Thesis Report 2020

Submitted by Mahira Noor

Registration: F2016-428

CHROMESTHESIA

Submitted in partial of the requirements for the degree of

Bachelor of Design (B.Des.)

In Visual Communication Design

At the Beaconhouse National University

Index

SIDE NOTES

Chapter 1

Keywords

Visual Communication Design, Image to Sound, Earthquakes, Natural Disasters, Coding, Real Time Rendering System, Musical notes, Chromatic Scale, Seismic waves, Sound Data, Low and High Frequencies, 2D Images, Heat Imaging, Visual Mapping, Data Mapping, Visual Trajectories, Charts, Graphs, Waveform, Spectrogram, Pixel, Values, Auditory, Memory

Abstract

A hazard and a Disaster are two different words commonly misused. A Natural phenomenon becomes disastrous when it destructs the living surroundings and affects the human mind. Deficits in visual memory can be caused by trauma to the brain making it hard for us to access it hence; the human auditory system can perceive a great deal of subtlety in seismic data. Natural disasters such as Earthquakes are most commonly experienced in Pakistan. The Media talks about the aftermath only such that the next day feels like nothing happened and we move on. How can we get into the minds of those who have witnessed such disasters by gathering visual information and dismantling it through auditory memory? What if there was only sound, light and color to simulate the experience as observers seek meaning in the sounds and images they grapple with the magnitude of this shift. Such an experience takes the form of a physical analogue trying to have a conversation with the viewer by dismantling 2D images of the disasters, identifying their patterns and then transforming them into sometimes noise and sometimes silence. Especially striking hence becomes impossible to tell which patterns of sound and light are real and which are created in the mind of the listener.

1: Auditory memory: Information that we have heard while visual memory is information we gather when we see.

Passion

I remember watching news and only finding distressful images of houses and roads and buildings collapsing after an earthquake. It was the 8th of October, 2005, one day after my birthday; I was woken up by the windows shaking from the second floor of my house and later one of it falling down. I only remember the loud thud and chaos after it. I always wondered what I could have done if I knew exactly what an Earthquake felt like. This is how I started thinking on the lines of how people act and react during natural disasters and what kind of sounds and noise do they hear first. Are there any colors that form our vision? I was passionate about understanding the language of sound.

Project Scope:

I intend to broaden the perspective of how natural disasters such as an Earthquake are viewed differently and not just images of buildings collapsing and to use the language of sound to simulate the experience of an Earthquake. It has been observed that humans tend to relate to sounds with certain spaces and objects to evoke feelings of nostalgia; thus their aural memory records data with their visual memory. I wanted to explore this notion so people can think beyond what they see.

2: 8th Oct, 2005, muzaffarabad Earthquake with a magnitude of 7.5 took place.

Design Statement

My idea began from a simulation; this is the closest I could get to recreate an immersive experience of the Earthquake to see how humans react to such situations and what kind of senses are heightened during such occurrences. There is a constant processing of sounds around us as we become conscious but we are so immune to those sounds that we can't decipher what sound it is. Earthquakes can repeat on time scales that are larger than our generational memories thus making it possible for people to lose sight of the hazard. Sense

of hearing is the most heightened one that allows me to deconstruct the human senses with worldly matter, what goes under the earth and the natural occurrence of the disaster is beyond human control. The ultimate goal is to simulate a reality through this Rendering System that allows your brain to hear sounds of colors extracted from images that are automatically converted to heat imagery and allowing us to exactly hear the sounds when exposed to high frequency and low frequency areas. The idea is not for us to feel the earthquake and to develop an emotional connection with the event but to decontextualize the sounds extracted from those images. The Muzaffarabad Earthquake, a magnitude of 7.6 in 2005- has a historical importance because of the destruction, so I wanted to use the same context however, change just the medium of data that can simply be interpreted through sound. While gathering quantitative and qualitative data, it allowed me to explore the approach of Generative art and to use Data programming in my visualization. I'm using JavaScript as my programming language.

Target Audience

This project extends the relative usability to any user potentially interested in reading data in a more abstract manner. The conflict comes into viewing and listening to sound. My idea and main agenda was to use sound in the rawest form as possible that literally translates color and its equivalent sound. So, people listening to an Earthquake Image might expect a disastrous chaos of a building falling or people screaming that shows their presence in the event however, this isn't that. The audience should be prepared to listen to a very raw form of sound which isn't melodious rather and apt audio visualization of Colored frequencies.

Chapter 2

Research Questions

The nature of my interest towards the occurrence of a natural disaster and simulating the experience provokes many questions and to narrow it down for the audience I eradicated the notion of relating the earthquake to an emotional occurrence as bad only.

1. How does the abstraction and Re-contextualization of sounds create a physical response in simulating an earthquake?

2. What if there was only light, sound and color to simulate the experience of an earthquake?

3. What does an Earthquake sound like?

4. The media talks about the aftermath of an earthquake only such that the next day it seems like nothing happened. How can we use the human memory as a tool for them to perceive such occurrences through sound?

5. The human eye cannot see infrared colors called Thermal Colors which emit heat at certain frequencies. Can these colors be translated to a musical score?

6. Is it important to relate the earthquake to an emotional occurrence as bad only?

3: Rendering system: It's the automatic processing or generating of images into various computer aided steps.

7. Does the color Red really have a sound that evokes anger, violence and love when changed to the algorithm of converting color to a musical scale?

