Hearing and Feeling Memories: Connecting Image, Sound and Haptic Feedback to Create a Multisensory Experience of Photographs.

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ABSTRACT

This paper discusses the process of how converting an image into sound can be used to generate an auditory and tactile relationship with photographs, a medium which ordinarily affects a singular sense. In the process of converting an image into sound, haptic feedback can be integrated into the process to allow for the greater amplification of the tangible properties of sound. In doing so a photograph could be both heard and felt. This process has been used to explore how data and artefacts can also be incorporated when generating a musical composition from a photograph.

1. INTRODUCTION

Photography is a powerful tool for allowing one to preserve and capture a memory. “Images have a deeply ambivalent relationship to time. The single image appears to freeze it, capture it, and memorialize it, and in doing so works against the flow of duration.” (Hunt & Schwartz, 2010). With a photograph being frozen in stasis and principally affecting the visual sense, this chapter attempts to investigate how making an image audible can generate a reanimation of a photograph. By using the pixel data from a digitized image to make it audible and feel the output via haptics, this chapter seeks to explore the ways in which an individual can metaphorically feel and hear a person by making sound from an image.

After the death of my father in April 2019, photographs of him became a powerful tool for preserving his memory for me and my family. As a doctoral researcher with a research project focused on translating image into sound, this prompted experimentation into how I could use his photographs and recycle them into new forms.

My father was a frequent user of social media and this was my first experience of losing a close family member who had a public online presence. Although my father was tangibly gone, there existed an archive that in some ways still felt active. The nature of a public Facebook page also meant that other users could interact with that digital space as they chose fit. This left me feeling that my father had been left in a kind of digital limbo. Brubecker et al. explain,

> Social network sites provide a new space for the bereaved to engage grief that is socially situated in the daily lives of users. While online grieving might be beneficial for some, the unmarked way in which it is handled by the system presents challenges to others who are not grieving or who are grieving differently. Some find comfort, while others express distress at seeing what they consider private expressions of grief and may even question the authenticity of users’ messages, given the medium by which they are expressed.” Brubaker et al. (2013)

It became clear how few photographs—digital and otherwise—we had of my father, so I was thankful to have this online archive. However, like some of the participants in Brubaker et al.'s research, I felt quite uncomfortable with the lack of control my father had over the page.

Facebook heightened this duality between comfort and unease even more so due to its cataloguing, organising and sheer amount of accessible data all in one location. This prompted experimenting with how I could utilise some of this data, but in a way that allowed me control over it.

After downloading his photographs, I deactivated my account in search of how my own research into interactive art could catalyse this notion of a portal between us and lost loved ones in a way that felt personalised and restored a sense of control to myself as an individual. Having spent much of my artistic practice exploring creating installation and composition works that employ algorithms, it seemed fitting that I could use this experience, and the data to which I had access, as a driving force for the generation of new creative outputs. Yet a photograph can be a promise of the unobtainable. As Gibson explains, in reference to a photograph of her own father,

> The absent, yet representationally, present body also haunts the photographic image. The three-dimensional body as a flat surface image on photographic paper, haunts as the substantial, the longed for, and the impossible. In the direct look at the camera lens the photographed subject says: 'Here I am', asserting their existence into the recording of the image. Registered in the image is my father's imminent death. In this photograph, my father is disengaged from the lens and production of the image. Technically, in terms of the image, he is in the photograph but he is not there. Gibson (2004).

In creating sound from image the objective for this chapter has been to uncover whether what Gibson refers to as the 'impossible' could be reconsidered. With death being an unavoidable mark of existence, photographs of our loved ones are a way of creating a sense of permanence from the precarious and fragile experience of being alive. The very nature of being here means that all things are transient, from our thoughts, our feelings and our physical self. Although a photograph may freeze a moment in time, in many ways that artificial construct deviates from the reality of human experience.

A musical note, however, parallels this transient nature more closely. In audio synthesis terms, an ADSR envelope is an apt metaphor for the nature of a human cycle. There is a sudden attack time of coming into existence, growth and development, a decay time of regulation, a sustain of the main sequences of one's life, and finally a release of not becoming once more.

The intention of this chapter is to document research into techniques and approaches that I as a sound artist uncovered using a cyclical practice-based research methodology (Candy, 2006) through the creation of the installation *A-D-S-R*.

