Resonant, dwelling, unfading

Independent Group Study
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1. Introduction

"from self and other
then no sound
then gently light unfading on that unheeded
neither
unspeakable home"

- neither, by Samuel Beckett (1976)

Shadow emerges from the interplay of light and corporeality, extending through physical space without its own materiality. Shadows are the afterimage of that which illuminates our world, luminosity tethered to surface, shape and form. Shadow stretches, multiplies, distorts. We seek shadow as a refuge from an oppressive midday sun, and we hide from the shadows of our psyche, those parts of our being that we attempt to remain hidden, both from our conscious selves and from those in our lives. To dance with this afterimage is to dance with that which we habitually turn away from. What might it mean to tap into the creative force of our shadows?

In this way, this work explores the use of full-body shadows as a means of non-traditional sound-based instrumentation. We explore the affordances of shadow-based interaction for performance and as a tool for embodied, immersive dialogue with self and environment. Such affordances include: multi-location, in which one's shadows may be cast on surfaces at distances; morphology based on source angle, position, reflection, as well target surface typology; and an immediacy of visible feedback.

The goal of this project is to evaluate the usage of shadow as an interactive medium for solo and collaborative participatory art. To do so, we designed and built an installation in which participants' shadows directly influence an immersive soundscape. The large size of this installation affords full-body shadow-casting, as well as multi-participant simultaneous interaction. We exhibited our installation to the public and recorded observations of behavior for over forty participants. The driving questions we explore include:

- What interaction does our design invite users to perform?
- What are trajectories of behavior as users explore and discover affordances of this interactive system?

- What is the affective experience of users during and after their interaction with the system?

One driving interaction objective throughout this entire project is that of "user as dancer". We sought to invite and enable participants to move organically and without inhibitive self-consciousness within our interactive system. Through this, we aimed to prompt for and guide towards a receptivity within the participants: a receptivity towards one's lived and felt experience. Our design challenge was to do this without words: how can we facilitate this via material and sensory engagement? We strongly felt that the participants should not be demanded of this receptivity, and we worked to avoid a sense of the participant being asked to feel any particular way.

In this fashion, we drew heavily from inspiration of the effects of noise on one's sense of receptivity: noise does not ask that you go out and reach for anything in particular, because there is no one thing in particular to be grasped. Instead, noise offers an experience of *being touched*, as an embrace, enveloping yet demanding nothing in particular besides perhaps presence. In this way, we focused on the clarity that emerges in the relationship between stillness and motion, such as that of a desert and an ocean, respectively. Both have a profound effect on our mode of perception, often softening our focus and creating a more quiet psychic state. By creating a sound experience that has elements of both engulfing noise and distinct quiet, we aimed to utilize this polarity to further explore shifts of awareness and receptivity. Furthermore, we were particularly interested in an engaged quality of receptivity, one in which self-expression emerges as a manifestation of reflective experience. In this way, we sought to create a sense of dialogue within our interactive system, in which receptivity and expressivity are in a constant relation and reflection to one another. We intended, through this, to create a sense of awareness of the dimensionality of one's presence, perspective and positionality: becoming aware that you are, indeed, seeing, feeling, moving, hearing, and that this experience is fluid, constantly in flux.

In terms of material aesthetics, we sought to invoke a sense of being enclosed within a cocoon-like space, and used translucent curtains to create this effect. Our intention for this material was to introduce a sense of permeability to the experience, blurring the lines between observer and performer. As an observer sitting on one side of the curtains, one sees both the performer as well as their cast shadow. This invites a participatory quality, encouraging the observer and performer to view their roles with fluidity, as reflection becomes expression and vice versa.

Our choices for sound and light drew inspiration from the experience of being immersed in a forest, as one's sense of self dissolves into the vibrancy and aliveness of this setting. Our lighting took a soft, glowing yellow-red hue, intending to invoke a sense of being bathed in a forestscape during the golden hour of the day, as the setting sun filters through the leaves. The sounds we selected were all recorded ourselves, and were gathered from local settings in the East Bay Area of California. These sounds include birdsong, crunching and rustling leaves, footsteps, flowing water, and human voice, and were selected in order to invoke the immersive quality of inhabiting the heart of the forest.