Theoretical Framework

Neil Harbisson is a color blind cyborg artist that only sees the world in gray scale. He happens to have installed an antenna in his head that allows him to

see color and then hear it in the world around him. The antenna allows him to record whatever his eye catches and sends those signals to the chip that decodes the colors into sound. He also makes sound portraits by perceiving colors and converting them into a musical scale. His theory on how to see sound through color better unfolds the framework behind my ideation into creating such a real time rendering system. The question here is how does our brain decode sound? Moving forward from this aspect, I wanted to hear color as pure as possible. What is sound? ‘Vibrations that travel through the air or another medium and can be heard when they reach a person's ear’ or sound produced by continuous vibrations, as opposed to noise’.

Moon Ribas is a cyborg artist who has a developing seismic sense by implanting a sensor in her foot that perceives Earthquake vibrations in real time occurring elsewhere. The Earth is a composer in her performances on stage. With keeping this notion in mind, I wanted to challenge and extend our perceptions of how we perceive Earthquakes only with destruction and disturbing sounds on the contrary, movement can be experienced in a deeper way. Not every sound that is an uncomfortably loud noise actually uncomfortable rather it can be a source of excitement for some.

Concept

To decode or simulate a natural phenomenon is beyond human control but the only thing that allows us to give access over it is how we extend our boundaries of perceptions to experience it in a unique light. Understanding what attributes to our senses being heightened in a space can result in reactions by what our eye detects something as simple as color. What if an Earthquake was perceived through Sound and Color in their purest forms? What is color? Objects reflect on the eye producing sensations that emit light also classified as the ‘warm to cool’ color ramp. Blue represents the low, green for the mid values and red for the high frequency values. All these

colors have a relation with sound and to touch upon the theory, we need to first understand the notion of Sound to Color correspondence where each sound has a corresponding color frequency that falls outside the visible spectrum; these colors are associated to Heat Imaging that show objects emitting less or more heat radiation hence, each color representing a frequency can be matched with a musical Scale. Our planet is moving and shaking constantly, every day and to translate the movement in a different manner is the challenge. The people haven't adapted to this natural phenomenon hence all earthquake perceptions are bad. However, mine is unique. I challenge this notion to see Earthquake images as colors and sound. Here sound takes the form of low and high frequency sounds that sometimes appear as silence and at other times noise to the ear.

Literature Review

An Earthquake is a natural disaster that is beyond human control and to simulate it only allows me to understand the topology behind it? What if there was only sound, light and color that showed the interplay between these frictions caused by the seismic activity taking place. This further introduces us to various associations of the seismic waves with sound, vibrations, amplitude, Frequency and the magnitude of the effect. To further elaborate on my ideation journey I would like to take you right back to the beginning of how I started this process of communication and developing my own sound language.

Understanding the notion of a simulation broadened my reality of interpreting this project as an approximate reality of the experience. Simulations in entertainment was my starting point, theme parks and Indoor museum parks (Wonderworks Orlando the Upside down Building) being the biggest example highlight that simulators trace back to the 1930's expanding from film and television. However, manufacturing these simulations allows for

certain techniques, logic to evaluate the effect. This further draws light on to diegetic narrative. These kinds of sounds help create an atmosphere or experience for the people to be in. At this point it was evident for me to develop a relationship between sound and what I was trying to achieve out of it so let's talk about the topology of the Earth and what kinds of sounds do we hear when an earthquake occurs? The Earthquake is a sudden jolt of energy release that results in the seismic activity in the ground causing movement and destruction. The most prominent and recurring words include; shock, temblor, upheaval, fault, movement, quake, light, vibration, sonic booms, frequency and magnitude. At this point it is discovered that sound is a prominent medium of communication but what happens when it needs to take the form of a visual. Seismologists say that it has recently been employed to use 'thermal anomaly' as a reliable earthquake sensor. The heat released and the stress in the rocks caused by the seismic activity can result in variation in temperatures from warm to cool that have exposed frequencies starting from 20 hertz to 20000 hertz: Red being the low frequency color of 430 – 480 Hz and violet being the high frequency color of 670 – 750 Hz. This means the sounds produced would be in this range and this is judged through a Spectrogram that allows us to identify the Quality of sound that is produced, Overtones of different sounds, brightness and darkness of the lines depict low and high frequency sounds and their amplitude. Furthermore, this allowed me to record accounts of people and their association with the types of sounds they heard during an earthquake: Sonic booms to begin with; the blowing wind, distant aircraft passing, artillery. All sounds have frequencies that depict the pitch and vibration in that sound. This notion allowed me to build a bridge between understanding sounds of the earthquake and visually show them.

To elaborate this idea, I was able to discover some renowned artists who have

worked in similar interests and helped me shape my idea more by understanding the language of sound. Haroon Mirza's work "The night journey" was a major sense of connection as he also aimed to work with sound and light where spaces would be occupied with sometimes noise and silence. He organized this installation with the perception to decontextualize as he quotes "all music is organized sound or organized noise''. He urges us to question the relationship between sound, noise and music. Taking this forward I started studying the decontextualizing of sounds and images to appropriate them. The term iconoclasm describes best as it talks about destroying images and icons by abstracting information extracted from it and converting into a new form or depiction. However, relating Earthquake data and treating the imagery with such technique to convert it into sound was the next goal. Artists like "Bridget Riley", "Kris Andrew small", "Ernesto Briel" and "Victor Vasarely" allowed me to see sound in image through Kinetic art and Optical illusions: to question how our brain can create such patterns that we see if we hear certain sounds. To further enhance the understanding of false perception of a real sound or the absence of sound shows that humans have the ability to react to sound they possibly heard or did not hear at all but registered a similar sound- this is called Auditory illusion. Darel Carey and Peter Kogler, visual artists create immersive line drawings covering walls and rooms to transform the feel of the room to evoke experiences like; the vertigo effect, these optical and spatial perceptions bend the perspective of the space through lines introducing us to neural networks where our mind interprets data through clustering raw information in a machine algorithm to recognize patterns. Similarly, humans are interpreting sound around us almost all the time subconsciously and hence perceive a lot of information through sound- approaching footsteps, door opening and motor sounds etc. This processing becomes conscious when we do not know what the sound is of an earthquake because it produces infrasonic sound frequencies that the human ear cannot hear as they are too low (20 Hz). However, earthquake

