge myself – to push myself out of what had become a comfort zone in terms of technical skills. My comfort withMax/MSP was mostly centered on simple Frequency Modulation, Amplitude Modulation, and granular synthesis, and working with MIDI. Additionally, my technical and production comfort zone included composing and producing fixed media pieces – preconstructed electroacoustic pieces that serve as enhancement during a performance. I wanted to try and make something that responded to my playing in a more immediate way, and that was unpredictable and not fixed. The second of these goals was to develop a proof of concept workflow and documentation. The third goal was to perform with the system as often as possible. All of these research goals were accomplished successfully during my residency at RITMO.I returned to the United States with the very stable beginnings of what became a more elaborate audiovisual system.

Arduino Setup

To diffract the laser light, I used a 5-volt servo motor powered by an Arduino Uno. The Uno is equipped with a software library for servo motors, enabling the use of pulse width modulation on the analog pin controlling the motor's angle. This particular motor can turn 180 degrees. To turn to the correct location, it needs to receive an integer between 0 and 180.

Initial Experiment

During the very first testing phase, I needed to find the range of integers that would keep the diffraction material (bubble wrap) in front of the beam of the laser level. This range would be what I would use as a default state for the project. I experimented with motor movements using integers from 0 - 180. The software library for servo motors in the Arduino IDE comes with a folder of example code, one of these files is labeled "Sweep" (code below), referring to the windshield-wiper type motion that the motor would make. I used this code to find the correct range of integers in order to keep the bubble wrap in front of the laser beam at all times. If 0 - 180 was the range that I had used, the bubble wrap would not stay in front of the beam. I noticed that with the largest possible range, the bubble wrap crossed the path of the beam for about 40 - 50 degrees of its "sweeping" motion. By adjusting the range each subsequent time I ran the code, I found that the range 40-90 or 30-80 worked best when the motor was attached to the top of the laser level. These ranges work best because the light is diffracted the entire time the code is running, thus obscuring the vertical laser beam line and allowing the viewer to focus on the slowly changing diffraction rather than the harsh brightness of the line by itself.

```
/* Sweep
by BARRAGAN <http://barraganstudio.com>
This example code is in the public domain.
modified 8 Nov 2013
by Scott Fitzgerald
https://www.arduino.cc/en/Tutorial/LibraryExamples/Sweep
*/
#include <Servo.h>
Servo myservo;  // create servo object to control a servo
// twelve servo objects can be created on most boards
```

```
int pos = 0;    // variable to store the servo position
void setup() {
 myservo.attach(9);  // attaches the servo on pin 9 to the servo object
}
void loop() {
 for (pos = 0; pos <= 180; pos += 1) { // goes from 0 degrees to 180 degrees
   // in steps of 1 degree
   myservo.write(pos);             // tell servo to go to position in variable 'pos'
   delay(15);                      // waits 15 ms for the servo to reach the position
 }
 for (pos = 180; pos >= 0; pos -= 1) { // goes from 180 degrees to 0 degrees
   myservo.write(pos);             // tell servo to go to position in variable 'pos'
   delay(15);                      // waits 15 ms for the servo to reach the position
 }
}
```

Serial Communication between Arduino and Max/MSP

Max/MSP is a computer software that allows a user to call pre-scripted objects inside of a GUI, and connect them to other objects, thus "coding" their own musical control surfaces, among many other possibilities. Max/MSP is the main control center for all of the various technological elements of this project, allowing each of their respective data to come into one software and affect one another. In order for Arduino code to be sent into Max/MSP and vice versa, the Serial communication protocol is used. It is not necessary for the scope of this paper to detail all of the different use cases and specifics of Serial, thus, Serial, most generally, refers to the process of sending data sequentially, one bit at a time. In this case, I am using Serial communication to send data over a USB (Universal Serial Bus), which is connected to the Arduino and to my computer. Both Arduino and Max/MSP have built in code or objects that initialize serial communication. These must be at the same baud rate, or speed, of 115200, and recognize one another on the same (USB) port. If the communication is working correctly from Max/MSP to Arduino, an integer can be sent from a number box and affect hardware connected to the Arduino. In this case, I needed to be able to send integers from Max/MSP to control the angle of the motor, and thus the way that the laser light was diffracted. I wrote the following code in order for the motor to receive a list of continuous integers from Max/MSP via the Serial communication protocol.

```
#include <Servo.h>
Servo myservo;
int pos = 0;
```

```
void setup() {
 Serial.begin(115200);
 myservo.attach(9);
}
void loop() {
if (Serial.available()) {
int pos = Serial.read();
myservo.write(pos);
}
  }
```

This code is effective in communicating between Arduino and Max/MSP. I can test the communication by sending integers to Arduino from Max/MSP using either an integer box or a slider, and the motor will move to the specified angle accordingly. The goal here is that some other control parameter, (in the first stage, as mentioned before, this would be my body position) would be controlling the angle of the motor and thus the light diffraction. Therefore, it is necessary to have a remote way of sending data between Max/MSP and Arduino, and Serial is the most user-friendly of these communication methods. The low learning curve with Serial communication is beneficial in this case because it means that the project is working more quickly, and there is more time for visual and sonic creativity and practice.

Phase One: Signal Analysis used in Computer Vision application

In October 2022, I began the first full prototype of the project. I decided to use a camera that would track the position of my body as the main control parameter to diffract the laser light. I started by using the Max/MSP computer vision external library cv.jit, using a logitech webcam connected via USB to my computer as the camera source. I tested all of the objects in the cv.jit library for use as the computer vision object that would track my body with the following criteria: The object needed to output data that was either integers by default, or could be scaled to integers, in order to send the integers to Arduino to control the motor and laser light diffraction. The object also needed to be able to respond to a number of lighting conditions, and have internal controls to account for changes in light. Finally, the object needed to be able to track my body with smooth changes in data, (ie: not "flickering" between two numbers, or glitching) with relatively low latency and relatively accurately, with the understanding that my camera source was low resolution and USB and Serial communication are not technically the fastest options for inter-software communication. The choice of the camera and serial were not variables within my control, as borrowing the camera from my advisor at the time was a cost effective way to get started on the project. After testing all of the objects with the above criteria, the most effective object within the cv.jit library was cv.jit.centroids, which returns the center of mass of an object. This object was particularly helpful because of the thresholding option, which accounts for the threshold between grayscale values for different lighting conditions, as well as the output format - a list of xy coordinates in pixel range. I scaled the x coordinate data to an appropriate range for the motor (40 - 90), and used the above code to change the motor's position by leaning more on my right or left foot, slowly swaying, while improvising. The goal of this phase of the project was to prove that this method was viable for experimentation, that the code worked correctly, and that there was room for expansion.

Audio Experiments in Fall 2022

In addition to testing the visual control elements of the performance, it was during the Autumn months of 2022 that I began experimenting with guitar pedals on violin using an electronic pickup that screws on to the bridge of the instrument. It was my goal at this time to understand whether or not these pedals would help achieve added personal sonic interest throughout the piece (i.e. create new frequency spaces that the violin does not naturally contain), and to understand some of their controls and circuitry. The pedal I used the most frequently, and purchased because of its capabilities, was the Empress Effects Zoia. This pedal is unlike others in that it allows modular chaining of presets, waveforms, and effects together, creating a truly unique set of combinatorial possibilities with just one pedal. The interface on the top of the pedal reflects this, as it is a matrix of white buttons that can be configured in any way the user chooses (Figure 7, below). This pedal also contains the ability to receive MIDI control change messages from another device and use these messages to affect its internal controls. Given the fact that I knew my Max/MSP patch could send control change messages from the integers generated by the x axis of my body movements, I wanted to experiment to see if my body movements could additionally automate the parameters inside of the Zoia, thus changing the audio output of my improvisation. The effects I worked the most closely with on the Zoia were a pre-made fuzz effect, a distortion effect, and a spring reverb.

Space left blank to accommodate Figure 7.

***Figure** 7. Empress Effects Zoia*

Test Performance of Entire Computer Vision Application

In December of 2022, and after several intensive days of testing all of the elements (camera, laser light, and audio control using the Zoia), I was ready to record video and audio documentation of the computer vision application of the project. This filming took place at RITMO in the studio used for Motion Tracking. I recorded two versions of the video. The first is more of a trailer-style index of techniques that I had been experimenting with during my improvisations for some time, and the second video is a short form drone based piece. In both videos, my body position is controlling the green laser light diffraction and there is frequency modulation synthesis between the fixed frequency of the Zoia with the changing pitch of my instrument.

Initial results of Computer Vision Application

The initial results of this phase of the project were limited - The camera that I used to track my body position was very sensitive to small changes in lighting conditions, and though it was possible to quickly adjust the values, this proved too time consuming to rely on in a situation where I was setting up documentation and needed to turn the lights on and off. Further, the piece works with an analog source of light, and the performance space needs to be as dark as possible. The cv.jit method of analysis requires *some* light in order for the camera to pick up my body position, and depending on the space, this amount of light varies greatly. Finally, from a performance and performability perspective, there was nothing personally compelling about the results of this iteration of the project. The goal of this phase was to make the laser light diffraction as sensitive in light output as I could be in my improvisation. While the instrumentalizing of light I was able to accomplish was quite sensitive, the relationship between body position and light diffraction is a 1:1 relationship – I move, and the motor moves in unison. However, it was quite satisfying to experiment with the sensitivity of my body movement as replicated by the motor and to see the subtle changes in light happening over a long period of time. Although there were many dissatisfactions at this stage, there was something still quite alluring. This phase gave me the confidence to continue to make changes to the relationships between the laser light and the control parameter. Figures 8, 9, and 10 below show stills from the documentation process.

Space left blank to accommodate Figure 8.

Figure 8. *Behind the Scenes, Documentation Video 2*

Space left blank to accommodate Figure 9.