In creating an interdependent, multi modal response from a photograph, this project aims to explore how the compositional form of an image can be used to generate a sonic composition. In translating image to sound, it seeks to explore how different mediums can be connected and how physical and contextual artefacts can be incorporated in the work to further embed the subject of a photograph.

2. MAPPING IMAGE TO SOUND

This project uses RGB data, the additive colour mode that is used to digitize real-world colour. A computer realises a photograph by assigning digital numeric data for red, green and blue to individual points much in the same way that pointillist painters such as Seurut and Signac used individual dots to realise patterns of colour. Via the analysis of pixel data, a photograph can be distilled back to the individual numeric data of which the image is comprised. This repository of data can be then used to generate sound through a variety of mapping techniques. Much like Seurat and Signac, who realised larger paintings from individual brush points, pixel data may be mapped to trigger individual sonic events that contribute to a larger sonic composition.

There are a variety of methods for translating image into sound such as the linear spectrographic process as found in Photosounder (Rouzic, 2018),

> Time goes from left to right, and frequencies from bottom for basses to the top for trebles. The brightness of the pixel define the volume at a specific place in time and frequency, the brighter the louder, the higher in position the higher in frequency, the more to the right the later it occurs in the sound. (Photosounder, 2018).

This scanning technique has been employed by artists in performative setting in works such as “Scanline: fp” (Kobayashi, 2016) in which the movement of geometric drawings is mapped to waveforms and “Soundlines” (Jette, 2013) which scans the movement of a dancer and maps that data to pitch and timbre. In creating an audible relationship between image and sound, Ciciliani states,

> The application of scanline synthesis in audiovisual projects is an interesting method to create a direct correspondence between a digital image and the resulting sound. When it is applied in its pure form, the musical variability is somewhat limited, but methods have been presented that are very suitable for adding sonic variability. (Ciciliani, 2015)

The sound produced by the scanline approach is often very sonically dense as each pixel in the row is mapped to produce a frequency. As an alternative, the probing approach used by applications such as VOSIS (McGee, 2013) limits the data set resulting in less noisy results. VOSIS takes a raster scan of grayscale pixel data of a section of a chosen image or live video feed. The technique of raster scanning can be used for generating or recording a video image by performing a line-by-line sweep of the image’s pixels (Yeo and Berger, 2008).

This scan produces values for each pixel ranging from 0 - 255 (0 representing black and 225 representing white). This is then processed and filtered in order to remove noise, scaled and finally processed into an audio wavetable that is used to perform audio synthesis. VOSIS allows the user to generate synthesis from the pixel data from any part of an image or live feed, “Using a multi-touch screen to play image regions of unique frequency content rather than a linear scale of frequencies, it becomes a unique performance tool for experimental and visual music” (McGee, 2013). Applications such as VOSIS can allow for greater compositional control compared with the spectrographic approach as the user can shift to different areas of focus on the image as found in the installation “Voice of Sisyphus” (McGee et al, 2012).

Rather than converting pixel data to audio synthesis as mentioned in the above, this project explores how mapping pixel data to samples can create a cohesive relationship between image and sound that can be used to link the persons digital and physical artefacts, in the case of this installation, a photograph of my father triggering samples of him playing the guitar.

3. VIBROTACTILE EXPERIENCES IN INTERACTIVE ART

Creating multi modal art installation has been explored in works such as “Sonic Bed London” (Matthew, 2005). This interactive sound installation invited the audience to lie on a bed that has a 12-channel sound system with 6 subwoofers incorporated into the mattress. A similar technique has been adopted in works such as “Wooden Waves” (Perini, 2015) in which sound is output via contact speakers and placed on a wooden floor to create a resonant surface resulting in an audio-tactile installation.

Haptic experiences are also becoming more common in virtual reality exhibitions. The Touching Masterpieces (2018) exhibition allows participants through the use of haptic gloves to be able to feel sculptural works, generating a new level of accessibility for people with and without complex disabilities. Other exhibitions such as Haptic Field (Salter & Martinucci, 2016) asks the audience to wear haptic garments that turn the gallery space into a multi modal sensory experience to give users a continually shifting exploration of the relationship between people and technology.

3.1. THE SUBPAC

The SUBPAC is a tactile audio vest that was initially created to allow music producers to be able to feel the bass frequency spectrum of the music they are making. The device has been used in installation such as “Internal Garden” (Wiggan, 2018) in which the electrical resistance of plants is converted into MIDI note messages with the resulting sound finally processed through the SUBPAC. As Wiggan explains, “by deciphering and registering the impulses and interactions of plants with a device that uses a MIDI interface to transform the impedance from a leaf to the root system of a plant into music, which gives voice to plant perception.” (Wiggan, 2018).

