Berklee College of Music

Creating a Chromesthetic World: Auditory Painting with Light

Submitted in Partial Fulfilment of the Degree of
Master of Music in Music Production, Technology and Innovation

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Abstract

The aim of this project is to create an interactive space in which the audience can partake in an artistic experience, as well as immerse themselves in the creative process of composing music. This project is important in creating a link between multiple artistic realms, with the goal being to have an installation that can function as both an interactive drawing experience, and for participants to further understand the link between musical keys signatures and their effect on colour interpretations. The scope of the project includes the creation of a circuit that contains a collection of sensors that can be programmed with a range of keys signatures that can correlate with different colours in the colour wheel, thereby delivering an interactive sound art installation. Using light-dependent resistors (LDR's) set up in a circuit with an Arduino Leonardo, light is detected and sent to Max/MSP; allowing both music and colour to be produced when drawing within the air, directed at the camera. Undertaking this project, has also created a learning curve in how to provide an interactive experience whilst also maintaining social distancing. The aim is that this will be beneficial to installations that may take place in the future.

Keywords: Sound installation, light, interactive, sensor technology, artwork

Acknowledgements

I'd like to thank Marta Verde for all her wisdom, knowledge, and support throughout both this program, and the completion of this project. Your patience throughout this process has allowed me to thrive.

I'd also like to thank my family for the sacrifices they have made so that I could have this experience, and grow as both an academic, and a person.

Introduction

1.1 Background Information

The purpose of this project is to try to create a deeper connection between the visual stimulant of art, and the aural satisfaction of music making. Upon my musical journey, I have become fascinated with the visual interpretations that music can provide. This has stemmed from my longstanding enjoyment of actively viewing musical events such as concerts, musicals and dance.

Whilst on this journey, I came to learn about the condition known as Synaesthesia; a perceptual condition which means that a sensory pathway triggers an involuntary secondary sensory pathway.[1] I became aware of it when I discovered that many people within the music industry that I met had Chromesthesia, (or "sound-to-colour" Synaesthesia).[2] This means that whenever music is played, those with Chromesthesia have an involuntary reaction that makes them experience colour associations.

Although I do not personally experience Chromesthesia, I have become increasingly interested in how colour and music intertwine, and how this involuntary experience could be brought to life for those who do not perceive it.

1. "Synesthesia", Wikipedia.org. Wikimedia Foundation. Accessed July 1st 2021. https://en.wikipedia.org/wiki/Synesthesia

2. "Chromesthesia", Wikipedia.org. Wikimedia Foundation. Accessed July 1st 2021. https://en.wikipedia.org/wiki/Chromesthesia

1.2 Project Aim and Purpose

The aim of this project is to bring to life this experience, and to further understand what the similar principles that underpin both art and music consist of. For example, both music and art have a spectrum of correlation; this means that both mediums have a scale in which they are measured. For music, this could be the cycle of fifths, a system that breaks notation into chords and notes that are harmonic and dissonant, as shown in Figure 1. For art, this is the colour wheel, which breaks down colours into different groups that complement each other, and those that clash, as shown in Figure 2. It is with these two principles that I will begin to build my own scale; one that takes the information from the colour wheel and includes it in the cycle of fifths. Both colours and notation will clash and complement each other in unison.

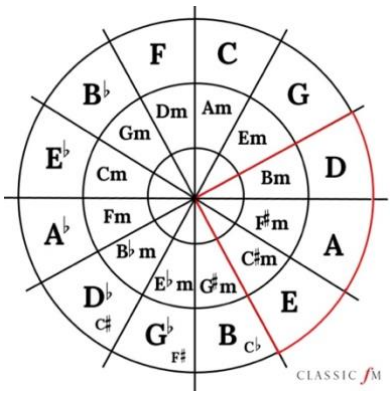

Figure 1 What is the circle of fifths? Acessed June 24th 2021.

https://www.classicfm.com/discover-music/music-theory/what-is-the-circle-of-fifths/#:~:text=What%20does%20it%20show%3F,shows%20a%20map%20of%20keys.&text=As%20you%20go%20round%20the,has%20a%20whopping%20seven%20sharps.

Figure 2. The Martian Colour Wheel, Accessed 24th June 2021.
http://warrenmars.com/visual_art/theory/colour_wheel/colour_wheel.htm

The purpose of this project is to create more cohesion between the two mediums. If this is achieved, the technology could be used for more mainstream purposes, such as for children's entertainment (through creating their own musical and artistic pieces) and cerebral development (through the interactivity of colour and sound). However, the project is also a vessel for discovery, my personal intention is for it to become an immersive and therapeutic experience.

With the inclusion of light, this also creates another interesting overlap as both light and sound are measured in frequency, giving us another area of exploration with audible range vs visual range. As well as this, light can be linked directly to colour, as we see colours through light reflecting over surfaces. This shows the innovative and immersive experience that this installation can be.