Figure 9. *Still from Documentation Video 1, December 2022*

Figure 10. *Still from Documentation Video 2, December 2022*

Phase Two: Initial Audio Mapping

After finishing the filming of Documentation Video 2 in December 2022, and for the reasons described above detailing dissatisfaction with the camera workflow, I wanted to try using audio from my violin as the control parameter for laser light diffraction. As the first test to check whether or not this was possible, I used the Max/MSP object fiddle~, which analyzes incoming audio and detects which frequency is being played. In the initial audio mapping phase, I kept a 1:1 relationship between pitch detection and motor movement, so if the pitch was higher, the motor would move to the left, and if the pitch was lower, the motor would move to the right. I scaled the floating point frequency numbers that were detected by the fiddle~ object into the motor range (40 - 90), and experimented with improvising using drone-based sonic materials, containing many natural harmonics.

Initial Audio Mapping Results

Partially because of the sonic material I was playing, and partially because of the internal settings of the fiddle~ object itself, the results of the first test using audio as a parameter for light control were unsuccessful – the response from the motor was very jittery, as it was responding to the small (and inconsequential) pitch changes that fiddle~ detected. In Chapter 3 of this paper, I detail the reasoning behind my choices in playing techniques and harmonic-based drones, but traversing this particular kind of sonic material was non-negotiable, and therefore, I needed to find the appropriate analysis tools to make best use of the audio that I would be playing. After using some smoothing objects to slow down the stream of integers and get rid of any irregularities, I found that the system worked much better for the 1:1 relationship mapping. I used the onepole object, which is a low pass filter, and helped to reduce the glitch-like quality. I also used zl reg, which stores and outputs an incoming list at a specified time, instead of outputting all numbers as soon as they come in. However, in order to provide sufficient and sustained visual interest for myself and an audience, I knew that I wanted to depart from the 1:1 audio to visual mapping.

RapidMax External Background and Selection Process

From December 2022 - March 2023, I experimented with some Max/MSP external libraries that contained machine learning objects. I was drawn to machine learning because of the importance of creating an "animated" performance space, where new sonic materials could be reproduced in real time that were based on my original playing. I developed a test case scenario in which I tried three different machine learning libraries (ml.star, FluCoMa, and RapidMax), to see which would be the best for my use case. The criteria I used to evaluate the success of these libraries were as follows: stability (not prone to crashing or causing CPU overload, or causing Max/MSP to crash), ease of use, and integration with existing architecture inside the Max/MSP patch. FluCoMa, (standing for Fluid Corpus Manipulation and developed by a team of researchers at the University of Huddersfield), while an excellent tool, was not best suited for the needs of this project. It was too complex of a learning curve for the timeline and goals I had in mind and contained features that weren't compatible with my existing patch. Again, throughout the entire project, I recognized a personal need to privilege creative experimentation and playing with my system instead of spending excessive amounts of time troubleshooting software. The ml.star library, developed by Benjamin Day Smith, had similar issues to those of FluCoMa. Rapid Max, a library based on the RapidLib C++ machine learning library and developed by Sam Park Wolfe, [19] was the external that allowed for the most stable and easiest integration into my existing workflow. I began by using the help file for a classification algorithm version of the object rapidmax. Classification in machine learning refers to a process by which a neural network is trained on an existing dataset, and the user (or computer itself) selects a new point of data and asks for the algorithm to classify the new point using its existing model. In my case, I wanted to train the object on specific frequency content from my playing and use this frequency content to set different output speeds for the motor to move at, creating different patterns in laser light diffraction.

Frequency Analysis Tools

As a frequency analysis tool, I used an external package called zsa descriptors, developed at the Institute for Research and Coordination in Acoustics/Music (IRCAM).[20] By playing and sending my "default", harmonic-based sonorities as audio inputs into the objects within this package, I was quickly able to determine which object's response would scale the most effectively into motor movements and light diffraction. By this point in the project, I had begun to intuitively understand which types of motor movements (those that were smooth and fluid) looked the most interesting in terms of light diffraction, and I evaluated the smoothness of the frequency analysis using similar criteria. I found that the object zsa.mfcc~ was the most effective considering this set of needs. MFCC stands for Mel Frequency Cepstrum Coefficients. These coefficients are computed by taking windows of recorded sound, applying a Fourier Transform to them and converting the audio to the Mel scale, which includes more information about the human auditory system (humans hear logarithmically, meaning that one measure of frequency or amplitude "higher" or "louder" does not indicate a one degree change exponentially). After converting to the Mel scale, the logarithm of the previous Fourier transform is taken, and again a Fourier transform is applied to the result. For my purposes, zsa.mfcc~ was the most effective tool to be able to detect and visualize amplitude variations in multiple harmonic partials that I was playing.

Creating a Motor Sweep using the line Object

In order to see the full range of control I could have of the motor movement from Max/MSP, I tried sending the output of a line message object into the serial object. The line object operates using destination and time pairs of integers. This means that the motor could move to position 40 (its starting position, per my tests) in, for example, 1000 milliseconds (or 1 second) and then to position 90 in, for example, 5000 milliseconds (or 5 seconds). By connecting the output of the line object (which sends a "start" message) to its own input, I could move the motor in this particular sweeping proportion in a repetitive loop.

Integration of Zsa Descriptors and Rapid Max

The rapid max object allows users to store and recall training data, alleviating the need to re-train the classification algorithm inside the object every time the user opens the patch. As a

[19] Samparkewolfe. "Samparkewolfe/RapidMax: A Max MSP Object Encapsulating the Rapid Lib C++ Library." GitHub. Accessed May 7, 2024. https://github.com/samparkewolfe/rapidmax?tab=readme-ov-file.

[20] Mikhail Malt, Emmanuel Jourdan. Zsa.Descriptors: a library for real-time descriptors analysis. 5th Sound and Music Computing Conference, Berlin, Germany, Jul 2008, Berlin, Germany. pp.134-137. ffhal-01580326f

first test, I set the number of output states for the motor to be 3, and devised appropriately different looking line object messages for the motor. I would train the rapid max object on three distinct pitches, and map these to the distinct states of the motor's movement. In terms of training, the rapid max object allows users to record incoming audio signal, which is sent through zsa.mfcc~. The resulting frequency content of zsa.mfcc~ 's analysis is displayed using a multislider object, which is recorded inside of the rapid max object itself. Figure 11 shows the full Max/MSP patch as of March 2022 - March 2023.

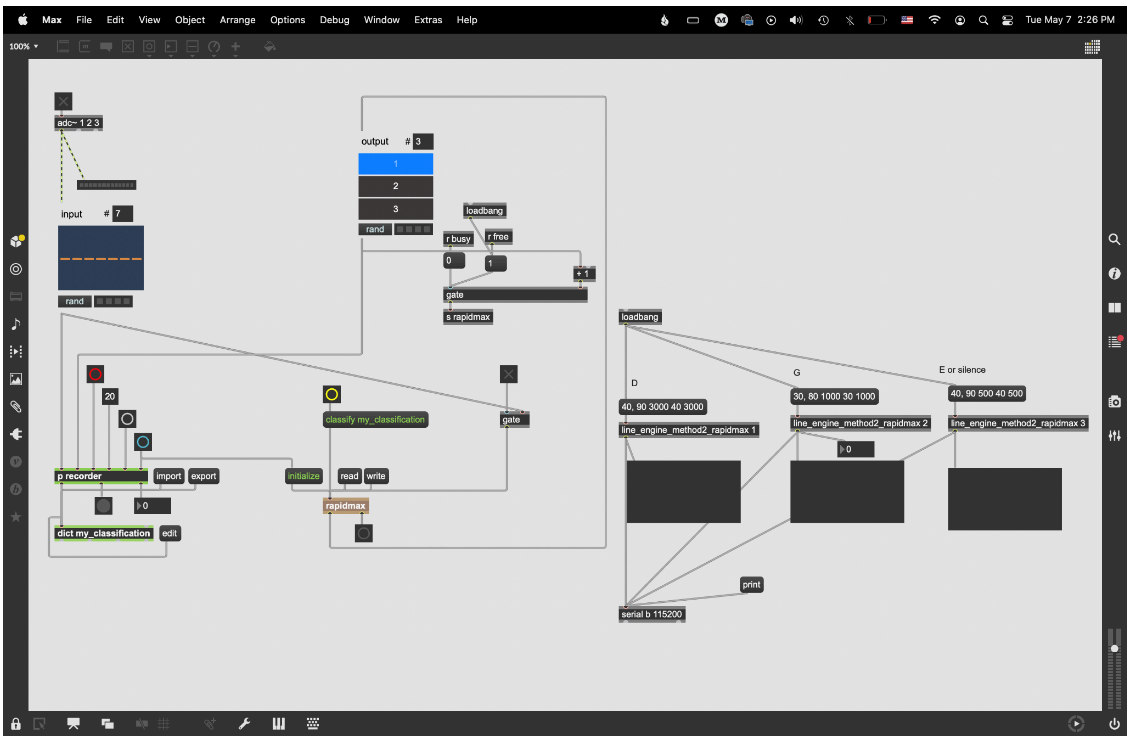

Figure 11. *RapidMax Patch, March 2023*

One important part of this patch is a custom line engine that is initialized when the patch loads. The purpose of this line engine is so that the motor never stops moving completely when there is no new pitch detected, and so that the motor does not interrupt an in-progress sweep if a new pitch is detected while its previous motion is still happening. If this is the case, the motor will move to the newly detected state as soon as it finishes the in-progress sweep. This engine is in Figure 12, below.

