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Master's Thesis
Academic Year 2020

Melodia: An Alternative User-Friendly Solution
of Melody Composition Inspired by Colour and
Music Synaesthesia



Keio University
Graduate School of Media Design

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A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
Master of Media Design

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Abstract of Master's Thesis of Academic Year 2020

Melodia: An Alternative User-Friendly Solution of Melody Composition Inspired by Colour and Music Synaesthesia

Category: Design

Summary

With the wider application of technology nowadays, music composition is becoming more accessible. Whoever has a computer can use various software to obtain or create their own music. But for those without much knowledge of music, it is difficult for them to actually create their own music by themselves.

In order to raise more people's interest of music composition in a stress-free way and emphasizing the process of creating, transforming the creating part from actual music composition to some other process can be one possible solution. Also, instead of the general concept of music, the outcome has been narrowed down to only the melody, which plays a significant role in music.

In this research, we focus on transforming the melody composition to art creation, designing a device or a system that is inspired by the "Music and Colour Synaesthesia". Both tangible and digital prototypes were produced.

The goal for the design is to help music amateurs to better experience music creating in a more sensual and stress-free way, also provide a similar experience of "Colour and Music Synaesthesia". The design was validated through qualitative testing and might be further developed for music educational use.

Keywords:

melody composition, art creation, connection of colour and music, design for leisure time, music education

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Yiyuan Gao

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Chapter 1

Introduction

In these days, thanks to the Internet, learning a brand new skill is no longer a very time-consuming activity. From the news, we can read about an eight-year-old boy self-taught himself to drive a car via only YouTube videos and even succeed in driving himself and his sibling to their destination, a McDonald's located 2.5 miles away [1]. Also, machine is capable of more and more various jobs, driving, cleaning, cooking, etc. We are actually obtaining more time for ourselves, to focus on our hobbies, relationships, and our spiritual pursuits.

And art plays a very important part in most people's private time, people read books, watch movies, listen to music and do many other things to not just entertain themselves but also finding themselves new inspirations, thinking, or just peace in their mind. In many different forms of artwork, music is one of the most accessible forms, since people can listen to music whenever and wherever they want in nowadays. It is for sure that appreciating others music can be inspiring and relaxing, but what if we can find the same benefits in the process of creating our own music?

As mentioned above, learning a new specific skill is taking less time, but for music beginners or people without adequate music knowledge, it might still be a quite challenging task for them to create their own music from zero. The process of using musical instrument or software to create music is likely to be a bit stressing instead of as enjoyable as just simply listening to others' music. In the large demand of copyright-free music led by the booming of Youtubers, there are already many music generating tools on the internet, but most of them restrict user's creativity. They are very convenient to use, but users feel lacking of the sense of possession for those generated works because of the lacking of participation. Although they will not cause stress or other negative feelings, they will not be able to provide positive feelings like relaxation, sense of accomplishment

and enlightened as well. Is there any tools can help and encourage people try to compose their own music in a more interactive and stress-free way? Inspired by the “Music and Colour Synaesthesia”, this research aims to finding a solution for this problem by transforming the process of melody composing to colour-base artwork creation.

1.1. Art and Music

Art and music have no doubt play very important roles in human history and, of course, our leisure time.

Evidence from a huge analysis of rock art and cave paintings and engravings shows that, from their origins, humans have also been *Homo aestheticus* [2]. Humans are born with the sense of art. We are able to create art and also appreciate art.

Art might not be quite accessible during our time of working or studying, but when it comes to our leisure time, it is in our nature that, we are very likely to look into something more or less art-related.

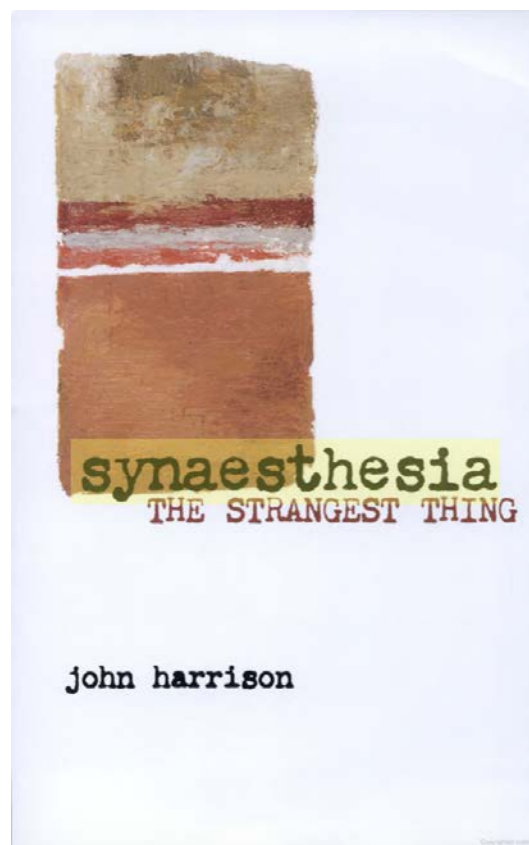
As one of many forms of art, music is a poorly understood ability. Its strong power over humans, its origin and cognitive function, have been a mystery for a long time [3]. We might not be able to figure out where exactly did music came from, but the power it can have on humans is indubitable.