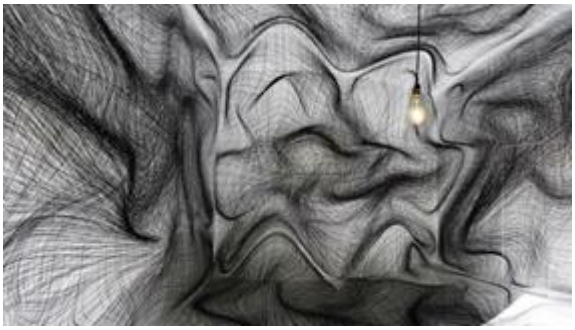
produced seismic waves can have a frequency span from about 20 Hz (low) to 20k Hz (high). High Frequency waves are the ones that cause much damage and danger to buildings and bridges in comparison to low frequency waves. So far, we are able to understand the relationship of an earthquake with sound waves but what really is sound? It is the reception of waves interpreted by the brain. Newton observed the sensation of color as a light receptor in our eye that transmits messages to the brain. However, no object has color but an object's reflection on a surface absorbs all colors and reflects on to the objects. Can the human brain interpret color as sound?

Visual references

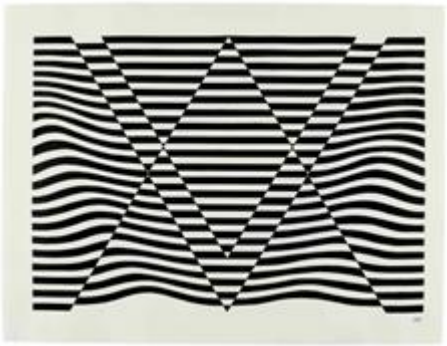
I divided my process into two categories; the visual and the auditory, for the former I was looking at spaces and large scale installations that would disorient the special perspective of my visuals.

Darel Carey

Peter Kogler



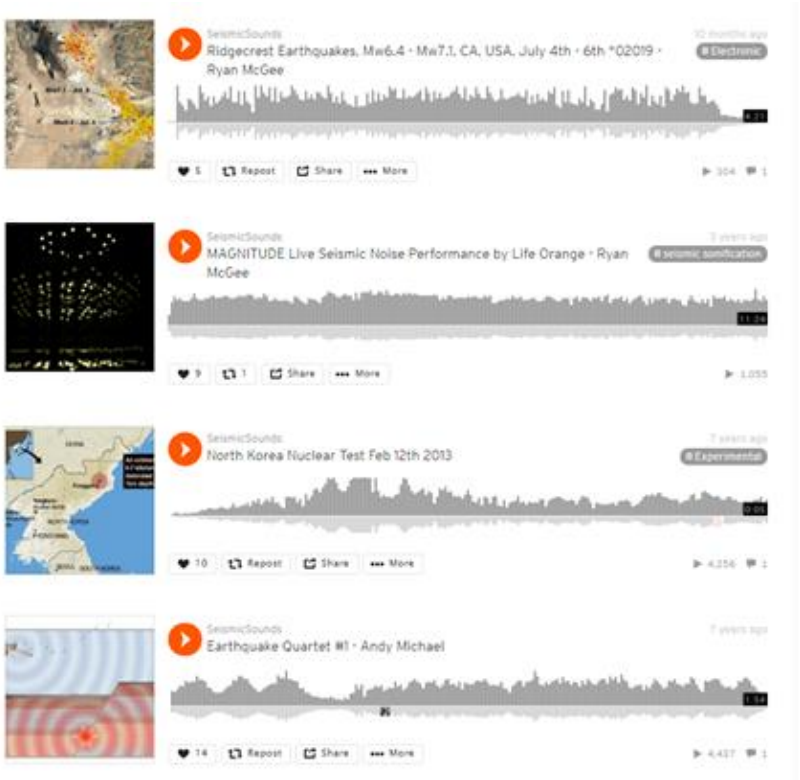
Ernesto Briel



Olafur Eliasson

His work is in geometric terms, made up of squares fixed around a pentagon to create patterns in a kaleidoscopic effect where colored reflections are casted on the surrounded space to create an illusion.

In the second stage of my visual reference, I shifted the focus of my project into developing an interface that converts images to sound data; I was more focused on various musical scales that are present in sound compositing; major, minor, Chromatic, Pentatonic etc. Sound artists compositions on hearing earthquakes include many; these composers use depth, magnitude and vibrations through various musical notes. This helped me better understand how I could operate my own musical scale.