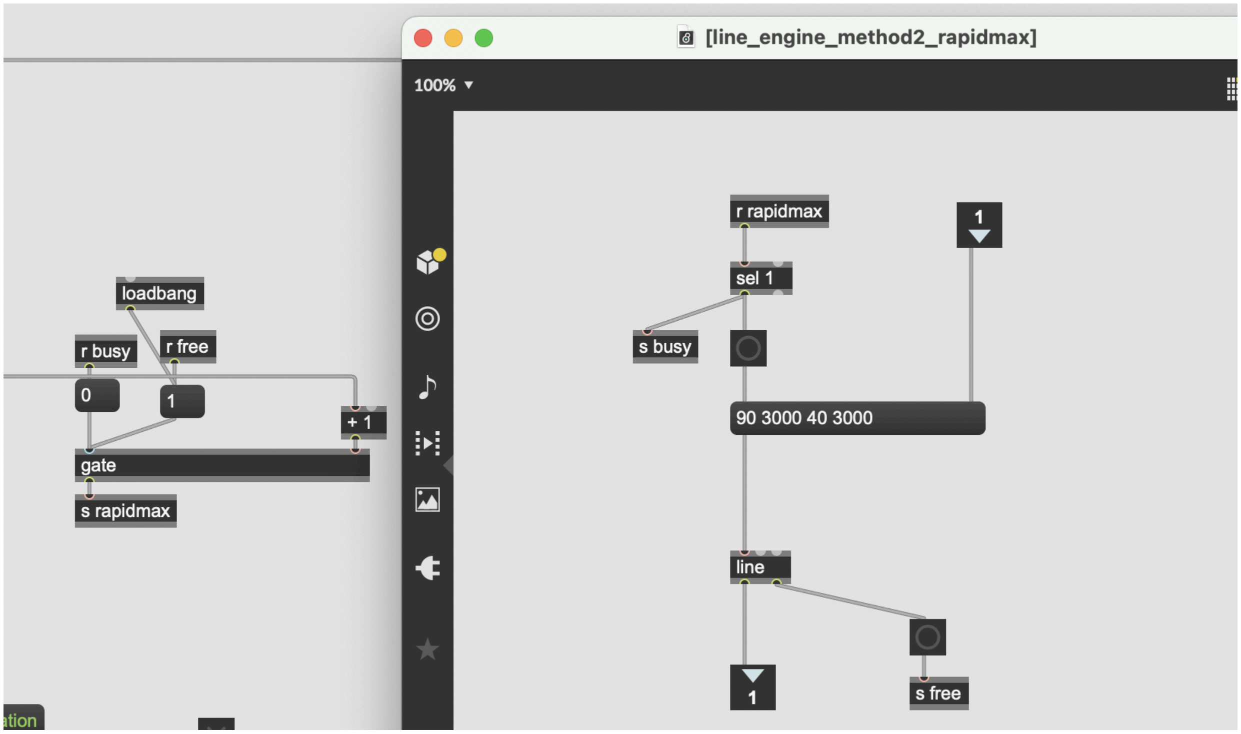

Figure 12. *Inside the Line engine*

This particular audio workflow has stayed the same from March 2022 until March 2023.

Phase Three, September 2023: Visual Expansion at CNMAT

Upon my return to the United States, I recognized that the visual element of the piece needed some additional artistic research. It was at this time that I began working at the Center for New Music and Audio Technologies (henceforth CNMAT) on these visual elements. The minute movement of the laser light diffraction was an element of the project that had great potential, if it could be magnified in some way. I decided to try focusing a camera on the light diffraction and projecting this camera angle onto moving (billowing, from a large fan) fabric. The reasoning behind this decision is so that the projection surface is not static, it contains a kind of "life" and sheen. Because the camera angle has to be relatively zoomed in, there can also be a lack of focus to what it is seeing, creating a hazy quality to the light that it picks up. I additionally experimented with the placement of the projector and the type of fabric I wanted to project onto - I mostly purchased large quantities of light colored satin, but there are two distinct layers of fabric in order to add visual interest to the performance. The top one is completely sheer and the bottom is the actual projection surface. Figures 13 and 14 are stills from this documentation process, and is the first time that I began to see what could end up being the final product of this piece.

Figure 13. *Still From Documentation Video 3, September 2023*

Space left blank to accommodate Figure 14.

Figure 14. *Still from Video Documentation 4, September 2023*

Spring 2024: Late stage Visual Development

In order to provide more visual interest for myself and for the audience of the piece, in Spring 2024 I decided to explore other options for the camera that was used to view a close-up angle of the laser light diffraction. I was looking for a camera that allowed for remote control of panning, zoom, tilt, and focus. In my research I came across the PTZOptics Move 4K camera (Figure 15), which fits these criteria, and even allows for MIDI control to recall user-set presets. Practically speaking, the MIDI feature means that I would be able to use a MIDI foot pedal as I am playing to send the camera to an entirely new view. It also means that I would be able to compose visual scenes that are not only fixated on green laser light diffraction, but that contain different layers of movement and different colors. Perhaps these would be different types of light diffraction (through glass) or have a different light source or light color (a RGB LED light, for example). The possibility of automating the camera movement helps to allow hands-on experimentation with the material visual environment. This ability for hands-on experimentation is of high value to the project's workflow and ethos.

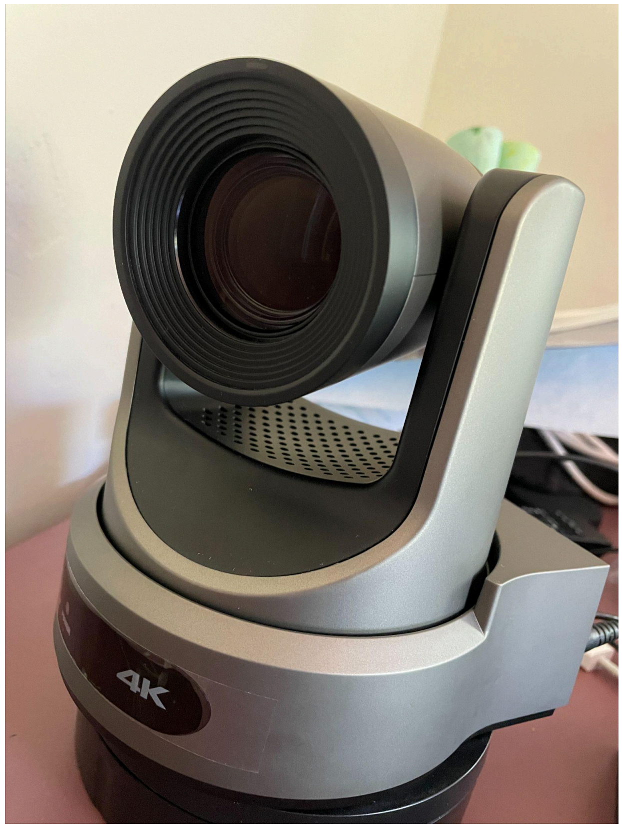

Figure 15. *PTZ Optics Move 4K Camera*

Automating the Camera

The PTZOptics Move 4K camera has several output port options to display the images it sees. The manual recommends that users connect the camera with a Power Over Ethernet cable to a separate router, and use this wired network to connect to the camera's browser-based control panel (See Figure 16). As I started working with the PTZOptics Move 4K camera, I realized that the MIDI control option was very much in a beta testing stage, meaning that it was completely unusable for my purposes. It unpredictably recognized MIDI devices, and did not respond to control change messages. Further, the MIDI page needed to stay open in order to continue to stay connected to the MIDI device, and this made it impossible to navigate to the camera's main page to update or set presets. In researching technical help to find a different remote control option, I came across the following webpage (Figure 17), which has an example of http commands that users can paste into their browser and call camera presets. This method of calling presets was successful when connected to the camera's network and using the camera's IP address. Presets can easily be set via the control panel. It was at this time that I needed to see if there was a Max/MSP object that could work with http commands, and I found that the object maxurl worked incredibly well for this purpose. Figure 18 shows a simple control patch which can be used with the ctlin object (which outputs MIDI control values) in order to trigger the camera presets accordingly. Figure 19 shows a screenshot of all available http commands that the camera can respond to. This document is found in the technical specs for the camera.

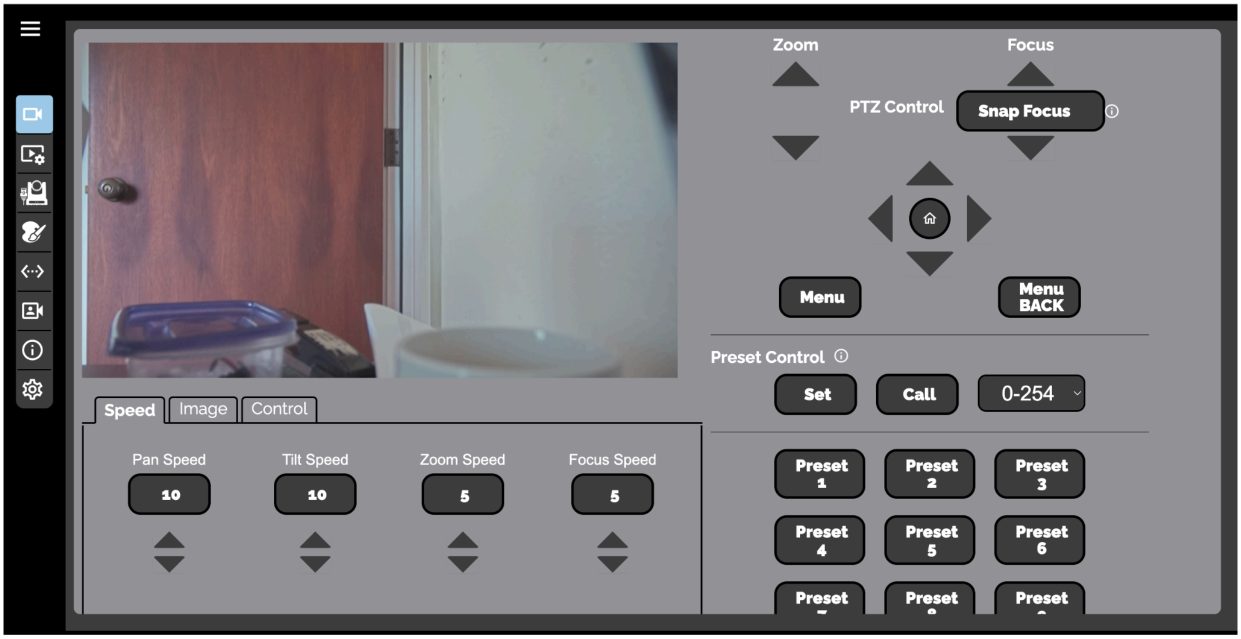

Figure 16. *PTZOptics Camera Control Panel (url address ptz.local, as per the manual)*

An Introduction to IP Control & Scripting for PTZOptics Cameras

Feb 13, 2024 · Knowledge

Details

There are a few options for "remote" IP control of the cameras using either PTZOptics VISCA over IP or HTTP-CGI commands.