Examining the relationship with sound and image through the use of the SUBPAC has been undertaken in events such “Sound in Pictures” (SUBPAC, 2018) in which deaf and hard of hearing participants incorporated the device to gain haptic feedback when creating experimental film and animation. Other interactive installation such as “Seeing Sound and Hearing Frequencies” (Stilon, 2018) uses the SUBPAC to generate a relationship between sound and image. “A music track was chosen and split up into its separate instruments. These instruments were associated with a colour and shape and linked to an Ableton controller so the user could have the ability to choose which instrument to listen to along with seeing visuals associated to that particular instrument.” (Stilon, 2018).

In my own practice the SUBPAC has been used in the installation “ R e f l e c t” (Evans, 2019), an interactive sound installation. In the case of R e f l e c t, a camera housed in a mirror turns visual representation into a sonic one through the process of translating pixel data into synthesised sound. The synthesised sound can be then heard on headphones or through loudspeakers. This audio signal is then turned into haptic feedback via the SUBPAC.

4. THE SYSTEM

My father had a deep love for music and was an amateur musician himself, taking a keen interest in writing his own music. This prompted the concept of using his images to catalyse composition, in a sense, having him still remain as part of the composition process if only as a source of data. This led to the creation of a generative system (Spiegel, 1985; Eno, 1996; Eigenfeldt and Pasquier, 2013).

Figure 1 explains the process used in the work that translates image to sound to object. RGB pixel data extracted from a photograph of my late father creates a generative composition by mapping the data to MIDI note messages. These note messages trigger a sample of him playing the guitar, which is output via a vibration transducer. The transducer is attached to the strings of a guitar owned by him, the sound of which is detected by pickups and amplified. The resulting sound is sent through a SUBPAC, a wearable vest that offers haptic feedback by the amplification of low frequency audio signals.

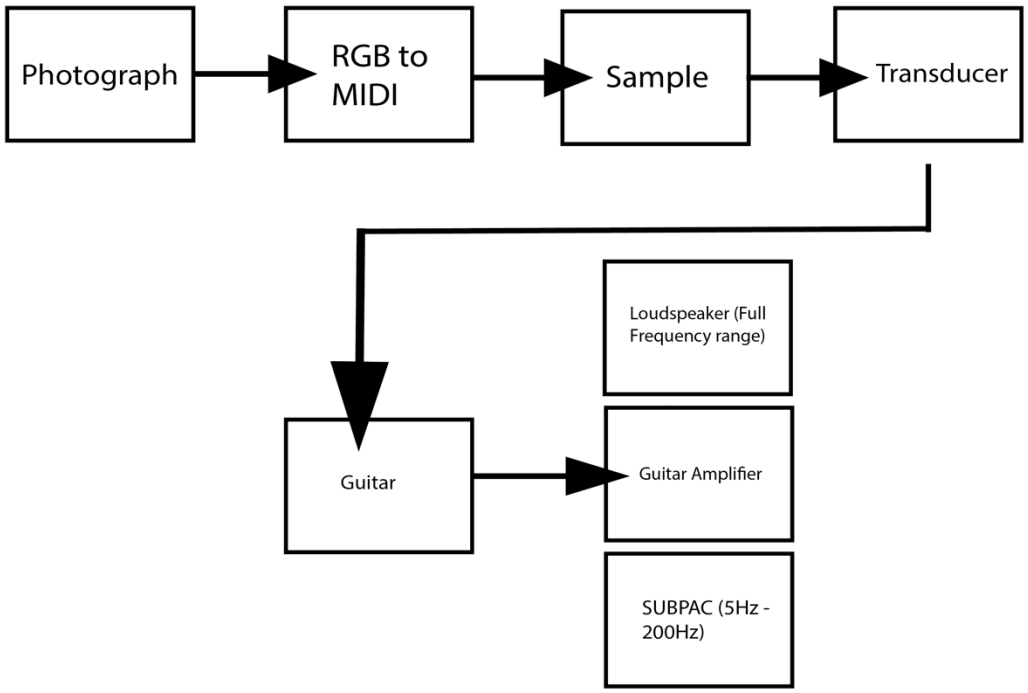

Figure 1: Installation Process

Figure 2 outlines the image-to-sound process that has been used in this installation. The system, realised in graphical programming environment Max, begins with the photograph. A probing method (Yeo, 2005) is employed, by which individual pixel data points are read by clicking on the image or raster scanning through it. The spectrographic approach, dependent on image, can produce a very busy sonic output. By implementing the probing approach, the intention has been to create a more nuanced sonic output by selecting individual pixel data points.