Music is also necessary in many other forms of art, plays, movies, games, etc. We have to admit our leisure time is somehow closely related to music, no matter we like or not. Music adds more colours to our life and is able to empower other artworks and even empower us.

There are therapies using music to help patients maintain a healthier mental status, there are methods using music to help people better memorise some information, there are restaurants using music to help people enjoy their food subtly. . . Music is of much use, and we do need music in many ways.

1.2. Synaesthesia

Synaesthesia is an extraordinary phenomenon earlier known as “coloured hearing”. While the word “Synaesthesia” is a blend of the Greek words for ‘sensation’ (*aisthesis*) and ‘together’ or ‘union’ (*syn*), implying the experience of two or more sensations occurring together [4]. In John Harrison’s book *Synaesthesia: The Strangest* (Figure 1.1), many other types of synaesthesia were also discussed.



(Source: *Synaesthesia: The Strangest Thing* [4])

Figure 1.1 The book cover of *Synaesthesia: The Strangest Thing*

Although earlier researches about synaesthesia mainly focus on visual sensation caused by auditory stimulation, the phenomenon of synaesthesia actually exists among many other sensations as well. Music and Colour Synaesthesia, as one of the most typical synaesthesia, has deep effects on many artists since early 20th

century, many artists claim to be affected by synesthesia and incorporate their affliction into their art creation. No matter if the process is colour to music or music to colour, colour and music synaesthesia certainly facilitated a series of fascinating music and art creations.

1.3. Research Purpose

The main purpose of this research is to encourage people to have a try in music-composition in a synaesthesia-like way by combining colour-base art creation and melody composition. Although, as mentioned above, learning about music theory and music composition from zero would not cost as such a long time as it was in old days. Learning new things is always associated with anxiety, Learning Anxiety comes from being afraid to try something new for the fear that it will be too difficult, that we will look stupid in the attempt, or that we will have to part from old habits that have worked for us in the past. Learning something new can cast us as the deviant in the groups we belong to. It can threaten our self-esteem and, in extreme cases, even our identity [5]. Therefore, this research is trying to simplify the traditional process of music composition to a certain extent. It is for transferring the whole process into a more stress-less and sensational one. People will have more freedom to create two works at the same time, a piece of artwork and a piece of melody.

The research is, at the same time, trying to simulate a similar experience of colour and music synaesthesia, in order to provide people with inspirations and entertainment in their leisure time.

Also, considering the needs in large amount of original music in Youtuber business, this research is trying to provide an alternative solution for fast music composition as well. Instead of randomly generate any piece of music, the process of creation in this solution keeps user engaged, and therefore, hence the sense of possession.

Finally, this research is aim to apply music and colour synaesthesia for music educational use of early stage as well.

1.4. Thesis Organisation

This thesis is consisted of 6 chapters:

- Chapter 1 is for the introduction of the background, motivation and overall purposes of the research.
- Chapter 2 shares several existed works that are related to this research based on their forms, functions and characteristics.
- Chapter 3 explains the possibilities of the design concept, also introduces the design process of the alternative user-friendly system of melody composition by simulation of colour and music synaesthesia, Melodia.
- Chapter 4 elaborates the fabrication process of several prototypes, also shows some possible modified versions of the prototypes.
- In Chapter 5, the results and data analysis of user tests are shared, which prove the validation of the research.
- Chapter 6 concludes the whole paper, and discusses the possible further development of the research.

Chapter 2

Related Works

In order to achieve the following goals:

- Providing a user-friendly interface.
- Providing a new tool for music composition.
- Attempting to provide an experience that similar to music and colour synaesthesia.

Existed cases or works focus on the design of new musical instrument and process of music composition and were looked into. Papers related to music and art therapy, the application of colour in music education, and studies investigated into existed music and colour synaesthesia cases have also been discussed.

2.1. Playful Toy-like Musical Instrument

One of the large categories have been studied during this research was musical toy or toy-like musical instrument. Since when it comes to music, musical instrument is for no doubt, a very important tool.

Traditional musical instrument that can be used for music composition might need a certain level of musical education to played with, and is usually quite big, which is not very suitable for kids of young age to play with. As is shown in many researches, music has a great amount of positive effects on children or younger people [6]. Therefore, being the potential group might be benefited from this research the most, sizing down the musical instrument seems to be an urgent. Also, considering of the factor of user-friendliness, it is also very important that the musical instrument is easy enough to be played with.