Here is some insight on easy ways to test / implement control using these options.

PTZOptics HTTP-CGI Commands - Download Page: https://ptzoptics.com/developer-portal/

- The HTTP-CGI Commands are likely the simplest form of control using simple POST & GET Commands.
- In the beginning you can issue these commands by simply entering the strings into the URL bar on any modern web browser for execution.
- Please note that each of the commands features variables such as IP Address, Mode, Values, etc... that must be entered for proper execution of the command

Example for "Preset Recall"

- Here is the provided, with variables, preset recall command... http://[camera ip]/cgi-bin/ptzctrl.cgi?ptzcmd&[action]&[position number]
- So in this example we will use a camera with the IP address of 192.168.100.88 and we will recall preset 3
- The final command would look as follows... http://192.168.100.88/cgi-bin/ptzctrl.cgi?ptzcmd&poscall&3
- If executed in a web browser it would tell our camera at 192.168.100.88 to move to Preset 3
- Once you get more advanced these commands can easily be built into a customized web interface for operation.

Figure 17. *Preset Recall http example*

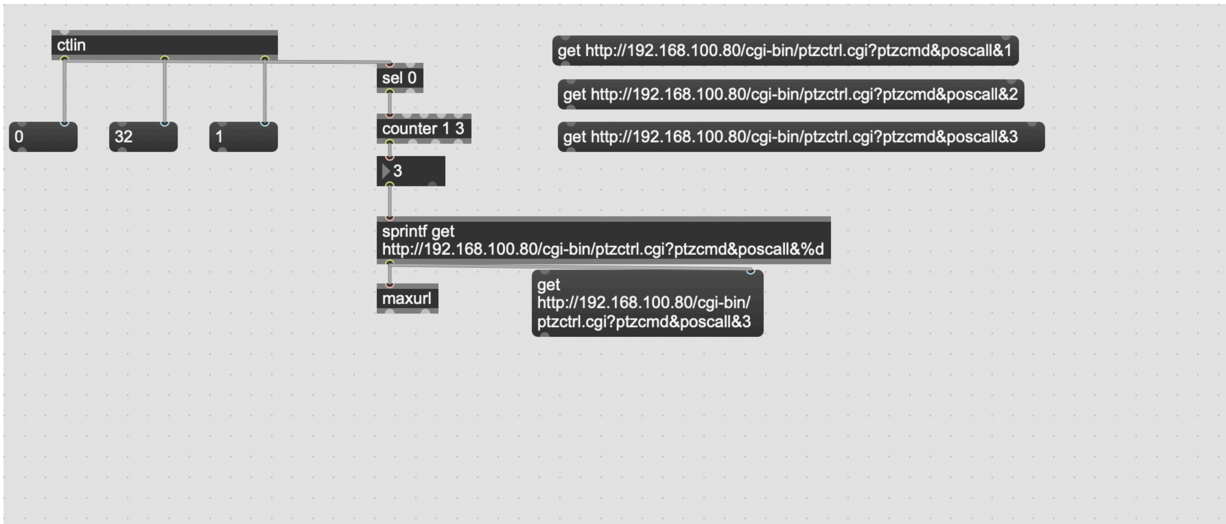

Figure 18. *Max/MSP Patch for camera preset calling*

			...	ranges from 1 - 7
			7	fastest 'focus' speed
Focus Lock	http://**[camera ip]**/cgi-bin/param.cgi?ptzcmd&**[action]**_mfocus	**[camera ip]**	*cameras current IP	
		[action]	lock	locks focus state
			unlock	unlocks focus state
Home Position	http://**[camera ip]**/cgi-bin/ptzctrl.cgi?ptzcmd&home	**[camera ip]**	*cameras current IP	Moves camera to HOME
PT Reset	http://**[camera ip]**/cgi-bin/param.cgi?pan_tiltdrive_reset	**[camera ip]**	*cameras current IP	Performs pan / tilt reset "dance"
Preset	http://**[camera ip]**/cgi-bin/ptzctrl.cgi?ptzcmd&**[action]**&**[position number]**	**[camera ip]**	*cameras current IP	
		[action]	posset	position 'set'
			poscall	position 'call'
		[position number]	0	beginning of range 1
			...	range 1 from 0-89
			89	end of range 1
			100	beginning of range 2
			...	range 2 from 100-254
			254	end of range 2
Direct Position Recall	http://**[camera ip]**/cgi-bin/ptzctrl.cgi?ptzcmd&**[mode]**&**[pan speed]**&**[tilt speed]**&**[pan position]**&**[tilt position]**	**[camera ip]**	*cameras current IP	
		[mode]	abs	Absolute Positioning
			rel	Relative Positioning
		[pan speed]	1	slowest 'pan' speed
			...	ranges from 1 - 24
			24	fastest 'pan' speed
		[tilt speed]	1	slowest 'tilt' speed
			...	ranges from 1 - 20
			20	fastest 'tilt' speed
		[pan position]	0000 or FFFF	home position
			0001	first step pan right
			...	range from 0000 to 0990 (HEX)
			0990	last step pan right
			FFFE	first step pan left
			...	range from FFFF to F670 (HEX)
			F670	last step pan left
		[tilt position]	0000 or FFFF	Home Position
			0001	first step tilt up
			...	range from 0000 to 0510 (HEX)
			0510	last step tilt up
			FFFE	first step tilt down
			...	range from FFFF to FE51 (HEX)
			FE51	last step tilt down
Direct Zoom Recall	http://**[camera ip]**/cgi-bin/ptzctrl.cgi?ptzcmd&zoomto&**[zoom speed]**&**[zoom position]**	**[camera ip]**	*cameras current IP	
		[zoom speed]	0	slowest zoom speed
			...	range from 0 - 7
			7	fastest zoom speed
		[zoom position]	0000	Full Wide
			...	range from 0 - 4000 (HEX)
			4000	Full Tele

Figure 19. *Example page from complete list of http commands*

Additional Late Stage Visual Development

The other visual developments during this time have to do with the physical setup of the materials. The fabric, which was previously taped to a wide wooden beam, is now sewn to have pockets for a curtain rod, which is a metal backdrop stand (as would be used for photography backdrops). Figure 20 shows the metal stand (which is about 10 feet tall x 13 feet wide, adjustable) with the curtain installed. Additionally, it was important at this stage to set up a table with the camera, the laser level and motor, and additional diffraction material (I chose small drinking glasses, after some experimentation). I set the camera, laser level, motor, and glasses on a table facing a whiteboard on wheels, which is the white surface upon which the camera pans around over the course of the piece, zooming in on different areas of the diffracted light surface. Figure 21 shows the behind the scenes look at the location of camera, laser level, and glasses. These were spiked with tape and taped down to the table to avoid movement, only a centimeter of which drastically changes the visual effect and the camera presets. Setting the camera presets (the number can go as high as 254, I use between 14 and 17) is a labor and time-intensive process, so to ensure efficiency, I also taped off the corners of the location of the table legs and whiteboard wheels. Figure 22 shows a full behind the scenes look at the location of all of the elements for the piece: the table with the camera, whiteboard, laser level, the MIDI foot pedal used to trigger camera presets, the projector, and the table that the violin and viola are placed on when one is not in use. In the lower left hand corner of Figure 22, the fan is also visible (though quite obscured by shadow). In the late stage visual development of the piece, it was of the utmost importance to find a fan to blow the fabric that did not make a lot of noise. I experimented with both a box fan and an industrial fan, and both produced a very audible hum that I found to obscure the delicate sonic environment of the piece. I turn the fan off and on using the Digital Multiplex (DMX) protocol, which is commonly used to remotely control lighting and special effects. Figure 23 shows an OPDM-20 dimmer device which can be used to control the amount of voltage sent to IEC-powered devices (the standard, grounded, three-pronged power socket / cable). Controlling the amount of voltage sent to a fan, for instance, can change the speed of the fan, and can be done so over time using line messages inside of Max/MSP. There is an additional output converter (Figure 22) attached to the OPDM-20 device which converts DMX protocol into USB protocol, and can be connected to a computer. There is an object inside of Max/MSP that allows DMX to be sent to different devices, this object is called DMXUSBPro. It also uses a serial port, so it needs an argument of which serial port the computer has detected when the usb cable has been plugged in. In my experiments with DMX-controlled fans, I found that changing the fan's speed over time is what contributed to the audible hum, so I decided to simply turn the fan on to a particular speed and then off, later in the piece. The messages sent to the DMXUSBPro object need to have 4 integers, one representing each possible channel that is capable of receiving voltage on the OPDM-20 device. Since I am only using 1 channel, I send the message 250 (followed by three 0's) to turn the fan on, and 0 to turn it off. This strategy works incredibly well as far as noise is concerned – because I am using a clip-on microphone that is highly directional (meaning it does not pick up other sounds easily), the sound of the fan in the recording is completely inaudible. Figure 24 shows the fan itself, selected based on its Decibel rating.