Review of the State of the Art

This project has been influenced by a number of sound installations. One of these installations is LINES created by Swedish composer Anders Lind for the Västerbotten

Museum in 2016.[3] This installation saw multi-coloured lines being placed around the room, with each different colour having a separate electronic sound associated with it.

Another installation that has influenced my project is that of Lenses, created by creative agency Hush, based in New York.[4] This installation has the same interactive qualities of LINES, with the bending lenses changing the colours and reflections of the objects on display whilst simultaneously triggering a variety of pre-determined sounds.

'BEYOND' is another sound installation that has monitored the relationship between sound and art.[5] This installation used lights and space through the means of a tunnel and strobe lights, to create an immersive display that puts those involved into a state of unease; with changes in depth perception and the scale of the space. Not only does this installation do this through the changing of light, but this is also mimicked through the music to enhance the experience.

An artist whose ideas align with this project is that of Thomas Evans, a multi-disciplinary artist from the US.[6] Evans is known to create art that incorporates other mediums; a perfect example of this is from his YouTube channel. The video entitled "Interactive painting and sound installation demo in my art studio" is exactly that. An extremely visual and animated studio can be seen, with every different colour and picture having a unique sound attached to it which is triggered by a sensor. As well as having a different sound for each colour section,

3. Anders Lind, "LINES – Interactive Sound Art Exhibition." Cycling74.com. Ableton. Accessed July 1st 2021. https://cycling74.com/projects/lines-interactive-sound-art-exhibition/

4. HUSH, "Lenses", heyhush.com. Accessed July 1st 2021. https://heyhush.com/work/hush-lenses-interactive-art-installation/

5. Playmodes Studio, "Beyond", posted by Playmodes Studio, January 24th 2018, YouTube video, 4.38, https://www.youtube.com/watch?v=e6paLMaZGpk&t=2s

6. Thomas Evans, "Interactive painting and sound installation demo in my art studio", posted by I am Detour, March 19th 2018, YouTube video, 0:59. https://www.youtube.com/watch?v=_zZZCVoQGYY

each painting is triggered by a diverse range of sensors – i.e., brushing strings, heat and pressure. Although not entirely the same concept, it does possess a number of similarities such as colour being associated with specific sounds, and the use of touch sensors to trigger this.

All of these installations have similar properties to my own; including the relationship between colour and sound, as well as producing an interactive experience. However, this project will look more closely at how the relationship between the music and sound function together, rather than just how we can make the two modalities signal to each other. This is an innovative way of understanding how different areas of art are very similar.[7]

Description

My project is to create a multimedia installation that allows the audience to draw with their phone torches, to create art. Each colour they select will be met by a different musical motif that has been hand-picked to match the colour they are using. The keys and colours have been chosen using both the colour wheel and circle of fifths; overlapping them to create an array of sensors with each new selection.

7. Oskar Lindskog, "10 Sound Installations that Inspire and Create Connection", Medium.com. A Medium Corporation. Accessed July 1st 2021. https://medium.com/@oskarlindskog/10-sound-installations-that-inspire-and-create-connection-73eabd5ce075