2. Related work

Resonant grew out of previous work by members of the team. *Shadow Synth* [4] functioned as a musical instrument. Layers of sound (loops in Ableton Live) were activated and made louder by the shadows cast on photocells installed on a small panel. Users participated individually or in groups by placing their hands in between the light source and the panel, and they could see how the shape of their shadow in turn shaped the resulting music. *Sextet for Sitters* was an installation consisting of six chairs with force sensors under the cushions. Musical sounds were activated when users sat on the chairs and the sound responded to which chairs were sat on and the shifting of weight on each chair. In *Resonant*, we expanded shadow-casting and sound responsiveness to the entire body.

Our choices regarding lighting aimed to imitate the light of the sun setting through translucent curtains. The aesthetics are reminiscent of *Threshing in the Palace of Light* [5], an audiovisual composition by Jean Piché that uses images that evoke light, shadow and translucent fabric, along with the text of Samuel Beckett's play *Krapp's Last Tape*. In addition, there are a few art installations that use light and sound in aesthetically and conceptually similar ways to *Resonant*. A participant mentioned that our work reminded him of Olafur Eliasson's popular and renowned installation The Weather Project [6], which uses monofrequency lights to create the illusion of being close to the sun. *The Place Where You Go to Listen* [3][7] by John Luther Adams creates a sound and light environment to connect an indoors installation space to the natural world. In the words of the composer, it is an "invitation to you to slow down and listen more deeply" [8]. However, while both of these installations are inhabited by visitors, they are not interactive environments, despite their similarities to our project.

In *Ademruimte* [1], a single participant sits in a space where ambient light and sound is responsive to their breath. The goal of the installation is for the light and sound to stimulate the user to take slow, regular (and ideally calming) breaths that are synchronized with a gentle and pleasant sound and light environment. Thus, although the light and sound are initially responding to the participant's breath, the goal is to reverse the interactive relationship: in the end, the user is responding and syncing with the fluctuations in light and sound. In a similar vein, *Groupflow* [9] uses biosensory feedback as a way to synchronize multiple participants' affective states, by externalizing all participants' internal rhythms of heartbeat and breath as sound and light to be attuned to collectively.

3. Prototype

3.1 User interface

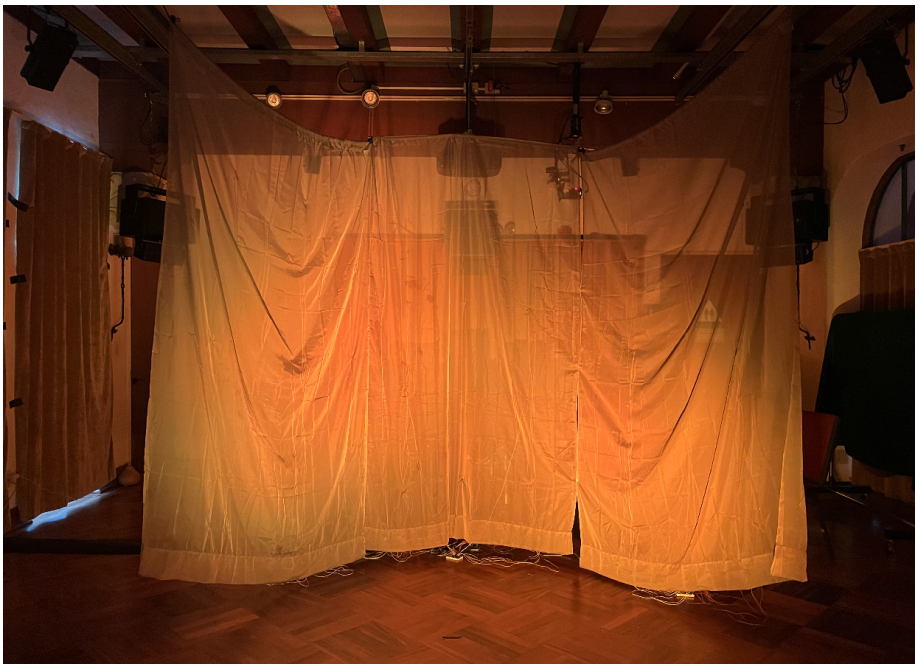
Lights play a critical role in our installation. We use three Blizzard HotBox Exa lights, placed next to each other. These lights allow for RGBAW color mixing through DMX messages. We select an amber-red color with a slight green tint to emulate the light of the sun setting. The outer two lights are angled outward and slightly upward from the middle light, enabling light to reach the angled curtains and shadows to become distorted as users shift their distance from the source lights. Importantly, while the light is directed, coming from a single source, the sound is multi/omni-directional, coming from 16 speakers in a circle around the space (more details in 3.4).