Research Questions Explained

When I started my visualization process there was one recurring theme throughout; changing the way existing images looked by layering to take away the original form. This urged me to think about re-contextualization and appropriation. To begin from the first question, I wanted to establish a solid relation between sound and color by creating a language that would help me simulate this experience. Sound itself is a language that is understood by all and in various ways allows the listener to be perceived. While researching upon sound to color correspondence, it became evident to settle on creating an apparatus that converts heat imaging colors by extracting their frequencies and converting them to sound or notes. Moving forward, to establish an earthquake photograph and its response, it was important to see and read what was causing all this disruption. The topology of the earth describes an earthquake as a big jolt followed by violent shaking that releases energy in

seismic waves making their way to us to amplify the experience. Even seismic waves have data that can be amplified to reveal sound information, type and size of the wave. Earthquake sounds are mostly associated with sonic booms, blowing wind, distant aircraft passing, explosive, rushing and artillery like sounds. Sounds are divided into ultrasonic and infrasonic where the former waves are too high for the human ear and the latter too low for the human ears hence drawing connection with low frequency and high frequency sounds. Humans interpret data everyday around themselves through sound to the point that we are immune to certain sounds such as; doors opening or approaching footsteps and what these sound like. However, all these sounds if heard individually will not be as similar to that of what they sound like all together. Similarly, the color red has the connotation of a fierce color with a shrill or sharp sound however, in color theory; red is a low frequency color with a very pleasant musical note F. The irony here is our preconceived notions about colors would make us feel emotionally has a direct relation with how colors can be heard differently. The human brain should be trained to see and experience visual information in a deeper context and as pure as possible.

Chapter 3

Research Methodology + Data Sources

My research was both qualitative and quantitative however the latter takes more precedence over my methodology. I started with my desktop research that involved a lot of reading and understanding the topology of the Earth and gathering Geographical facts. What really goes around under the ground that causes so much movement? Since there is so much information available about Earthquakes over the history but to specifically gather data about Earthquakes that occurred in Pakistan was challenging, except very rare case studies. (http://serra.gov.pk/) I cited images of the event specific at

Muzaffarabad from this Website of State Earthquake Reconstruction & Rehabilitation Agency (SERRA). To further understand the human reaction and how simulations are carried out I read up on various Earthquakes happening elsewhere. Moreover, to capture the human response and highlight what senses play a major role in being activated during Social experiments in psychology. To resolve my subject, I gathered the human response of people; what kind of sounds they hear and what visuals are in front of them in their memory. However to really understand the nature of sound and relating it to such an experience I had to convince myself to take off the hat of seeing this as an emotional simulation of an Earthquake. This however, involved gathering lots of numeric data; the magnitude, depth, frequency of the sound or the color for visualizing seeing color and hearing sound. Since the project intends to convert images to sound, all data required in it was gathered from desktop research; geographical facts about the Earthquake and how Sound and image correspond together https://munsell.com/color-blog/neil-harbisson-hearing-colors/. This research further solved my question where I was able to build a bridge between SOUND to IMAGE correspondence and figuring out an algorithm or code to actually make it happen.

Chapter 4

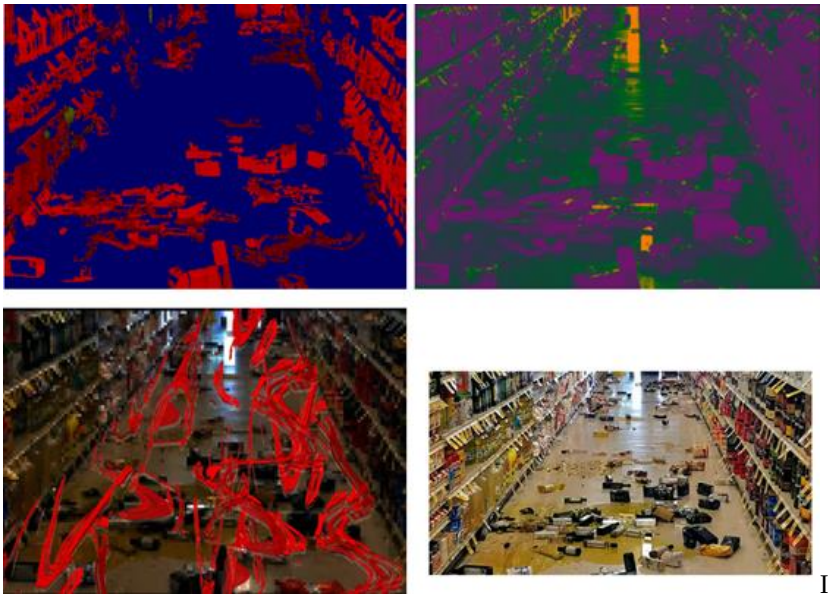
Medium of Presentation

My process is a mixed medium technique of incorporating mathematical algorithms with design. My project explores the nature of writing code that acts as a rendering system and converts images to sound. I started off by creating still images that have movement in them; vibrations, amplitude and depth etc. by manipulating existing images. These visualizations gave the perception of generative art- a non-human system but are controlled by the artist as per desired outcome. As I looked into various tools and techniques,

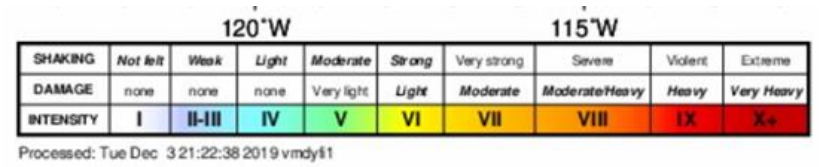
my treatment evolved too. I developed a web application that is user controlled on python. I studied a bunch of libraries that would convert the images into arrays and then heat maps. The image is divided into columns that helps calculate an average of pixels defining the most dominant color taken from the image converted into a heat map in that column. Similarly, a sound library is attached that applies the average color to the corresponding sound. Calculating the spectrum and waveform is being done in real time when sound is being played, similarly the waveform take various forms and sizes defined by pitches; low and high. The second aspect of my visualization is sound; I used Ableton as the software to record various frequency data according to the colors with their musical notes and export them as mp3 files, which were then incorporated into the code to link image with sound. While I was recording these sounds, I was more aware of the pre conceived notions about colors and sounds in our minds, for example; as constituted by Neil harbissons theory, an eggplant is violet and has a very aggressive sound however a red traffic light should have been violent but it sounds rather soft and innocent as it's a low frequency sound. So the objective is more highlighted as I broaden the perspective of listening to color by running it through an algorithm.