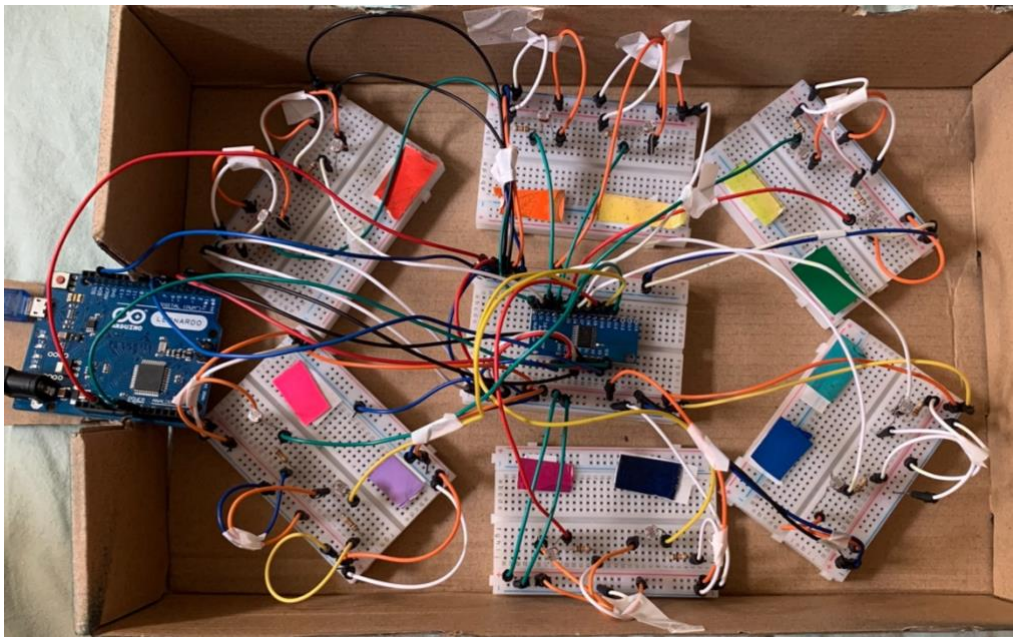

Figure 3. The sensors arranged and used for the installation

An installation setting was chosen, rather than just using the technology for personal use, so that others could share in the experience. The concept itself has changed dramatically from its inception, with the original idea being to create a handheld MIDI controller that would be used as a real paint brush onto a canvas, with the controller reacting to whichever paint pot it came into contact with. However, as a result of the ongoing pandemic, changes were made so that it was suitable for a contactless society. To achieve this, objects that would not require constant cleaning were needed, leading me to use phone torches; an object that most people carry with them 24/7. The advantage of this is that all participants had quick and easy access to their phones which meant they were easily able to participate. Although, the downside of this is that phone torches have a wider light spread, meaning that the drawings were slightly less accurate than those which the original participants had drawn.

To create the technology, an Arduino, LDR sensors and an analog multiplexer were used. The LDR's are used to detect the light coming in from a torch or other light source and is displayed on the Arduino serial monitor; there resistance changes with the amount of light they receive from the incoming values. 12 sensors were soldered, one for each key of the cycle of fifths. Due to the vast number of sensors, the multiplexer was required, as a regular Arduino does not have enough analog inputs to receive the data, however with this came other issues. Using the multiplexer meant that there were more inputs to deal with which made it extremely easy to connect certain parts in the wrong way, without realising this as the space between pins is very small. However, this was resolved by using breadboards, with a cardboard lid covering each LDR so that the light didn't stimulate to multiple sensors all at once. The disadvantage of using cardboard coverings is that they were not 100% accurate, but they did greatly reduce the amount of light pollution from the sides.

The code from the Arduino, which displayed the values coming from the LDR's, was sent to Max/MSP using the protocol of Serial Communication. Using Max/MSP, a program was built to receive the sensor data and use it to perform different actions. This can be seen in the images below (Figure 4, Figure 5, Figure 6, Figure 7). The sensors connect to Figure 4 (also seen in full in Figure 5), sending the values from those sensors to the main patch (Figure 6 and 7). Within the main patch, the sensor values are received, triggering both a colour change and a musical motif change. The camera feed can be opened, and this tracks the image, follows the light, and draws the colour and music that were triggered when the sensors connected with the light. A sketchy brush stroke (Figure 8) was chosen so that there was a more authentic connection to art, in keeping with the original concept.