Figure 19. *Fabric hung from metal backdrop stand*

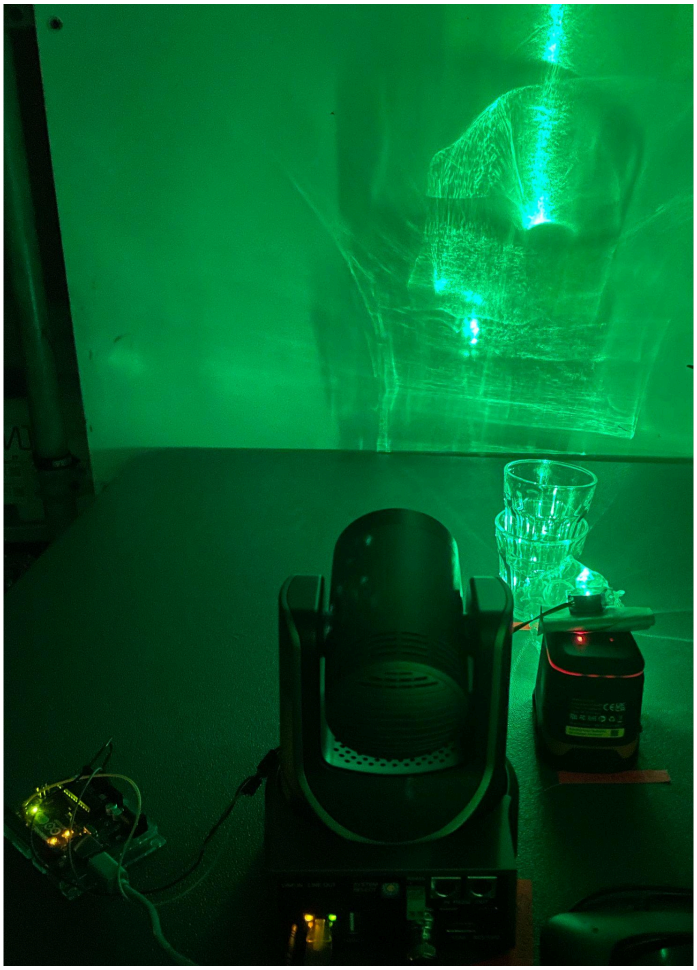

Figure 20. *Placement of Camera, Laser Level, Motor, Whiteboard, and Glasses*

Space left blank to accommodate Figure 21.

Figure 21. *Behind the Scenes, June 2024*

Space left blank to accommodate Figure 22.

Figure 22. *OPDM-20 DMX Control (fan plugged in here)*

Space left blank to accommodate Figure 23.

Figure 23. *DMX to USB converter (connected to computer)*

Space left blank to accommodate Figure 24.

Figure 24. *Lasko Wind Machine Fan*

Phase Four: Technological Debt

As of June 2024, the preceding workflow using signal analysis, MFCCs, and the rapid max object no longer functions. The rapidmax object has not been updated to be compatible with Mac M1 architecture, rendering it useless for this project. My technical support request to the current author listed on the project's github has not received a reply. From my perspective, this is a minor setback and does not impact the piece in a major way. The rapidmax and zsa descriptors-based system is one potential way to achieve a similar effect. I consider the system a success in the fact that I was able to learn, understand, and perform with it multiple times over the period of approximately a year. Given the complex nature of the harmonic content that I play, signal analysis using zsa descriptors had minimally noticeable effects on the motor's movements. I have since transitioned the piece into a new Max/MSP patch (Figure 25), one in which I trigger motor movement presets using a MIDI foot pedal. Through the development of the previous motor movement states (which were triggered using rapidmax classification and signal analysis), I have 12 different motor movements and states formatted as line messages, or destination/time pairs. For instance, I can tell the motor to start at 30 (degrees) and move to 80 over the course of 10,000 milliseconds, then move back to 30 in 5000 milliseconds. I group these line messages in four groups of 3, and the engine randomly selects a new line message at the end of the previous one's completion. I use a MIDI foot pedal to increment a counter which goes to a new preset.

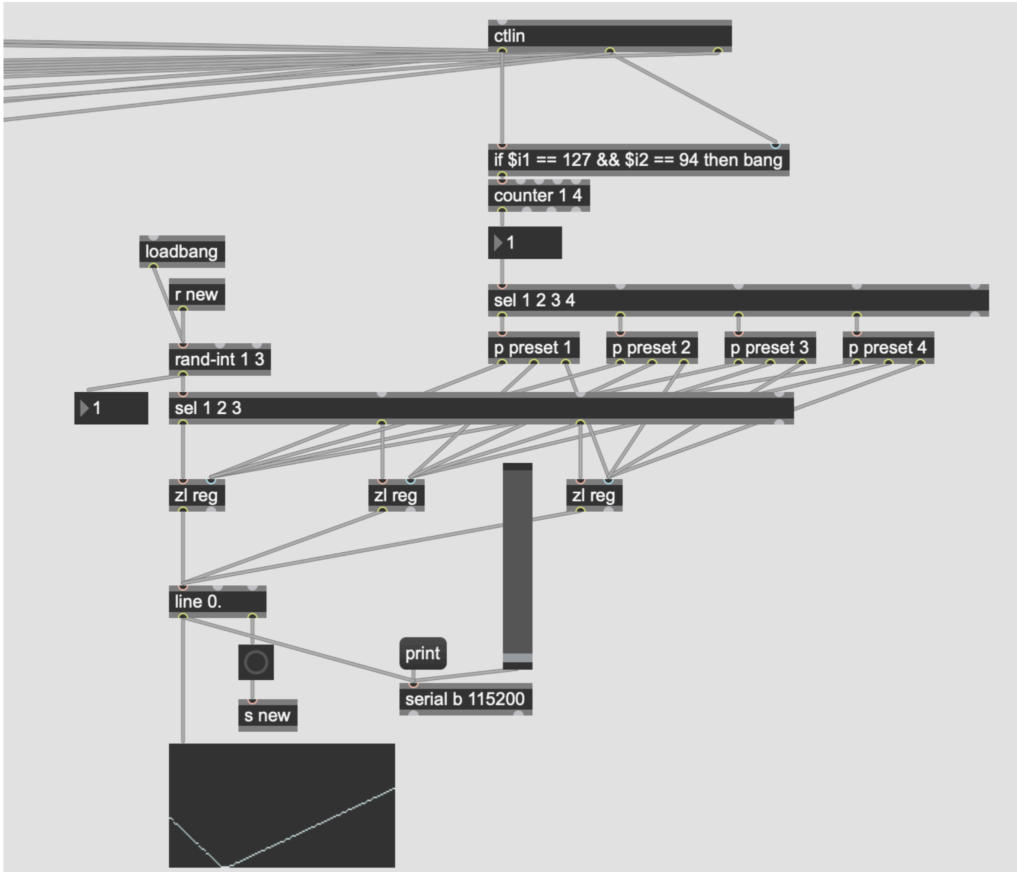

Figure 25. *Max/MSP Patch Section for Motor Presets*

MIDI Foot Pedal Presets

Because of the need for a different workflow as described above, I use a MIDI foot pedal when I perform the piece (Figure 26). As shown, this foot pedal contains six different buttons that all come into Max/MSP as different numbers. Max/MSP has several objects that can parse MIDI information, one of these (and the one that I use) is ctlin. This object outputs the controller number, the value, and the velocity of the button pressed. In this case, I use a series of "If" statements to bind the controller number and button press with the incrementation of different presets. There are four elements that are controlled by the incrementation of presets: The camera presets (position, tilt, zoom, focus), set in advance, the playback of a pre-recorded sound file, which serves as transition material while I change instruments, the start and stop of a fan, and the different speeds of the motor movement (which impacts the laser light diffraction). Figures 27, 28, and 29 show the separate sections of the Max/MSP patch which control the fan, camera presets, and playback, respectively.

Figure 26. *MIDI Foot pedal with button labels*

Space left blank to accommodate Figure 27.