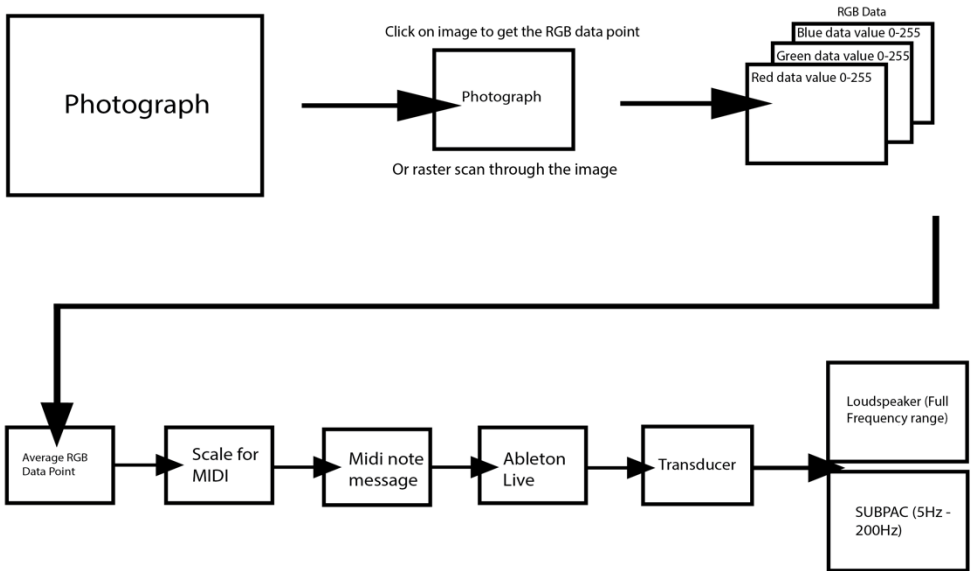

Figure 2: Image-to-sound-to-haptic feedback system

The system can be used by clicking on the photograph. Figure 3 shows the photograph used in this installation. The probing method allows myself to click on areas of specific interest, for instance I can 'play' the guitar by clicking on the neck of the instrument. This enables the development of a reflexive and exploratory relationship from the feedback of the sound from the image which can be further informed by the response of the SUBPAC. However, in the case of this installation, investigation has been undertaken into how the mapping of image-to-sound can establish a paradigm that allows myself to feel more of an audience to the process rather than an active participant.

Figure 3: The photograph of my father used in the installation

Each pixel has a red, green and blue value. These three values are gathered and scaled relative to MIDI. (MIDI has a data range of 0-127, the RGB data has range of 0-255, halving this RGB data output allows for the RGB data to be scaled relative to MIDI). This results in the resolution of the image matching the restrictions of the MIDI protocol, meaning no matter what the colour of the pixel is, there is an equivalent note or frequency.

In the case of this installation, the photograph of my father, triggers a sample of him playing his guitar. The idea of playing the guitar and creating music is embedded in the photograph, therefore the way in which the data is mapped has been chosen to be representative of the meaning of the image. When a person plays an instrument there is a continuous decision process of which note to play, the velocity of those notes, and their duration. Therefore, the average value of each pixel data value is mapped to affect each one of those properties. The photograph used in this installation has a principal set of colours (red, white and black) and by mapping the pixel data points in the ways described, the visual pattern can become a compositional one. For instance, the predominant shade of red of the wall creates the MIDI note G2, the white of the shirt cerates the note G8 and the black of the sofa —although out of the range of piano keys— creates a frequency of 10.91 Hz, which generates a significant response from the SUBPAC.

In the initial iterations of the image-to-sound process I experimented with altering the incoming note pitch based on diatonic scale mapping. This resulted in the sample being pitch shifted to remain in particular modes of my choosing. However, this reverted far more of the compositional agency back to me and not with the colour or the formation of the pixels of the image. If I truly wanted to have an experience of being an audience to the image-to-sound process, limiting arbitrary compositional decisions was desirable. Choosing to be less restrictive of areas such as the modality of the sonic output also meant that if I input a different image there would be a significant difference in the notes that are produced.