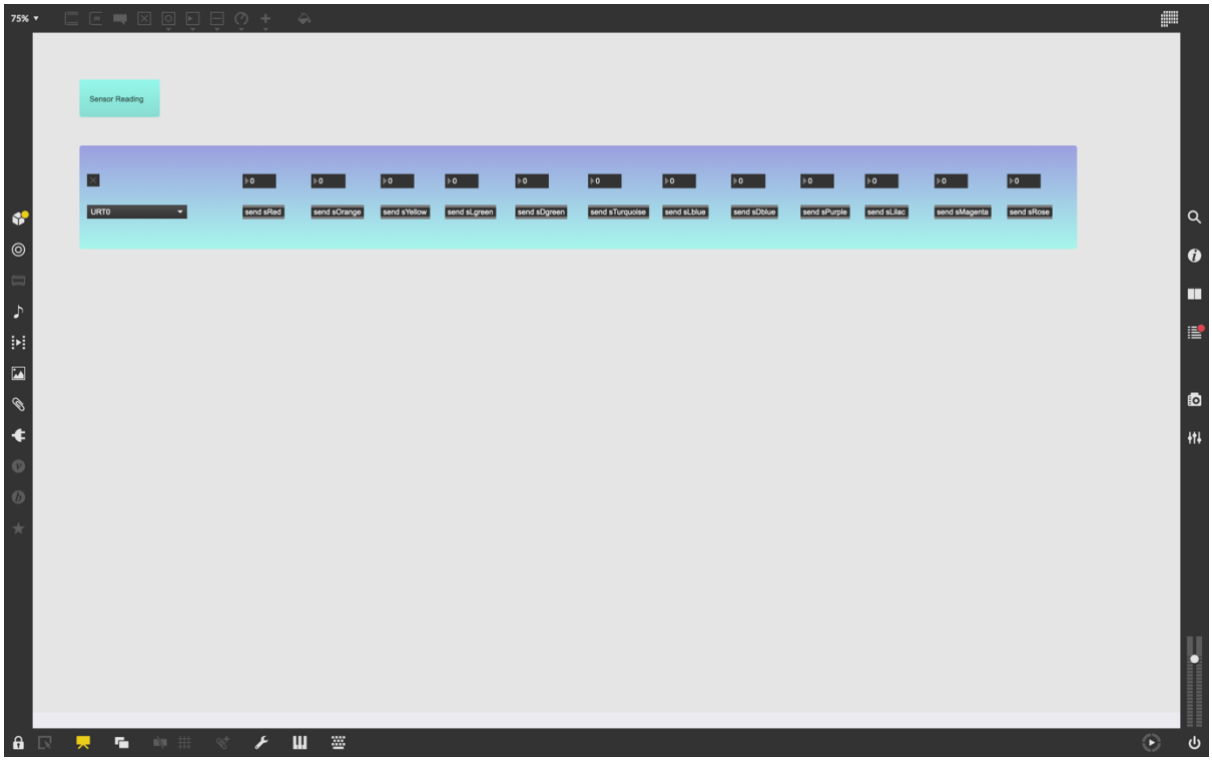

Figure 4

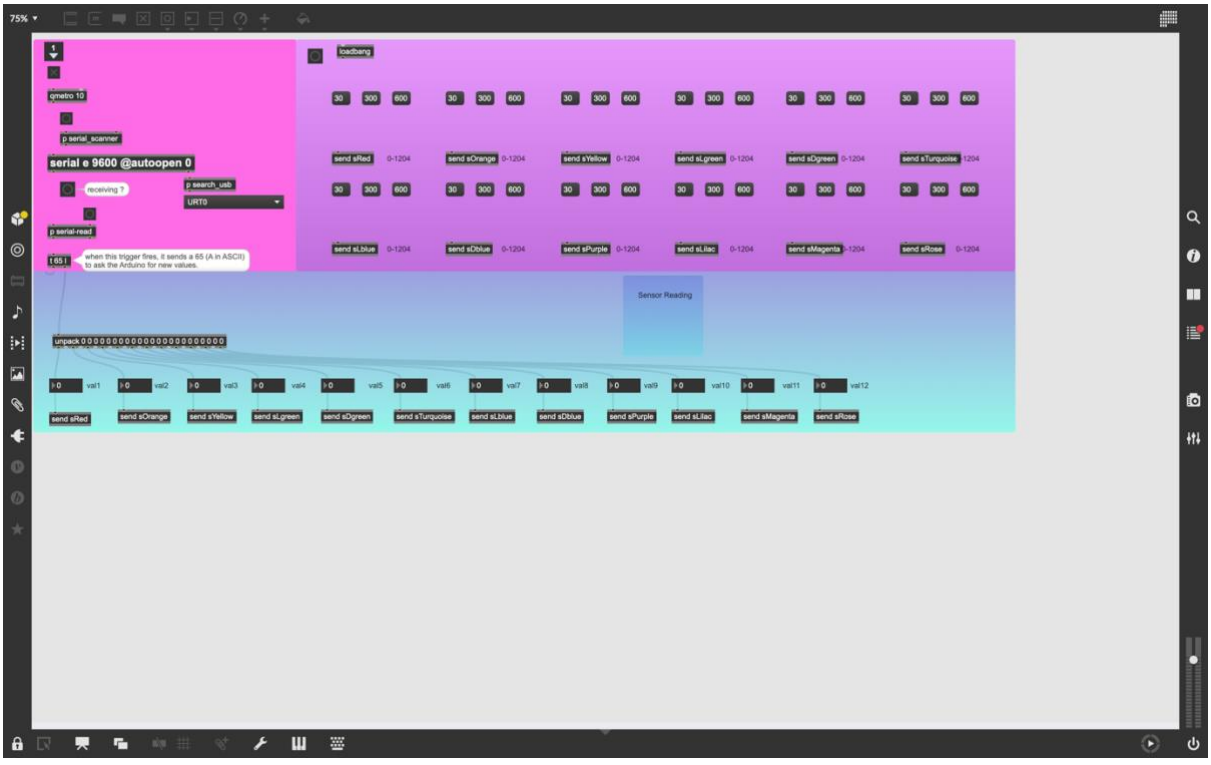

Figure 5

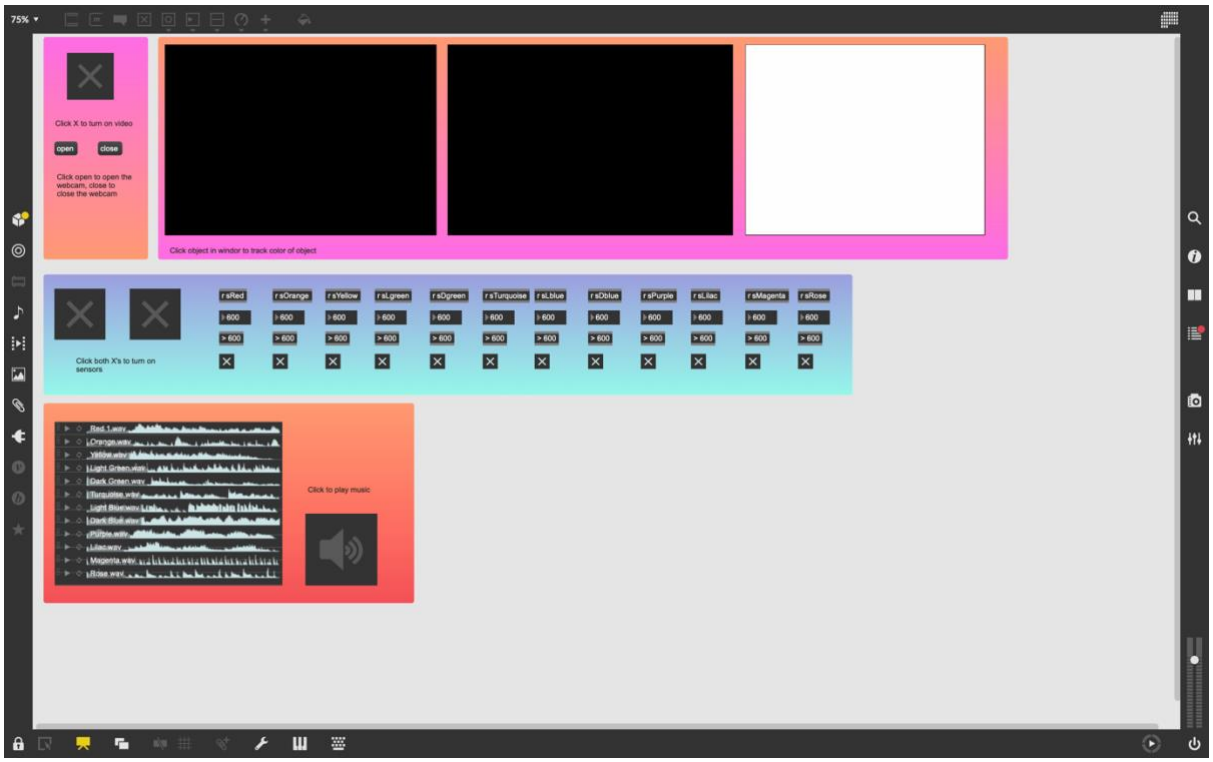

Figure 6

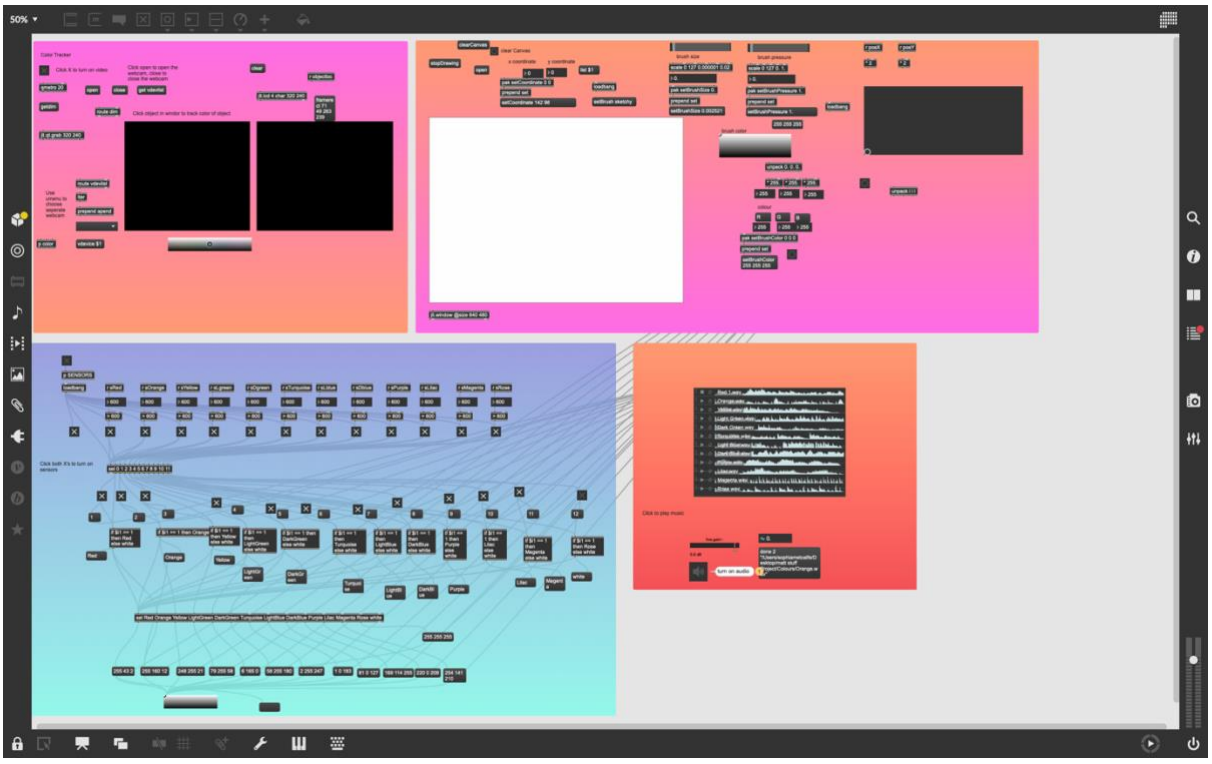

Figure 7

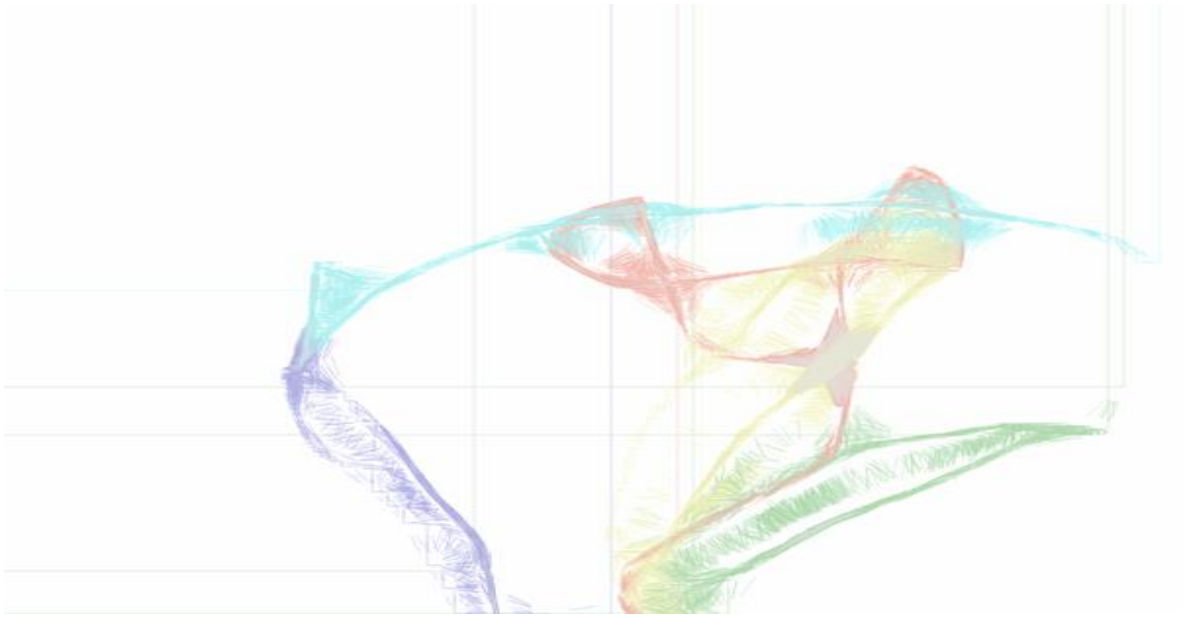

Figure 8

After this, the recorded music was sent directly into Ableton and edited within this software, using both original content and samples found on Splice. The original plan was to send the values directly from the sensors to Ableton to modify the audio parameters (i.e., reverb and delay) in real time, however this overcomplicated the sound, so only the recorded tracks were used. The songs themselves were inspired from the colour selection, as I started by listening through samples in the different keys, and then analysing whether the instruments matched the colour for me. After this, I recorded some extra instrumentation and converted it to MIDI so that I could easily add different layers of instruments to each motif. Each sound has been selected from my own perspective, which has worked well now that the project is on a smaller scale.

Innovative Aspects

This project is innovative for a number of reasons, mainly due to its adaptable nature. The Max/MSP patch can be shared with others so that they are able to create their own variation of this experience with the tools they have. Additionally, this technology can be used more widely in studios to analyse the connections between colour and sound, enabling it's used for marketing, branding, album artwork and even song writing – in order to better target specific audiences.

Not only can this technology be used in an artistic setting, but it has real capabilities in human development, which is another one of its innovative factors.[8] Studies have shown that the admixture of colour and sound in young children has a huge effect on cerebral development, which enables the developing mind to better navigate its way through new sensations, associations, memories etc. This technology could be implemented into children's toys or even as a children's installation to capture data.

Conceptually, this project is innovative as it is taking a unique condition and allowing others to see it through an academic scope. The colours and keys have been assigned to each other through combining two academic measures of each medium, and although this does not mean that everyone with the condition will associate these keys and colours together, it does allow us to get some sort of cohesion between the two; getting a sense of how this condition may feel.