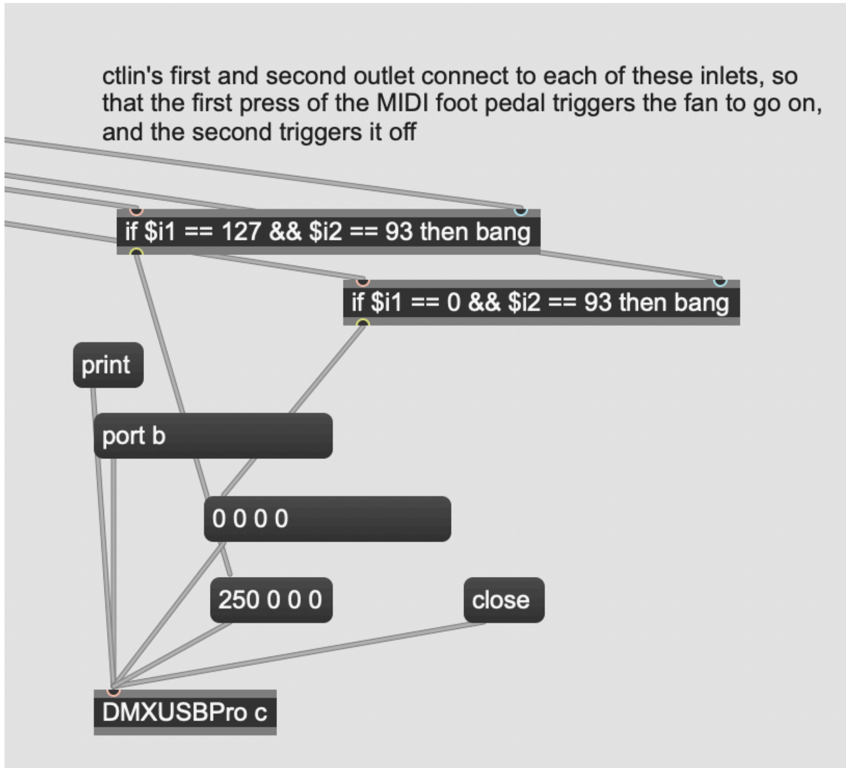

Figure 27. *Max/MSP Patch section that shows fan on and off.*

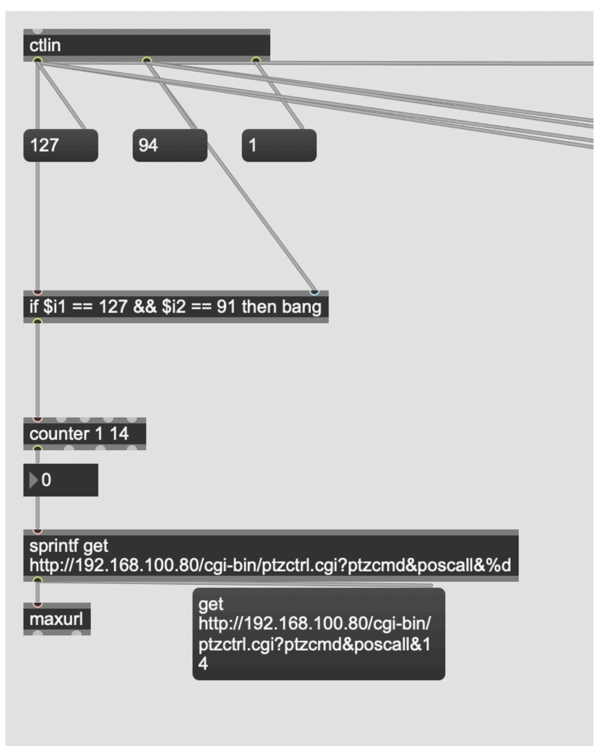

Figure 28. *Max/MSP Patch section that shows camera preset control.*

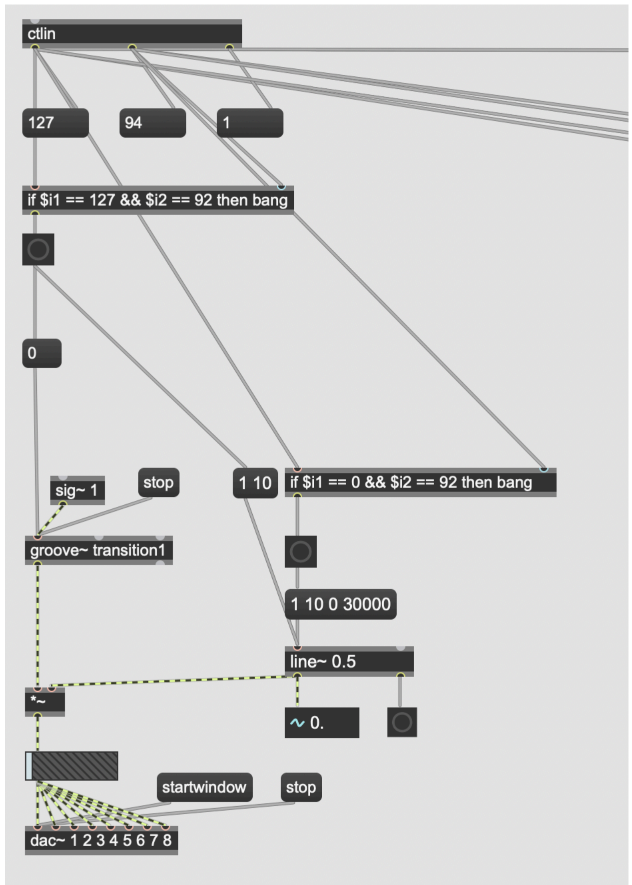

Figure 29. *Max/MSP Patch section showing playback of transition track.*

Technical Conclusions

To close this chapter, it is important to note that each phase of the technical development of the piece was and is in progress, and may evolve in the future. At the time of this paper's writing, the system is as described in the subheading "Phase Four", but requires maintenance and testing to ensure that materials are still stable and work well. There are some contingency plans that I have in cases where, for example, certain objects stop being supported, or if external libraries are no longer maintained. In cases like these, I can find other objects that perform similar functions and continue the project with constraints like this in mind. The technological practice of this piece is linked to the performance practice of the piece. This means that there is not a singular outcome, but rather an intention toward constantly updating the technological system.

CHAPTER 3:
Performance Practice in *Akerselva*

The performance practice in this piece comes out of a long tradition of free improvisation, beginning most notably with musicians like John Zorn, George Lewis, Fred Frith, and many others. Myra Melford, too, has been incredibly influential in this particular scene, and is one of the many sources of musical inspiration that make up the performance aspect of the piece. The musical aesthetics within improvisation, and specifically improvisation in new music, are increasingly becoming intertwined with interdisciplinary art practice - performers like Viola Yip, Laetitia Sonami, Natacha Diels, Michelle Lou, Jessie Marino, and Jennifer Walshe, among many others, are emblematic of this shift.

Instrumental History

The violin, used as an instrumental force for classical playing, has not seen any changes since approximately the 19th century.[21] By contrast, within the context of non-explicitly classical styles of playing, musicians like Tod Machover and Mari Kimura (among many others) have developed technologically integrated violins. [22] [23] This is important to note because, as I detail below, both the instrument itself and its classical playing techniques are founded in a style of playing that is upheld, in many circles, as the only valid standard for music making. In my case, my background and training emphasized classical playing as the only option, and therefore, a large part of my return to the instrument after deciding not to pursue a performance career is based in a reclaiming and changing of what it means to be a "good" violinist, and defining what "good" means on my own terms. The aesthetics that I privilege and prioritize within my own violin improvisation have to do with making expressive sound-based gestures, and not with playing classically-approved sounds or melodies. Due to the fact that white supremacy, capitalism, colonialism, and imperialism (among other forces of oppression) cannot be separated from classical music history, theory, and education, the violin also represents a reminder of power. [24] [25] This fact is an incredibly complex topic, itself worthy of years of study and engagement. For the scope of this paper, I focus on my own personal narrative with the instrument and acknowledge the intersections of power that have shaped my playing and understanding of what it means to play violin over the last 25 years. It is a power that I will never be able to escape or shed.

Background Information and Training

I began playing the violin at age 4, studying the Suzuki method at the community division of the Hartt School of Music. This training emphasized the traditional aspects of

[21] Alecia, "Violin History: From the Origin to the Modern Times," Prime Sound, April 22, 2024, https://primesound.org/violin-history/.
[22] James, Richard S. "Tod Machover," Towards the Center"." *American Music* 10, no. 1 (1992): 112.
[23] Kimura, Mari, Nicolas Rasamimanana, Frédéric Bevilacqua, Bruno Zamborlin, Norbert Schnell, and Emmanuel Fléty. "Extracting human expression for interactive composition with the augmented violin." In *International Conference on New Interfaces for Musical Expression (NIME 2012)*, pp. 1-1. 2012.
[24] Kajikawa, Loren, Kimberlé Crenshaw, Luke Charles Harris, Daniel HoSang, and George Lipsitz. "The possessive investment in classical music." *Seeing race again* (2019): 155-174.
[25] Bates, Vincent C. "Standing at the Intersection of Race and Class in Music Education." *Action, Criticism & Theory for Music Education* 18, no. 1 (2019).

classical violin playing that are common in the style: technique, clean and pure tone, and noted orchestral, group, and solo repertoire. As I completed my high school education, I turned toward composition and completed my undergraduate degree in music composition. It was during this time that I became interested in expanding my performance practice with improvisation as well as with technology. Contemporary performance techniques became important as a method of playing. I led an improvisation workshop and participated in several improvisation-based seminars. Though I was beginning to gain some experience, it was not until my second year of graduate school, after I started to work with Myra Melfod, that I became comfortable with improvisation. Myra and I covered some jazz history, and she introduced me to seminal pieces and readings. A major project was a transcription exercise of Leroy Jenkins' solo on Strayhorn's on "Lush Life." I also participated in Myra's group improvisation seminar, co-led by Zeena Parkins with a cohort of Zeena's students from Mills College. This experience, though it was remote, was incredibly valuable and solidified my confidence in improvisation. I have since continued improvising, playing at local venues, including on the Mosswood Performance series with the group sfSound.

Motivations for Drones

My practice is focused around drones because they represent a tendency toward micromovements and inflections in pitch, which, if listened to carefully, present an entire world of sonic possibilities. Tapping into often overlooked microcosms of movement is a tendency that is at the core of my artistic practice. It invites me as a performer to slow down, physically, to accommodate the small changes. When I am physically still, I can feel my heart rate and breathing slowing down, I am hyper aware of exactly where I am in the bow as I play, and exactly where I can move a musical phrase. Slowing down to play drones represents a calming alternative to the stereotypical amount of movement and quick thinking required in classical violin playing. Arguably, the best classical players also have ways of generating their own internal stillness to be able to execute classical virtuosity, and yet, the material itself is vastly different from drones. Specifically, I practiced playing *sul ponticello*, with my bow very close to the bridge. Like the end of the fingerboard, the bridge is a node on the instrument, meaning that the closer my bow is to it, the more natural harmonics will become audible. This is especially important for a few reasons. Normally, playing harmonics on string instruments requires applying very light finger pressure to a specific node which divides the string length at an integer ratio. The sounding result is a whole number multiple of the fundamental. Playing *sul ponticello* harmonics means that I send the "work" of creating harmonics entirely to my bow arm, leaving my left hand fingers free to find additional pitches to create more complex dyads, or sometimes, full chords. Shorter string length at the node means that the node is more taught and more stable. When asked, most string players (myself included), find that controlling harmonics when playing *sul ponticello* is an incredibly difficult, if not futile task. It is common practice within string writing (of most any style), that if a composer wishes for a stable harmonic, they notate it as a fingered pitch, even though it is possible to sound harmonics while playing *sul ponticello*. In my case, I wanted to see if I could *practice* the amount of bow speed, pressure, and weight needed to consistently achieve certain harmonics while playing near the bridge. Even after two years of practice, the results are still unpredictable, meaning that I am able to "ask" my bow arm to produce a specific harmonic and hear the desired result inconsistently. Again, in most traditional cases, this inconsistency is undesirable and renders the technique almost useless. However, the unpredictable nature of the resulting harmonics and the fact that I am unable to consistently "map" an action to a desired sound is what makes this practice rewarding. It introduces an orientation that I have to my material, that I am responding to its inconsistencies, and thus, as I discussed in the first chapter, that these inconsistencies in sonic output have a "taming" effect on me. There is a pleasant simultaneity to the fact that the automation of harmonics within this practice (the bow arm automates their production) is what contributes to the sense of "liveness" in the organically evolving pitch collections.