Raster scanning as a method of image analysis has been implemented so that the pixel data of the photograph can dictate the rhythm of the composition. Ordinarily raster scanning through an image is done at a steady rate which when applied in this process produced a monotonous rhythm. To create rhythmic variation, the value of each pixel data point controls the duration of analysis between the data points themselves. This was achieved by mapping the RGB data output of each pixel data point to set the timer of the system. This generates a relationship between each pixel data point and the photograph as a whole and further promotes the model of the image generating the composition.

By using the entirety of the image, the aim has been to preserve the wider contextual information present in the composition of the photograph. For instance, one could crop the photograph to focus more directly on the focal subject matter, however, in doing so a significant amount of data would be removed. In my case there are a limited number of photographs of my late father, so by incorporating the whole image, the full repository of RGB data is included. Much in the way that *mise en scene* is carefully considered in cinematography and photography, the focal point of the photograph is important, but the location, the lighting, the angle, the colour, all aid in the capturing and preserving of a memory.

Creating a correlation between the subject matter of the photograph and the sonic output is then further integrated through the use of a vibration transducer to output the image-to-sound process through the strings and pickups of my father's guitar.

5. THE SAMPLE

A lot of the image-to-sound applications that have been explored in this study use an internal synthesis algorithm that can result in a sonic output limited to the developer's choice. This can be observed in systems such as "Living Sound Pictures" Lynggaard Thorborg (2015a) which explores the connection of sounds with images by creating a system that takes a real time feed of the environment. Thorborg states, he aims for the sonic output process to be "aesthetically pleasing". (2015,b). The output produced is polyphonic, additive synthesis that retains harmony regardless of the visual source. This limits the user in relation to the subject. For instance, if one wanted to sonically explore subject matter that would be better represented with noise and discordance, the ability to do so with this application would not be possible. By creating a system that outputs MIDI note messages, the functionality of any digital audio workstation is available, meaning that a potentially greater range of sounds and effects are available. Ableton Live is used in *A D S R*, receiving MIDI data from the Max patch, which is then used to trigger audio events and processing.

In the initial iterations of the compositional output, the translation of image to sound focused around my personal memories of my father. On reflecting about our relationship, specific sounds became exceedingly poignant and sonically representative of my relationship with my father, for example, the sound of a dial-up modem connecting to the internet—a familiar sound around my home as a child. An audio clip of dial-up modem was loaded into Ableton Live's "Simpler" and triggered by incoming MIDI messages generated by the pixel data.

Although this provided the work with an output that was sonically rich and complex, this approach of the exploration of personal memory would provide the audience with little correlation between the photograph and sound. It felt more like a therapeutic tool for myself.

After sifting through other digital artefacts I had of my father, I came across one recording of him playing the guitar. Much of the audio was unclear, apart from a few seconds of him strumming. This section of audio was used also used as a sample in Ableton Live, enabling it to become the sonic focal point. By utilising the RGB data to affect pitch, velocity, duration and rhythm of the sample, this one precious audio clip was able to become far more diverse in its sonic and musical application.

6. CONVOLUTION

The final stage of the digital audio processing is the application of convolution reverb. Initial tests with this processing technique were for purely aesthetic reasons, i.e. to provide the composition with a greater sense of ambience and space to create a reflective and meditative environment for the listener. Aesthetically, ambient music is particularly suited for conveying the transitory and ethereal nature of the subject matter within this project. As Adkins explains, "Whilst ambient music may not rely on traditional functional musical syntax (melody, harmony, and rhythm) it can engender a deep listening experience through slow-moving immersive textures and drones enhanced through the use of noise and fragility to create emergent atmospheres." (Adkins, 2019).

To further embed my father as the subject in the work I experimented with what might be used as the impulse response. Drawing on my limited number of digital artefacts related to my father, I found some recordings of him speaking. Inputting a section of this recording of speech as a sample into Ableton Live's Convolution Reverb plugin gave the composition a novel sonic characteristic by timbrally stamping the triggered samples with my father's voice. It also provided the composition another way of connecting the subject of the photograph and the and sonic output.