8. Adrienne L. Tierney, "Brain Development and the Role of Experience in the Early Years." *Zero Three*, vol.30,2, (2009): 9-13, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3722610/

New Skills

Over the course of the last nine months, many skills have been developed, particularly those relating to programming and coding. Firstly, skills involving Max have been developed as it is the basis of the project. Some of the skills that have come out of this include, creating patches that can trigger different elements, such as audio, MIDI, and even visuals. This has undoubtedly aided the success of the project, as well as developing transferable skills to further my career. My future career will benefit from this as I can now start to create synthesisers and MIDI controllers for my own musical work, and utilise the visual effects for live events in both future installations and personal performances.

As well as software, skills relating to hardware have been improved, after many hours of soldering to create working circuits containing resistors, multiplexers, LDR sensors and other elements using an Arduino. This has not only formed the outline of the project, but having these skills will allow the creation of the original handheld MIDI controller – which can be used for musical performances and song-writing.

Challenges, both expected and unanticipated

Many challenges have been faced whilst completing this project, some were expected but some were not. Those which were expected related mostly to the creation of the technology. I had already anticipated this as prior to coming to Berklee, I had had no formal education in the world of technology. Having to develop everything from scratch was extremely challenging for me but I did find ways to increase my understanding. Whilst adapting the project, there were a lot of issues when constructing the sensors. Beginning by

learning how to connect the sensors using resistors, LDR's and breadboards that are able to receive data from the sensors to send to Max/MSP. The actual structure of this wasn't too difficult to understand, and after a few errors the sensors could measure light impinging on them and create values. However, when trying to develop them further, moving them to prototype boards instead of breadboards, it was a struggle to get them to work alongside the Max patch. This was due to the very small and detailed nature of soldering onto a prototype board. Not only was this soldering a more difficult task, but the use of a multiplexer with the prototype board also meant that there were an extra 20 holes to solder without the wires overlapping. Instead of wasting time trying to get the soldering correct, breadboards were used instead so that the project would still function as a working prototype. Although this looks less aesthetically pleasing, it was the right choice as it meant there was more time to focus on other challenging aspects of the project.

Not only did the use of the sensors cause problems, but the interactions between Max/MSP and Arduino were extremely demanding on the computer. There were many problems with lagging and often when the Max patch was opened it would freeze and be unable to edit. Usually Max projects, they can be coded to automatically start themselves, however it was not possible to do this. Instead, it was manually opened once the sensors were working. Although this meant that there was more set up time within the installation, I was able to edit any problems that occurred beforehand so that it would run more smoothly.

Although there were many challenges that were expected, there were some that weren't, with the main one being a lack of inspiration in terms of the music. After having experienced problems with the technological aspects of the project, this left insufficient time for the musical motifs until later in the project timeline. Too much time was spent trying to

figure out which instruments and genres to use, but many of the time these did not feel right for the project. Due to the nature of the project, it was difficult to authentically capture the right sound on my own, but to counter this, the sample library, ‘Splice’, wsd used to aid inspiration.

Future Ramifications

In order to further develop this project, surveys were taken from those who participated in the installation to understand their thoughts on how the music and colour interacted, and how this differed for them. This information will be taken, and used to recreate this installation on a larger scale, by inputting the data that the participants have given to us make this experience more accurate and unique. Pairing this with a better range of motifs with differing instruments and a variety of keys will aid the project and refine people’s association of colours with sound. As well as this, the more data received, the greater the likelihood that the experience can be personalised for different individuals; making this installation both an interactive and self-perspective experience.

This data can be used to further develop branding and marketing, for both myself and for others within the music industry. Understanding how colour creates associations with the music we listen to can have a profound effect on our target audience, and hopefully can be implemented when tackling merchandise and album artwork.

Finally, to further develop the project and utilise the technology to its full capability, this technology can be used for live events; using light to trigger different effects or musical motifs whilst performing. This would be a matter of connecting the Arduino to Ableton, or

switching out my current musical motifs for ones that I could use in my live acts. This concept would enhance my performance further by adding a layer of visual appeal.

Conclusion

To conclude, I believe that this project has major applications for future development. It is significant in understanding how we form associations through our senses, and can be applied to many areas within the music industry. There have already been great strides in the field of installations, particularly surrounding Chromesthesia – as visual entertainment is becoming more and more accessible in music. This technology and the research that it has created, can provide future installations with inspiration, as well as a starting point to further develop performances and interactive entertainment.

Appendix

Below is the proposed timeline for the beginning of this project (Table 1), at the end of the project (Table 2) as well as an updated budget and resources list (Table 3).