The surface onto which the shadows are projected are three curtains (each 59 inches x 95 inches), each installed with 12 photocells arranged in an evenly spaced 3x4 pattern. The curtains are of a taupe, semi-transparent sheer voile fabric. The curtains are hung from the ceiling such that the base of the curtains are one foot from the floor. From above, the curtains form the shape of a trapezoid without a base. These curtains make up the visual canvas upon which shadows are projected.

Users entering the space first see the side of the curtains with the electronic wiring visible. This is an intentional choice: we wished to make explicit the human-machine interfacing within this installation while also viewed the long tangle wires as an aesthetic similitude to the roots and tendrils of the forest ecosystem.

3.2 Space design

In addition to the lights and curtains, the more general space design is also critical to our installation. The room in which we set up our installation is completely darkened such that the only light the photocells register is coming from the three Exa lights. This gives the room a focal point of attention towards the lights, curtains, shadows and the sound that is being created. As the curtains are sheer, they are illuminated by the lights and look as if they glow (s. picture below). Another affordance of the transparency of the curtains, is that they enable observers to see people casting shadow from behind the curtain, acting as a one-way mirror.



3.3 Registration & Data processing

The 36 photocells are connected in parallel using two Arduino Mega 2560 Rev 3s and two Arduino Unos. The 36 photocell values are read and written as a serial message (s. code for Appendix) at a 100 Hz sample rate, and then unpacked in Max. The maximum range of values for each sensor was manually calibrated based on the physical space, as each photocell received different amounts of light based on light angle and internal resistance. The maximum value for each sensor was scaled to 127, and used to calculate a Cartesian coordinate to be used in CataRT (see section 3.4). The scaled sensor values were then

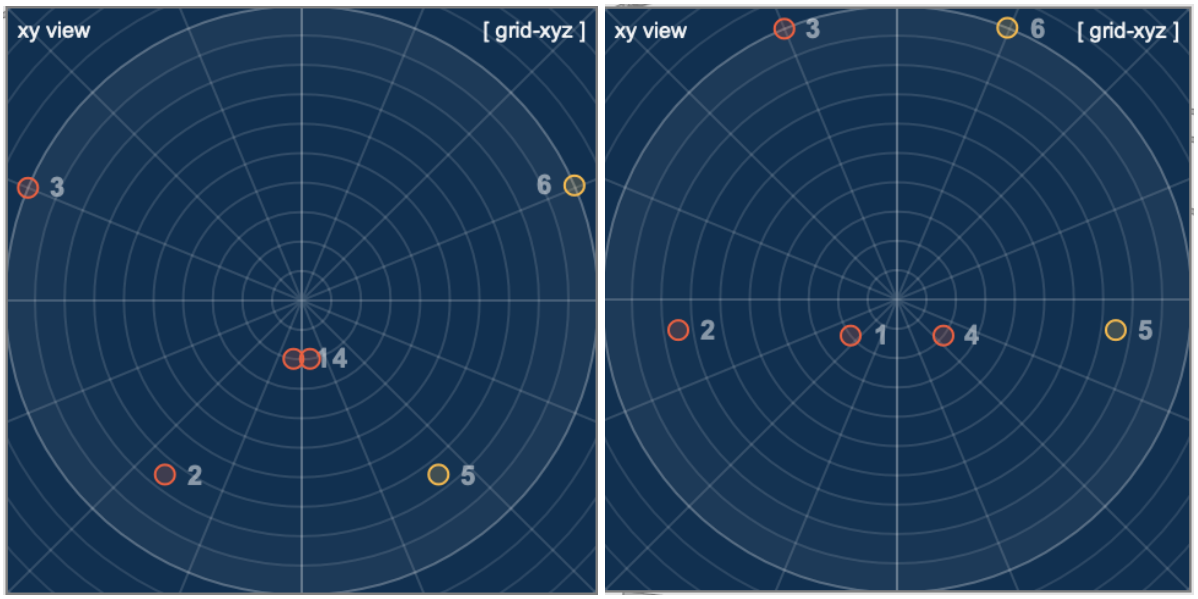
subtracted from 127, such that the sensors that were in shadows (low values) were weighted positively. We grouped the photocells into three sections corresponding to (1) the upper two rows, (2) the third row and (3) the bottom row of photocells across the three curtains. The weighted average of the sensor values within each section was used to produce a Cartesian coordinate for mapping sound according to the overall state of the sensors in that section.