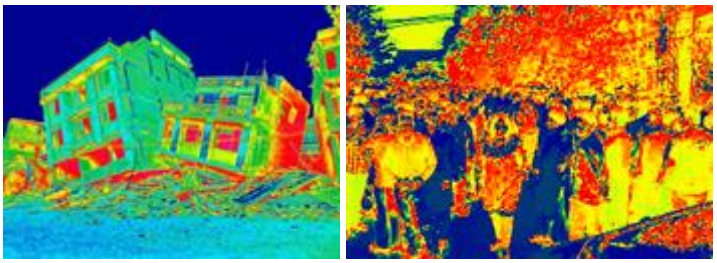
Pre-Production

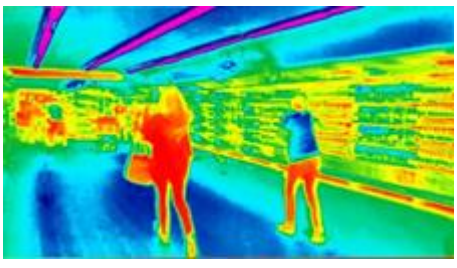
Initially a common recurring theme in my visuals was detecting movement through colored lines or pixels In Earthquake images. I was treating these images in adobe Photoshop. The idea of a line defined the way I was looking at sound, as it can be measured through a sine wave; zigzag, straight, curvy, square and wavy.



I incorporated the theory of heat map colors and their corresponding values as sound frequencies. In these images, all these colors expose the low and high frequency noise being released.

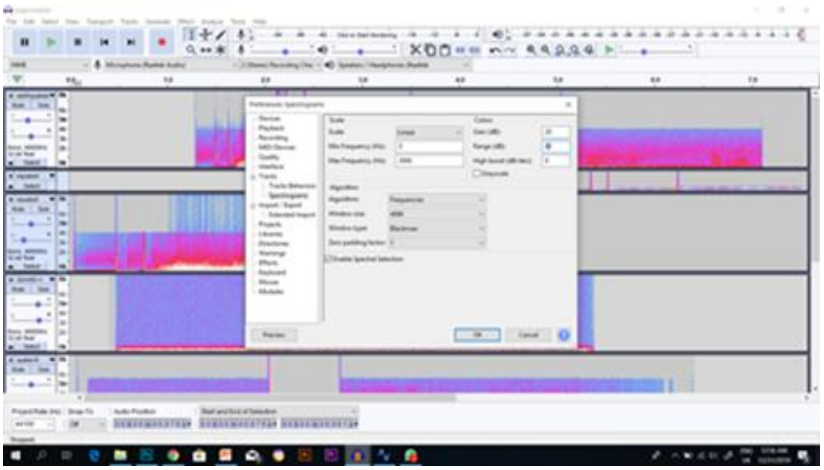






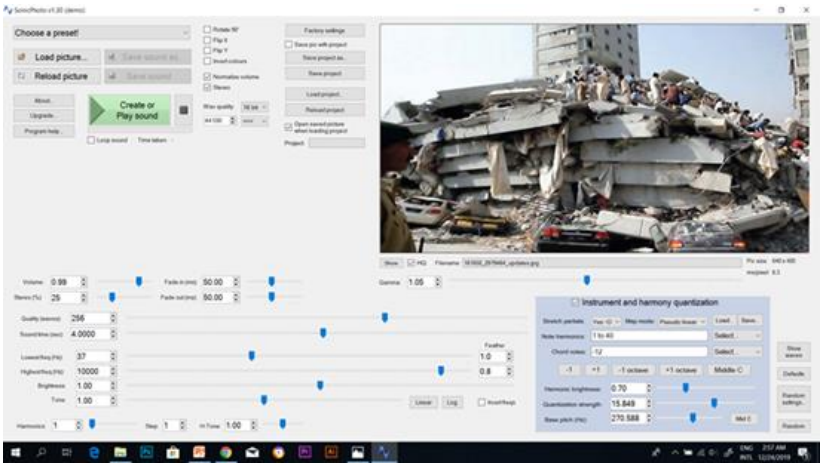
This opened my thought process and I started using code to make my design interactive. It was challenging to understand how colored data could be

translated through code for which I took help from various YouTube tutorials to begin. Processing (JavaScript) allowed me to set prototypes of what kind of visuals I would be producing. However, when I initially began the process, it was immensely different as the medium was yet to be decided but later after exploring tools and various techniques I was able to set it with generative art. The second stage is sound development; from collecting existing sounds of earthquakes and making my own by layering them in the software called Audacity by adjusting frequency, amplitude and pitch, a new sound can be generated.



Software: Audacity

Sounds included, Buildings collapsing, wind blowing, artillery sounds, a train passing by, thunder etc. all of these sounds as per accounts of people were associated with an earthquake approaching. Various applications including; sonicphoto brought me to a conclusion where I thought of defining my own musical scale. However, as a result, I chose to work with java script as my medium of production to translate images into real time sound.