Improvisation while in Norway

In October 2022, I had the opportunity to spend a week in the recording studio at the Norwegian Center for Technology, Art, and Music (NOTAM). At this point, I had already identified that the main material of my improvisations would be drones, and I was practicing their execution by developing sensitivity in my bow arm to small changes in weight, placement, and speed. During this time, I made over five hours of improvised recordings. My goals were purely experimental and generative. I wanted the focused work of extending my comfort zones in improvisation, which at this time were mostly drone-based. Although the results of these recording sessions are not heard in the piece, this week of concentrated improvising proved fruitful in developing an artistic language and vocabulary. I also began developing a literal vocabulary for some of the techniques I found interesting, and I wrote these on index cards, some of which are (sub-headings in italics):

-Erratic non-pitched *no motive*
-Left Hand Pizzicato into Ricochet
-2 - 3 Pitches repeat in rhythm that moves from complex to simple *(go somewhere else)*
-Pizzicato pitch evolves from Ricochet into bowed noise pitch
-Harmonics *(C# to open D string. Ab to A natural (G and D strings). Eb to G (D and G strings). B to G# to open A string. F# to G (D and G strings). A (G string) to D (artificial).*
-Rhythmic Noise *(circular bowing type). Can be somewhat pitched or not.*
-Drone noise based on bow position
-Windshield wiper *sul tasto, ricochet occasionally*
-Heavily erratic *lots of motion, lean into weight distribution*
-Erratic semi-pitched *with motive*
-With Left Hand pizz *if playing on the same string, pizz can create a bit of ricochet*
-Left Hand pizz behind fully fingered pitch
-Transition from fully pitched to fully unpitched *can still use short strokes*
-With rests *continue sound in your head*
-Extremely still *quiet, low heart rate, bubbling*
-Ricochet and related (pizz)
-How long can you transition?
-Over pressure
-Over pressure *sub tones*
-Col legno
-Heavy Left hand Articulation

While these were only the start of the musical vocabulary and techniques I began developing, it was very helpful to the process of learning to be a more fluid improviser to have literal language for the techniques I was working on. I also found bassoonist Dana Jessen's thesis *What Do I Play?: Approaches to Free Improvisation* incredibly helpful both for building context around the history of free improvisation, and in this case for warmup and practice exercises before improvising. I discovered that the proper warm up is invaluable for feeling prepared to begin improvising. The warm up exercises that marked my time as a practicing classical violinist (scales, tonalizing, arpeggios, double stops, etudes) were wholly impractical for use in the kind of improvising that I wanted to do and that the project is based on. I focused on exercises like the ones Jessen discusses from her former teacher Frank Gratkowski who suggests working one's way through the atonal interval etude book *Modus Novus* by Lars Edlund. Gratkowski Suggests: "1. Play a melody on your instrument. 2. Sing the melody. The pitches must be 100% precise, so check them on your instrument. Don't continue until the pitches are 100% correct. 3. Sing the melody while fingering the notes on your instrument." [26] While these exercises still involve pitches, they were also effective in creating my own phrases with pitched and unpitched sounds and techniques.

Performance Practice 2023 - Present

As with all artistic practices, the types of techniques and methodologies are ever-evolving, and continue to change as this paper is being written and will shift in the future. One important development in the winter and spring of 2023 / 2024 is the inclusion of non-drone based sonic materials and the use of the viola. The use of the viola in this piece comes from an aesthetic decision to include more low frequency content. The violin is, of course, the highest pitched member of the string family, and I am playing mostly harmonics, keeping the range of the piece between approximately 196 Hz (G3, the first partial of G2, the open G string) and 1975 Hz (B6). This is a relatively narrow range, given the possibilities of using lower stringed instruments. Further, lower stringed instruments have longer strings, therefore allowing for more natural harmonics to be heard. Given the viola's similarities to the violin in terms of technique (held with the left shoulder, bowed in a similar style), the learning curve for playing viola for violinists is essentially non-existent. I was not interested in learning to play the viola with classical technique, nor practicing reading music or mastering repertoire. For me, the viola exists as an instrument for which I do not have the embodied, unconscious pressure of classical technique. As I got used to the instrument, I also began an improvisation duo with my colleague and composer/performer Adrian Montufar. Adrian is a flutist, vocalist, and dancer, and we began our collaboration by comparing and contrasting our own improvisational materials and styles. We soon arrived at what we have called our "A" sonic material, where I play drone-based harmonics on the viola, and he intersperses with short, pointillistic phrases on flute and using his voice. As we continued rehearsing together, we gradually were able to find techniques that merged our individual sounds into a single mass – it is from these two types of interactions that

[26] Jessen, Dana. 2011. Review of *What Do I Play? Approaches to Free Improvisation*. Master's Thesis, ArtEZ Institute for the Arts.

we construct the forms for our improvisations and performances.

Over the course of these experiments with Adrian, I became more comfortable with inhabiting the sonic space of what I had come to know as "excess", which is not a word that I associate with a particular positive or negative quality, but rather a sonic space in which the space/time itself is full of sound – short, perforated, staccato, quick sound. We usually refer to this space as pointillistic, which, like the painting style, contains many iterations of similarly sized bites of sound. The comfort that I felt with this material is important, because, like my experiments with technology, I began to feel much more confident in my abilities as an improviser and facility with different kinds of techniques, many of which I had not explored before and came about as a result of improvisation with Adrian.

Since I had already decided to play the viola as part of the piece, given its lower frequency possibilities, I also incorporated many different techniques and playing styles (other than drones) into the final performance. Some of these include: Col legno playing (battuto and tratto), many different types and durations of overpressure, putting my left hand in many different pitch areas of the instrument, scordatura (tuning the strings, in this case, lower), and pizzicato while holding the instrument on my lap. There are now many more speeds at which I am comfortable playing, and the internal sense of time that I feel while playing specific materials changes more fluidly and easily than it did when I played only drones, and when I played only violin.

Performance with MIDI Foot Pedal

Performing with the MIDI foot pedal (which controls camera position, playback, fan, and motor speeds) was and is an adjustment. Given my background in classical violin performance, it is unusual to have to concentrate on foot position or pressure while playing. However, in the last ~10 years, more and more classical musicians have transitioned to looking at their music on iPads and using bluetooth foot pedals to turn pages. The advent of this technology has made it possible for musicians to store thousands of pages of sheet music in one device, and has made page turn hassles non-existent. The foot pedal presets that I am using are slightly more complex because there are four buttons to keep track of. Practice with the system makes it possible for me to not become distracted with the location and pressure of any one of the foot pedals, and concentrate on the musical performance itself. Additionally, there is a level of agency afforded by the foot pedal solution that allows each performance to be different, but the presets to always be in the same exact order. Because I trigger each preset, the timing in between changes significantly, sometimes meaning that I can complete a performance without having moved through all presets. Having independent control of the camera, the motor speeds, the fan, and the playback means that the performance can be automated in a critical way – allowing what I consider the most important element, the performance itself, to come through. I take satisfaction in the fact that the audience, depending on their experience level, may not know that I am controlling each individual element with a foot pedal, adding an element of inquisition and intrigue to the performance. My goal with the use of this foot pedal is to add a layer of animacy to the audiovisual system. This plays a crucial role in the type of visual environment that is constructed.

AudioVisual Environment Influence on Performer

As discussed in Chapter 1, one of the most important aspects in this piece is the lived relationship between myself and the technologically mediated audiovisual environment. Ideally, this relationship should be one of taming, as Audry defines it. Because I am standing very close to the fabric (in order for my whole silhouette to be visible), there are times where the fan blows it such that it brushes me as I am playing. This contact is important on a sensory level if I have mentally shifted focus – it brings me back to the present moment. Further, the visual environment looks as rich from the vantage point of the front of the fabric (where the audience is sitting) as it does behind, especially with the fan blowing the fabric, and especially when standing very close to it. The visuals that are created as I play impact me as though they were literally animate. My main goal with this aspect of the piece, and with all of my creative practices, is to imbue a "living" spirit into audio and visual material. In the audio and performance practice sense, this means choosing fragile, volatile drones, whose "voices" creak and crack with additional bow speed or pressure. It means choosing harmonic positions for my left hand fingers that can generate a multiphonic – two or more simultaneously sounding pitches, in this case, from left hand finger placement in the same position, using only one finger on only one string. There is a particular (and only one) multiphonic possible on the G string of the violin, in approximately the position of playing C4. In any case, giving the piece an animated quality has meant making particular audio and visual choices. It is often impossible to know whether or not something will work unless I physically build it or try it, and this workflow is also essential to the development of the piece.

Musical Score Considerations

Akerselva is an improvised piece, and does not have a formal score. A score would not aid the decision making process nor musicality present in the piece, and would instead hinder the potential for a high quality performance. The technical constraints of a score are also important to consider – the lighting for the piece is extremely important. It is crucial that the performance space be as dark as possible, and that there is no additional ambient lighting coming from behind the fabric, where I stand to perform the piece. In a similar fashion, it is important that I use a clip on microphone, as to not have a mic stand and microphone also in the view of the audience. Reading from a score would require some kind of additional light, whether this was from a stand light or from a digital device, like an iPad. This additional light breaks the visual and aesthetic flow of the piece. It changes the reality of the environment. Most importantly, I have developed a memorized form for the piece, and a score is not necessary to perform it. The flexibility to change and reconfigure this form is something that does not require a written score.

Transition Track

I play violin and viola in this piece. In order to have continuous sound happening throughout the piece while I change instruments, I recorded a transition track that I trigger with the MIDI foot pedal and Playback part of the Max/MSP patch shown in Figure 28. I perform over and with this transition track as it plays, and the audio recording is mixed in such a way as to keep the balance of these tracks relatively equal except at certain moments. This means that at certain points, given the low light nature of the video documentation, it may be difficult to tell where the sound is coming from – what is recorded and what is live. This is intentional, and helps to underscore the blurred acousmatic conceptual framework that was discussed in Chapter 1. It is here that I think of composer Steven Takasugi's chamber piece *Sideshow*, in which musicians on stage mime the actions of playing while spatialized recordings are played to the audience, contributing to a sense of perceptual slippage between the heard sound and the visual source. Given the nature of the transition track in *Akerselva*, this type of slippage is an intentional element that serves to highlight and obscure the mapping between sight and hearing. Further, as mentioned above, the transition track helps to ground my performance. For each repeat performance, I am hearing the exact same track, but my playing with that track changes. While the minutiae are different each time, there are certain cues that exist in the track that I latch on to and take the opportunity to either imitate or contrast with my playing. The first of these "cues" is a rhythmic, percussive, sweeping of the strings, that I usually imitate rhythmically, but with different frequency content. My choice here is to highlight the higher frequency nature of the violin, while in the track I am playing viola. The second of these cues comes when multiple viola tracks are layered on top of one another, creating a droned chord containing the pitches C, G, E, Bb. These pitches are not as stable as they are written here, they fluctuate and morph in one direction or the other slowly. It is at this point that I begin what a former improvisation teacher of mine described as "Shelving", or playing repeated material "underneath" the main activity, providing a kind of shelf for the rest of the ensemble. In moments where the transition track quiets down, I pause and prepare to begin a new phrase. The transition track is very helpful in providing moments for me to rest. It helps not only in the physical endurance sense but also in allowing the music to breathe. The final moment that functions as a cue for me is near the end of the transition track, and it is simply a cue that I have learned means that the track is about to end, and I should prepare whatever material I would like to be present at the end of the track. Often, this means a return to a drone, but in some performances, there is a build of energy at the end of the transition track.