3.4 Composing a responsive soundscape

Each section of sensors on the curtains corresponds to a different category of sounds: birds for the upper section, leaves for the middle section, and steps for the bottom. The sound categories were chosen to evoke a forest, and the spatial distribution on the curtain was supposed to be intuitive, with birds occupying the higher, "sky," space, leaves along the "tree trunk" of the body and steps placed close to the ground. The sounds were taken from field recordings in the Bay Area collected by the team. The birds category was indeed filled with recordings of birds. The other two, however, took some trial and error and were less literal. The leaves section contained recordings of water and laughter. Steps were filled both with actual footsteps as well as with short crisp recordings produced, for instance, by striking or rubbing pieces of wood together.

The soundscape was generated in real time with MaxMSP, using CataRT [7] for sound synthesis. CataRT allows you to segment a sound recording into very short samples ("sound grains") and allows you to play specific grains according to sound qualities (based on sound descriptor analysis). To give a somewhat simplified example, the samples in the Birds section were segmented and classified according to the pitch and periodicity of each bird call. The segmented samples were plotted on a Cartesian plane GUI in Max with pitch on the x-axis and periodicity on the y-axis. The sensor values for the Birds section of the curtain were aggregated to produce x-y coordinates that were mapped onto the position of the samples on the GUI to play those samples. Based on the tutorial patches, we built a separate CataRT engine for the three sound sections on the curtains. In each of the CataRT engines, we fine-tuned the playback of each sample with parameters that included pitch-shifting, trigger mode (continuous, overlapping or non-overlapping) and the playback duration of each sample (which does not have to be the same as the length of the original segment) such that the sound aesthetics for each group were satisfactory.

A unique advantage of this showing of our installation was the opportunity to use the 16.8 speaker system at the Center for New Music and Audio Technologies at UC Berkeley. This allowed us to experiment with the spatial placement of our sound sources. We used the ICST Ambisonics [2] tools to execute sound location and motion. To increase the immersive and omni-directional quality of the soundscape we distributed the sound of our three CataRT engines in six sound sources, and we took the average of the Cartesian coordinates generated by the sensor mapping to control variations in the azimuth of the sound sources.



These images show the position of the sound sources in the ICST Ambisonics GUI. Sources 1 and 4 correspond to Birds; 2 and 5 to Leaves; 3 and 6 to Steps. Changes in sensor values impact the sound source's azimuth, its angle on the horizontal plane. The image on the left shows each sound source when the value of the sensor mapping is at 0, its minimum value, while the image on the right shows a sensor mapping value of 127, the maximum.

4. Observations from first time users

To test our prototype with users we invited people to the exhibition over two days and three time slots of each 2h. Participants were students and professors, spanning various departments ranging from education, music, business and engineering, as well as people unaffiliated with UC Berkeley. In total we had about 40 visitors.

Some participants found the installation with no other participants (only us) in the room, while others found a full room of up to 3-4 participants in the room who were either observing or interacting with the installation. Our instruction to participants was most often to just tell them to "just play with it" or to tell them that it was about casting shadow. Sometimes we offered further explanation.

4.1 Common behaviors in exploration

The most common behavior we saw was for people to walk along the curtain from one end to the other. Almost every participant did this early on in the exploration. After getting a first sense, people would walk more slowly to start "understanding the sound". As they found salient responses from the systems, such as very quiet spots or clear loud distinct sounds, they would pause, move around it (e.g. back and forth) and try to reproduce the sound. This mimicked the idea of "playing a note" after discovering a given behavior produced a certain distinct sound. Some participants retreated when the sound was too loud.

Discovering the photocells, either by seeing them oneself or after learning about the function of the photocells, participants would commonly use their arms and hands to cast shadows over specific sensors to "discover the possible notes". Almost everyone did this, but as the system did not create one-to-one mappings (sensor to sample) "notes" could not be discovered in simple-to-predict ways.

Lastly, one of the most common behaviors was also that people asked how the system worked. They were curious to test their theses from what they had explored and inferred themselves. Many participants became more curious to explore after gaining a deeper understanding of the system. Thus, it appeared that they enjoyed the discovery process of exploring with little knowledge, developing their own hypotheses of how the system works, comparing their hypothesis with how the system actually works and then exploring the system with knowledge of how the system functions. This learning and exploration process could be facilitated more strongly or more deliberately in future work.