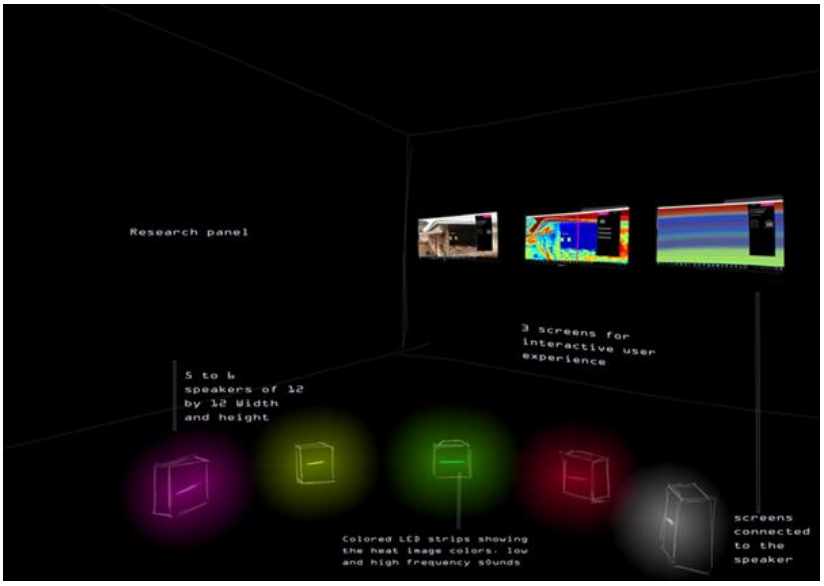


SonicPhoto

Chapter 5

Production

Initially my idea began from creating a simulation and experience for the viewer to be able to see sound and hear color present in a space but due to limitations today given the current circumstance I evolved my idea into an interactive interface as a web application. The following image shows how I imagine the rendering system called Chromesthesia to be displayed.

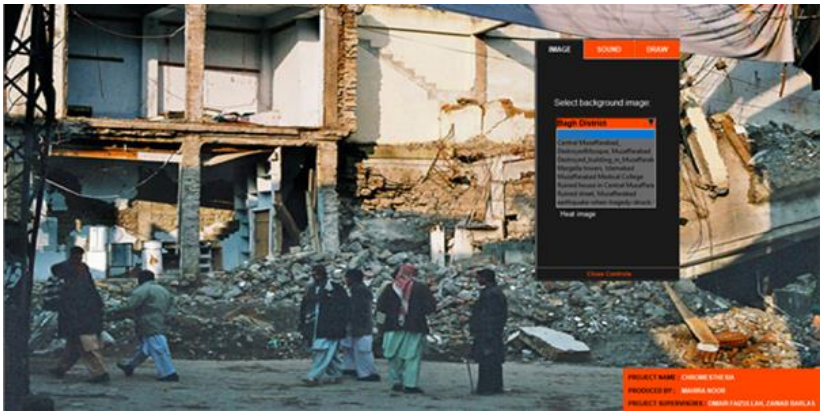


The speakers consist of a circuit that reads sound data as low frequency and

high frequency sounds in RGB mode. I incorporated the heat image colors and replaced each speaker with the corresponding colored LED strip from the spectrum.

Interface:

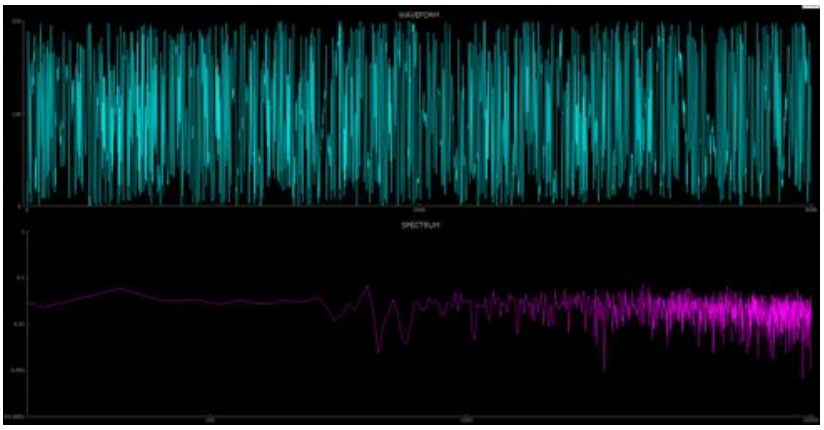
(Image)



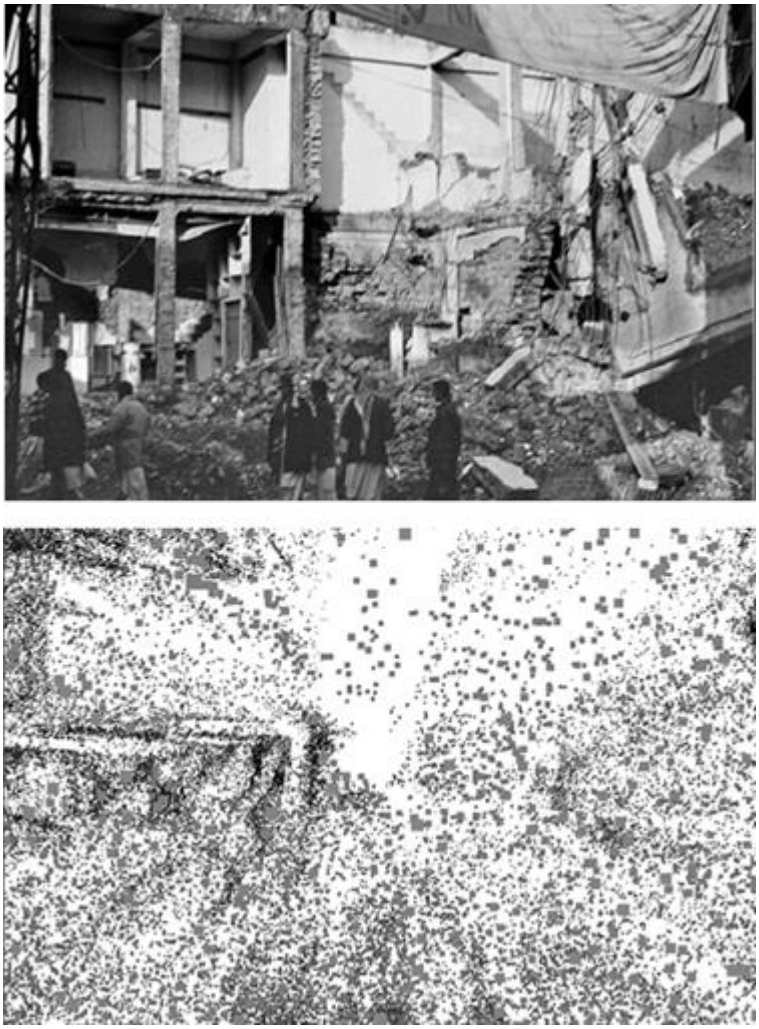
(Sound)