Silhouette Work, Posture, and Movement

As I have described above, I am silhouetted behind the curtain throughout the piece. The motivations behind this choice come from the desire to control the way I am perceived by the audience, to morph my body through the use of "incorrect" classical violin posture and displaced silhouette. Shadows have the unique quality of bending and sticking to the surface on which they are projected. This characteristic allows me to appear bat, turtle, or alien-like (based on audience descriptions). This choice is in keeping with the mythical creature-based, ambi-animate framework I described in Chapter 1. While there is no dispute that I am playing a violin or viola, at times, my head completely disappears. I become an interface, a surface. Acceptable classical violin posture requires a straight back, a degree of verticality to the spine, as if lifted from above. By contrast, I often end up curled inwards, the silhouette of my scroll only barely visible from the rounded mass that makes up the rest of my body. This choice helps me to connect to the material in a more thorough way, and, interestingly, allows for longer performances as it does not place tension and strain on muscles that have begun to atrophy given my (intentional) lack of classical violin performance opportunities. Where Sara Ahmed writes "spaces are like a second skin that unfolds in the folds of the body…" [27] I would go so far as to add that *technique* is the second skin, too. The muscles that developed as part of my classical violin technique (since age 4) are now shaped by an orientation away from classical violin playing. Instead, they are shaped by new (musical) choices – new social structures and musical forms that govern the scenes that I

[27] Ahmed, Sara. 2006. *Queer Phenomenology: Orientations, Objects, Others*. Durham: Duke University Press.

inhabit. The flexibility of the silhouette is part of the reason behind the choice to use fabric as a projection surface. A soft, malleable surface onto which my silhouette can attach and transform. So too, I use the fan at various points in the performance to ripple the fabric, further obscuring the edges of the silhouette. From behind the fabric, I see everything up close and change the orientation of my body (fully sideways, to slightly front facing) to appear as if I have no arms or legs. The movement between states of headlessness to limb-lessness is part of the piece. It begins and ends in stillness, both because the fan is off and because I stand relatively still while playing quiet, drone-based material. But even within small fluctuations there is potential for different scales of time and timing to emerge. This sensitivity to time and timing is one of the great challenges of the piece, and to being an improvising musician in general, whether playing alone or with others. Because silhouettes lack the detail of a mirrored reflection but resemble a likeness, I am anecdotally inclined to trust my silhouette a great deal more than I would trust my reflection. This kind of internalized trust is an important mental space to inhabit when getting ready to perform.

Drone-based Precedent

Though there are countless numbers of pieces, practices, and cultures that use drones, for the scope of this paper I would like to focus on two pieces which have been particularly inspirational and relevant to *Akerselva*. The first is trombonist Mattie Barbier's *untitled i* from their album "Threads". Mattie recorded this album in a seven-story steel water tank, making incredible use of the resonance of the space to stack pitches and harmonic series on top of one another using circular breathing. The power of sustained, evenly circulated breath is something that, anecdotally, I have heard wind and brass players describe as a sensation that is quite meditative. The space of the piece allows a kind of qualitative darkness to the drones, there is something contemplative about the process of both the material itself (Mattie improvises the entire album), and of the listening experience. Often, drone-based listening experiences do have a calming effect, one that is designed as such but, in my experience, rarely delivers. Mattie's album is an exception to this norm, and makes room for listeners to truly come to and away from the work with their own experiences, ideas, thoughts, and questions. This type of space is at the core of my artistic practice and is one that I take note of when I see it in other musicians' practices.

The second of these pieces is Tony Conrad's *Ten Years Alive on the Infinite Plain*, an hour long drone piece in which Conrad himself plays violin with simultaneous video projection. Conrad, an experimental filmmaker, musician, and composer, is part of a group of composers active in the 1960's minimalist wave in New York, including John Cale of The Velvet Underground, LaMonte Young, and Marian Zazeela. This piece is useful precedent for the drone based work that I use in this piece. Although Conrad does not play harmonics in the same way that I do, the overall approach to the piece is similar in that it requires endurance and negotiation of posture to be resting and playing at the same time. Further, Conrad's use of video projection and the projection content are markers of structural film practice at the time (1972).

Within the drone-based performance practice space, there are several other composers whose work involves harmonic-based drones and the subtle evolution of material over time. Italian composer Giacinto Scelsi's piece *Anahit*, for violin and an ensemble of 18 instruments, centers around a single pitch and uses *scordatura,* a process by which the strings of the instrument are re-tuned to G-G-B-D from lowest to highest. Given the amount of repertoire written for violin using standard G-D-A-E tuning, altering the pitches of the strings in this way essentially creates a different instrument, requiring the performer to relearn proper finger placement and orient differently to the idea of playing "in tune". Tuning, in Western Classical Music practice, is most commonly measured in equal divisions of an octave, or EDO. In standard practice, there are 12 equal divisions of the octave. By changing the fundamental frequencies of the strings on the violin, Scelsi has made more explicitly possible the addition of microtonality, or pitches in between the standard 12 EDO system. The violin is a continuously pitched instrument, with a smooth fingerboard, meaning that in theory, there is infinite space between pitches within the 12 EDO system. The flexibility of this space is what allows for different tuning systems to remain idiomatic to the instrument.

There are many, many other composers, pieces, and music practices whose work falls into the drone-based category. These practices span many music genres and time periods, but what remains is the stronghold that drones can have on an audience. It is this particular sensation of physical and emotional arrest that I tap into in *Akerselva*, for both myself and the viewers.

CHAPTER 4:
Conclusions

This paper has outlined the motivations behind the creation of the work *Akerselva,* for violin, viola, and laser light diffraction. It has also discussed historic technical, performance, and literature precedent. Given the nature of the creative practice involved with the piece, the metrics for a successful performance may change and evolve. At the time this paper is being written, success on the project means that I felt engaged, decisive, intentional, and present throughout a live performance and throughout the documentation process. I intentionally shift the metrics of success away from the historical modes in classical music, where a successful performance exemplifies *perfect* technique, *perfect* tone production, and *perfect* musicality. There is no perfect in *Akerselva,* or rather, as bell hooks writes in *All About Love: New Visions*, perfect does not mean without fault or defect, but rather, constantly refining.[28] Because I cannot control what a given audience member will feel or take away from such a performance, the success of it from an audience or more objective perspective is difficult to measure. However, it is my hope that audience members will, as discussed in Chapter 1, have a more complex and nuanced understanding of the ambi-animate and minute environmental changes that make up a large, potentially overlooked part of their daily lives; and be given the opportunity to absorb an intricate sensory experience, one in which they can create and hold their own meanings.

I have performed the piece in full at the time this paper is being written. Despite the challenges of learning to perform with such a system and the technical changes that were necessary to keep the project afloat, the performance was very successful. I had the opportunity to perform it as many times as needed to capture high quality audio and visual video documentation. The amount of research and technical experimentation, troubleshooting, and trial

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[28] hooks, bell. 2001. *All about Love: New Visions*. New York: Harper Perennial.

and error that have gone into the project are elements that make it additionally successful at this time. As discussed in Chapter 2, one goal of the project was to extend my areas of comfort when it comes to technology and use of Max/MSP, and I have absolutely increased my confidence when it comes to experimental technology and interdisciplinary, visual based practices. Further, through collaboration and practice, I have additionally become exponentially more fluent and comfortable within improvisation, and this was a major goal of the project.

As ever, contemporary music is alive and well, and undergoing dramatic change at the moment. There are established improvisation and experimental scenes in most major cities in the United States. There are 40 + year old venues dedicated exclusively to this practice. The summer of 2020 was a reckoning for a majority of politically left-leaning non-black (and particularly, white) people, and there have been lasting changes that have reflected the necessity of including and uplifting more black voices in every area of experimental music practice and programming. There is an increased awareness of the need for this reckoning to continue well into the future, and yet, there is additional complacency and indifference. The future of contemporary music exists in community, and it can only continue to flourish when it is equitable, and when making equitable choices becomes normalized to the point of becoming a non-issue. This work requires consistent accountability. As such, many music colleges and universities across the United States have begun to change major program requirements to include courses in music technology, recording, and production, making it clear that they understand the needs and desires of students from all backgrounds who want to involve themselves in music. These courses are an excellent first step. They look brilliant on paper as interventions toward the codified, institutionalized mission of Diversity Equity, Inclusion, and Belonging. The addition of these courses on their own is not enough. If the future of contemporary music exists in community, it is from such community that potential longer term interventions will come. The present of contemporary music includes skill sets and practices that, in theory, have little to do with music, and yet, have explicitly musical results tied to them. Skills such as circuit building, coding, building sensors, and the integration of other forms of art and media have extensive histories, and are essential for the continued growth of the field. In order to move forward, the orientation toward experimentation and inclusion must continue.

Future potential directions of the project include incorporating live signal processing and finding a way to translate the piece to other string players or make it a collaborative (duo) piece. In this case, I would aim to provide a duo partner with a library of video demonstrations of techniques I use, and encourage them to add their own versions of these techniques. This kind of undertaking would require dedicated time and rehearsal with the collaborating performer. I am also interested in experimenting with notation in the case that the piece involves an additional performer, these would probably be a kind of text score. In sum, the process of building, performing, and documenting this piece has been a very successful project on many levels, and it came together with the support of faculty mentors, staff, and collaborators both in the US and in Norway. I am very grateful for the opportunity to make and perform this piece over a period of two years, and I look forward to continuing in my musical and artistic practice.

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