4.2 Less common behaviors in exploration

More rare behaviors in exploration involved participants getting very close to the lights or blocking the lights completely, which left the room in darkness. In these cases people seemed to be curious about what "shutting down" the light would do to the system. This also relates to the distance at which participants moved more generally. Standing close to the curtain was most common, few went close to the lights and even fewer people stayed at a middle-distance for very long. Interestingly this is not guided by sound either as the middle distance is optimal for casting larger shadows and producing corresponding changes in sound. Thus, the behavior of standing near the curtain appears to be a strong preference, possibly because the photocells are most visible close-up.

Relating to photocells, participants sometimes touched, stretched or waved the curtain lightly in an attempt to uncover photocells in folds.

Notably, there were less "silencing sounds" (meaning more silent than starting condition) than noisy sounds and they also appeared to be harder to find, as less people naturally came across them in our setup. Participants, who found the silent spots, seemed to appreciate them, however, as they tried to return to the silent spots. This points towards more questions regarding how and under what circumstance we want to "place silence" in the future.

Other behaviors in exploration involved ducking and stretching, though these explorative behaviors were often learned from others. When one participant, for example, would duck, stretch or roll, many participants following would copy this behavior. But independently participants would not all explore in this way.

4.3 Group exploration

The most common way people collaborated in this context was by talking to each other and coordinating in actions. In some cases people would take videos of other players, trying to capture the light. Lastly, other less common ways of collaborating involved taking turns, creating figures of shadows together or dancing passed each other while passing along the wall.

4.4 Verbalizations

When asked to describe how people felt about interacting with the installation, some participants compared to feeling like being on stage. Participants related this and the loud sound as intimidating and overwhelming at first. However, many participants also shared that after calibrating to the sound and seeing others interact with the installation, they grew more

comfortable. Some participants specifically pointed out that seeing others interact with the installation made them learn from what one can do with the installation but also sparked new ideas, which they enjoyed. This “transfer learning” element and growing comfort perhaps, too, is something we can incorporate into the experience design in the future more.

Other participants also shared that they felt kept in an exploratory state as one could not directly map sensors to one predictable sound. Two participants shared that if the connection had been more obvious, they would have likely gone on to “beat making” in the installation.

Some participants also emphasized enjoying using their full body for the installation. Lastly, the metaphors that came to mind for people were zoo, forest, jungle, “golden-hours” for sunset, sound like goblins and puzzles (in relation to experience).

5. Discussion

After exhibiting our prototype of *Resonant, dwelling, unfading* we have good insight into what our installation conveyed well, what we could improve on and what future areas of exploration may be interesting.

5.1 Successes

In summary, we achieved to create an engaging full-body installation that made people open to entering an *explorative* state of mind and experience. We also successfully managed to draw people in on an *immersive* experience for many senses. Our selected sound direction and sound creation kept people engaged to explore. Further, the stage setup (lights, shadow and curtains), as well as, the required body-movement made people very active.

5.2 Improvements

While the balance of predictability and unpredictability of “notes” that can be played with given movements seems to be right for encouraging exploration, there is some further “fine-tuning” of patches we want to conduct for future iterations. Specifically, some sounds seemed to inhabit more space or were “played” much more frequently than others. These were especially loud sounds that also stood out. Further, we would want to master our volume across samples to not have strong jumps in volumes across different “sound patches”. Lastly, we may consider the sound creation to relate to more sense-making (e.g. larger shadows relating to louder sounds).

5.2 Future work

Beyond fine-tuning the soundscapes, we see many variations that could be interesting to explore: different contexts such as museums and other public spaces with high foot traffic are interesting contexts to experiment within, as they bring users with different mindsets into the installation.

Soundscapes created from voices or instruments could perhaps give completely different settings or modes to our full-body installation, giving it different settings and perhaps even envisioning an interaction where users themselves can in simple steps configure their soundscape.

Further, experimenting with light fading in and out (e.g. simulating sunrise and sunset) or other light patterns can also set a very strong visual dynamic and perhaps also interact with the sound in interesting ways (e.g. darker light leads to lower responsiveness, etc.). Lastly, future iterations may experiment with additional stage setup elements next to the curtains and the light, perhaps catering more to distinct and specific metaphors participants envision.

APPENDIX

Google Drive with Arduino code, Maxpatch and sound library:
https://drive.google.com/drive/folders/1LDAlnGTTEqyNAVjiMJkEBtQyZsI_l2sQ?usp=sharing

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