(Draw)

(Spectrum and waveform)



(2D to 3D image pixel explosion)



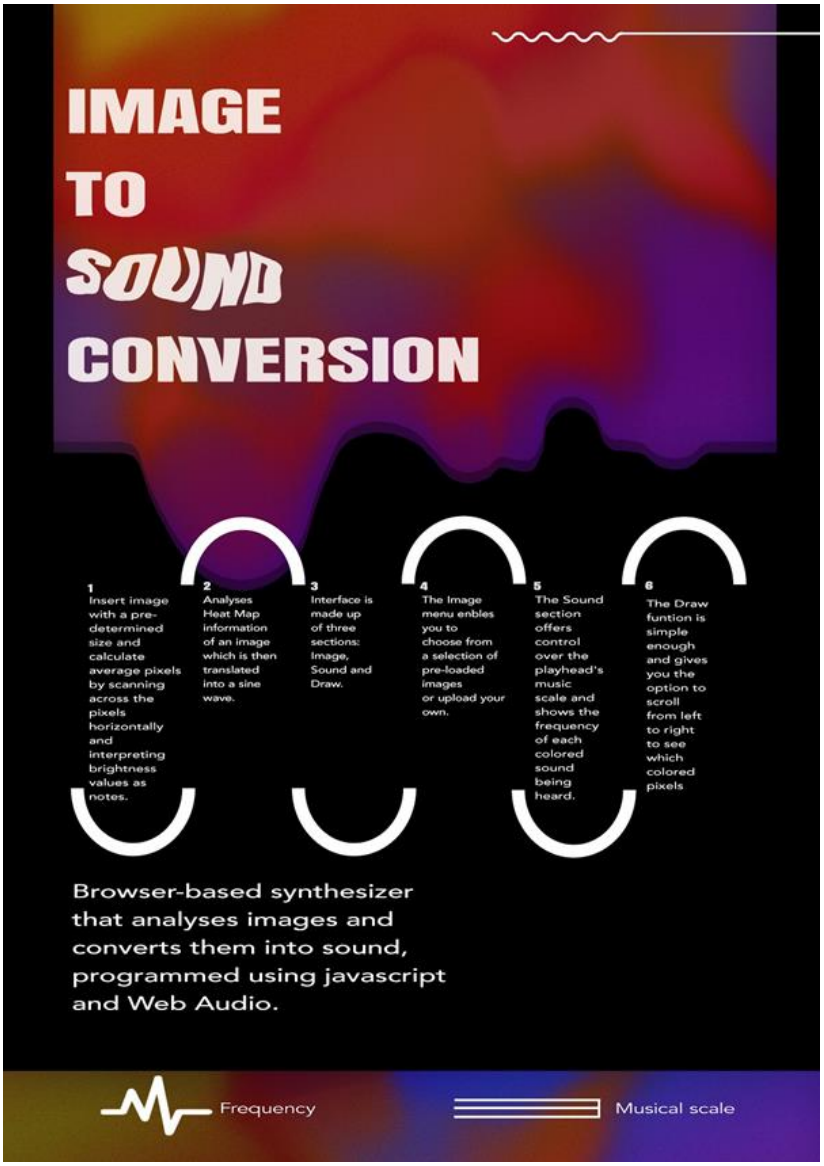
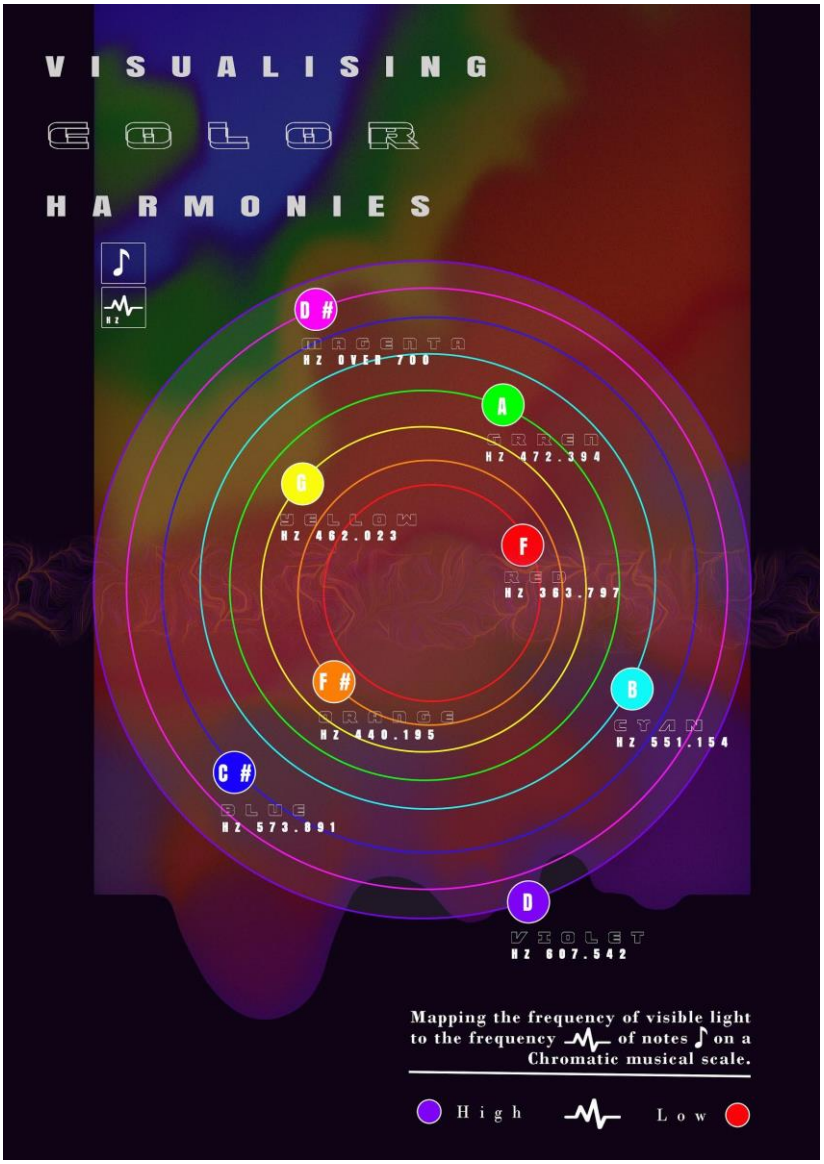