Table 1 – Projected Timeline (December 2020)

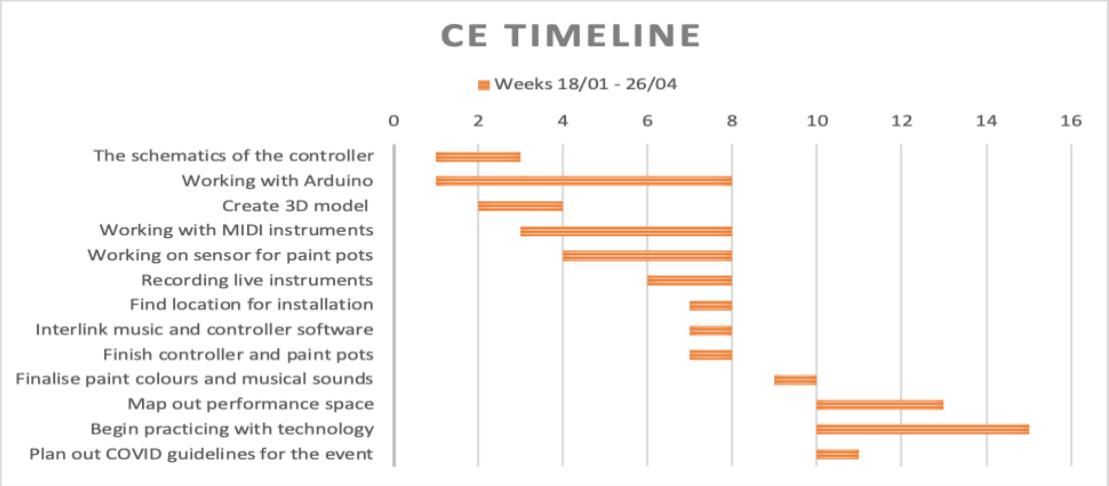

Table 2 – Timeline by the end of the project

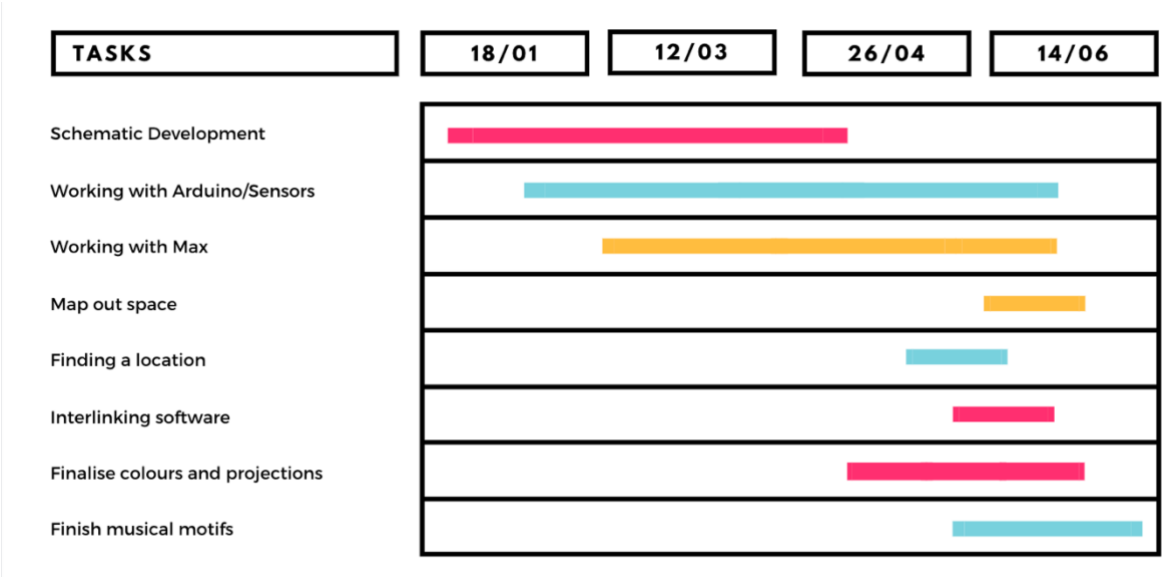

TABLE 3		
ITEM	**PROPOSED**	**REAL**
MATERIALS (disposables)		
HARD DRIVES	$300	$180
SPRAY PAINT	$20	$20
PLASTIC COVERING	$5	$5
EQUIPMENT		
HARDWARE		
MICS (Rental) 6 days	$200	$0
COMPUTER (purchase) 120 days	$2,500	$0
CAMERA (rental) 10 days	$200	$0
3D PRINTING	$100	$0
ARDUINO	$30	$30
CONTROLLER EQUIPMENT	$100	$0
SOFTWARE		
ABLETON (purchase) 120 days	$118	$0
Pro Tools (120 days)	$150	$0
MAX MSP (purchase) 120 days	$60	$0
PERSONNEL		
CAMERAMEN	$150	$0
HELP AT THE VENUE	$50	$0
BERKLEE daily x 6 of days	$0	$0
CATERING		
REFRESHMENTS	$50	$0
OVERHEAD		
SPACE	$500	$0
TOTALS	$4633	$205

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