7. THE OBJECT

By connecting the digital space and the tangible by the translation of image to sound, a variety of techniques have been implemented to link physical artefacts, and also exploit the physical characteristics of sound through the use of haptic feedback. In doing so, the aim has been to create an immersive sonic and physical experience that provides the audience with a work that allows them to see, hear, and feel this interplay between the multiple media.

Using artefacts in this way in sound art installation has been explored in works such as "Hearing Loss / Cold Atlantic" (Wynne, 2007a) in which the artist uses the hearing aids of his late father to create a feedback field.

> My father died in 2006, leaving behind three pairs of hearing aids and a typically extensive supply of batteries. Hearing aids, like false teeth, are very personal objects which are not only used daily but are actually inserted into bodily orifices. One of the first things that struck me when I began to work with them is that they are made in the shape of my father's ear canals, giving a positive shape to a negative, internal and intimate space that no longer exists. It was literally through these objects that he heard the world during the final years of his life. (Wynne, 2007b)

One of the physical artefacts that came into my possession was my father's guitar. This was an instrument that held significant sentimental value. As a child, we went to buy the guitar for his 40th birthday and it was the first instrument I can remember playing. In connecting the sonic output and posthumous objects, it became of real interest for me to explore how, through this process of translation, the guitar could be played by 'him' once again. The instrument has been used within the installation in a variety of modes. Firstly, as a physical manifestation of the nature of the situation. Rather than presenting the guitar on a stand, the instrument rests in the open hardcase symbolically evoking a sense of memorial and a final resting place.

The compositional output has been played through a surface vibration speaker which like *Hearing Loss / Cold Atlantic* generates a feedback field. By mounting the transducer to the strings of his guitar, the strings and the pickups of the instrument colour the output. Like the photograph, this takes the instrument out of stasis. The image is triggering the sound of him playing a guitar and although via an extensive chain, in some sense my father is playing his instrument again.

Figure 4: *ADSR* installation

8. HAPTIC FEEDBACK AND THE CAUSAL CHAIN

The final sonic output of the installation is processed through the SUBPAC. This can be integrated into the translation process to allow for the greater amplification of the tangible qualities of sound, enabling the user to have a more visceral and immersive experience of the installation. The device is placed on a chair and the audience are invited to engage with the installation by sitting whilst the output of the generative composition is played through the device. In doing so the aim is to provide the audience with multi-sensory experience of the photograph in sound. In creating a haptic response this is to provide a heightened emotional response. As Bonefont explains,

> Sound wave transmission, though on a different level than it, is similar to manual touch in that both are gestures carrying physical energy through space to interact with – to contact - the flesh of another's body. Both seem to be able to generate sensation, and subsequently, emotion, image, and perhaps even meaning for those involved in touch, or sound-touch, relationships with each other. This is a complex and not always linear chain of causality. (Bonefont, 2012).

In the case of this installation, an attempt has been made to recycle data in a way that is able to reanimate the digital and the physical. Although a person can never be brought back, the repository of what remains can be used to create new mediums. By using the SUBPAC at the end of this image-to-sound process, a chain can be connected in which a photograph can be both heard and felt.

9. CONCLUSION: FUTURE DEVELOPMENTS

In translating an image into sound, multiple modal experiences can be generated. By analyzing the digital data stored within an image, it becomes a vast repository of information that can be used creatively. After the death of someone, the digital and the real-world artefacts can be limited, so exploring the ways in which new experiences can be generated can provide a new way of experiencing what is left behind. Posthumous photographs become a major source of preserving memories, but they are frozen in time. Through the techniques and approaches explored through this project, the data in an image has been used to catalyse new outputs, reanimating what was locked in stasis.

In future developments of this work, an aim is to explore how these approaches could be used in relation to moving image. In mapping the change of RGB values of a video to a sonic output, a video could create a self-reflexive score, further integrating the relationship between the audio and the visual.

Working on this project has been an extremely helpful tool for maintaining a relationship with my father. When a sudden loss occurs, there can be an intense feeling of lack of control. This process, however, has allowed me to revisit and reanimate his photographs with a renewed sense of possibility, from circumstances that at the time felt like the end of a process rather than the start of one. At present this research has been focused on my own relationship with loss. In the future I would be interested to investigate how this image-to-sound process could be further abstracted as a creative method for others to cope with bereavement.

10. NOTES

1. The Compositional output can be heard here via Soundcloud: https://soundcloud.com/user-242010528/a-d-s-r

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