IMAGE
TO
SOUND
CONVERSION
1
Insert image with a pre-determined size and calculate average pixels by scanning across the pixels horizontally and interpreting brightness values as notes.
2
Analyses Heat Map information of an image which is then translated into a sine wave.
3
Interface is made up of three sections: Image, Sound and Draw.
4
The Image menu enbles you to choose from a selection of pre-loaded images or upload your own.
5
The Sound section offers control over the playhead's music scale and shows the frequency of each colored sound being heard.
6
The Draw funtion is simple enough and gives you the option to scroll from left to right to see which colored pixels
Browser-based synthesizer that analyses images and converts them into sound, programmed using javascript and Web Audio.
Frequency
Musical scale



Chapter 6

Conclusion

Language is constantly evolving everyday but to give Earthquakes the language of sound is why my project is unique. Sound can be heard almost everywhere around us but can we see sound and hear color consciously? Every day our planet is shaking and moving, I thought it would be amazing to translate the massive movements of the planet in a different language hence the interface allows the creation of new perceptions of reality and hearing color as pure as possible. Initially when I started hearing colors, all I

could feel was my head hurting because of the electrical sounds but later, I got used to it and acquired my favorite color too; Green being the neutral one and violet being the high pitched sound that keeps me in an alert state. In retrospect, a major aspect of what I learnt from the project is that we associate colors with certain sounds and events but sound always behaves in conjunction with how the image is when it is run through an algorithm. However, for you as a listener, I urge you to view this data as merely sound frequencies rather than an emotional experience of the Earthquake.

What do I know that no one else knows? To reach this point I would thank my thesis advisors and myself for believing in me.

BIBLIOGRAPHY

1. Harbisson, N. Rearranging the Senses of Color Sight and Sound, from https://munsell.com/color-blog/neil-harbisson-hearing-colors/

2. Raz, G. Ted Radio hour < What's It like to Hear Color?, (2014)

3. Harbisson, N. Sound portraits by neil harbisson, from https://www.youtube.com/watch?v=JDqL-PUZ148&feature=youtu.be, (2014)

4. French, H. Victor Vasarely, from https://www.artsy.net/artist/victor-vasarely

5. McGee, R. and Dickinson, J. VOICE OF SISYPHUS: AN IMAGE SONIFICATION MULTIMEDIA INSTALLATION, from http://lifeorange.com/writing/McGee_ICAD_2012.pdf, (2012)

6. Display, S. A. Seismic sounds, from https://soundcloud.com/seismicsounds

7. Scale music, from https://en.wikipedia.org/wiki/Scale_(music)

8. Gaia, J. Diamond - Audio Visualisation [Processing] (Live Rendering), from https://www.youtube.com/watch?v=vfZnQHDBNSw, (2019)

9. Brice, A. Transcript: Here's what an earthquake sounds like, from https://news.berkeley.edu/2018/01/12/transcript-berkeley-seismologists-capture-earthquakes-rumble/, (2018)

10. Fry, B. and Reas, C. Video Tutorials Links to videos that cover the Processing basics, from https://processing.org/tutorials/

11. Fry, B. Computational information design, Communication Design, 1997

12.SPECTROGRAM,fromhttps://musiclab.chromeexperiments.com/Spectrogram/

13.The devastating impact of Natural dIsasters, from https://www.childfund.org/Content/NewsDetail/2147489272/, (2013)

14. Ahmad, Z. A. Timeline of major Earthquakes in Pakistan, from https://www.dawn.com/news/1215521, (2018)

15. Acoustics of speech and hearing, UCL psychology and sciences, from https://www.phon.ucl.ac.uk/courses/spsci/acoustics/week1-10.pdf, 110920/9

16. Jhobson, C. Vertigo inducing rooms illusions by peter kogler, from https://www.thisiscolossal.com/2016/12/vertigo-inducing-room-illusions-by-peter-kogler/, 2016