2.1.1 Monome Grid and Yamaha Tenori-on

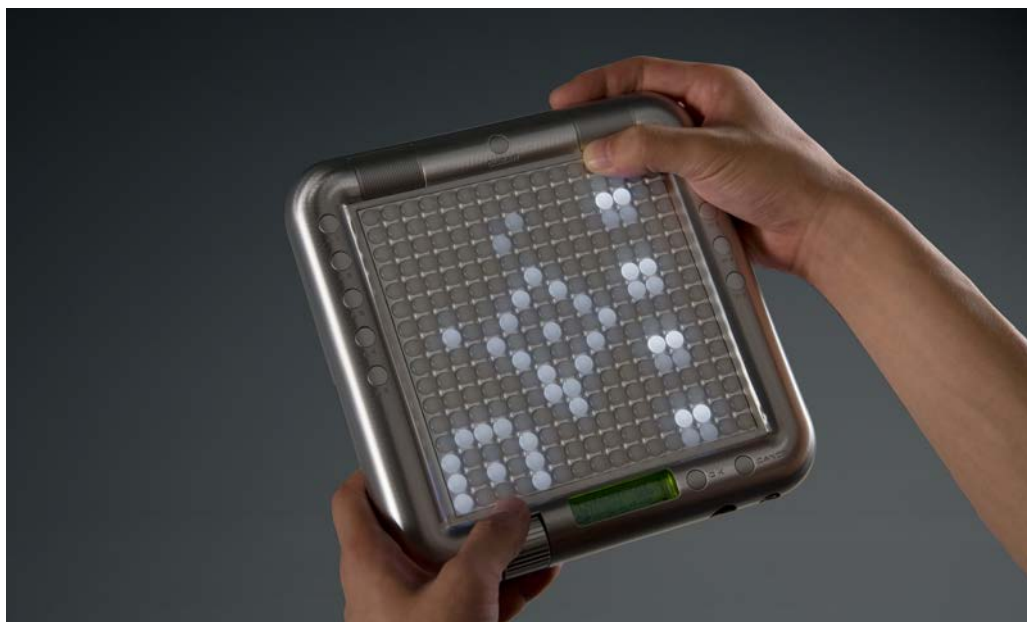
Monome Grid and TENORI-ON are both handheld electronic musician interfaces that have a lot in common conceptually [7]. Monome Grid is actually a MIDI controller, after connecting to a computer, it can function as anything from a sample cutter to a math machine [8]. Since this part of research is mainly about musical instrument, only the circumstance when it is used as a musical instrument is going to be discussed. Once connect it was a personal computer, and configured by specific musical softwares, Monome Grid can turn into a musical instrument with very a simple interface, an enclosed box with a bunch of buttons (Figure 2.1). Users push those buttons to control the computer to make related sound, and lights of those buttons will communicate back with the users. Apart from this most music-playing-like experience, Monome Grid is not very easy to understand and be used by beginners without much electronic music knowledge.



(Source: Monome.org [9])

Figure 2.1 A 128-key Monome Grid being used

On the other hand, Tenori-on, manufactured by Yamaha, is more like an upgraded but restricted version of Monome Grid. It can generate sounds itself, and can be played without connecting with anything. It also has a fancier light communication (Figure 2.2). Not as variable as Monome Grid, Tenori-on is more likely to only be used as an electronic musical instrument and a small device for simple illumination art display. It shares a similar interface with Monome Grid, consisting of a hand-held screen in which a sixteen-by-sixteen grid of LED switches are held within a magnesium plastic frame. Any of these switches may be activated in a number of different ways to create sounds. Two built-in speakers are located on the top of the frame, as well as a dial and buttons that control the type of sound and beats per minute produced [10].



(Source: Yamaha Design “Synapses” TENORI-ON [11])

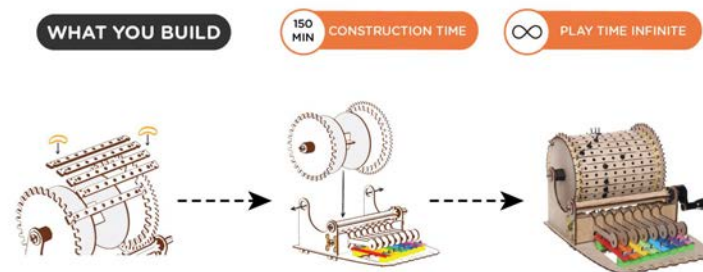
Figure 2.2 A Tenori-on being played

As it allows even those without any musical knowledge to create and perform music using only visual cues and their own intuition [11], Tenori-on is for no doubt, a revolutionary musical instrument. Also, its layer design for a more complete music composition experience is just genius.

However, although the process of using Tenori-on kind of meet the first two goals already, it cannot meet the third goal. We can say Tenori-on is also, at some point, providing something similar to music and graphic or symbol synaesthesia, but colour does not seem like a very significant role in the process.

2.1.2 Smartivity Mechanical Xylofun

Mechanical Xylofun(Figure2.3) is a STEAM(Science, Technology, Engineering, Art, Mathematics) Educational DIY(Do It Yourself) Building Construction Activity Toy Game Kit [12] manufactured by Smartivity, an Indian toys brand.



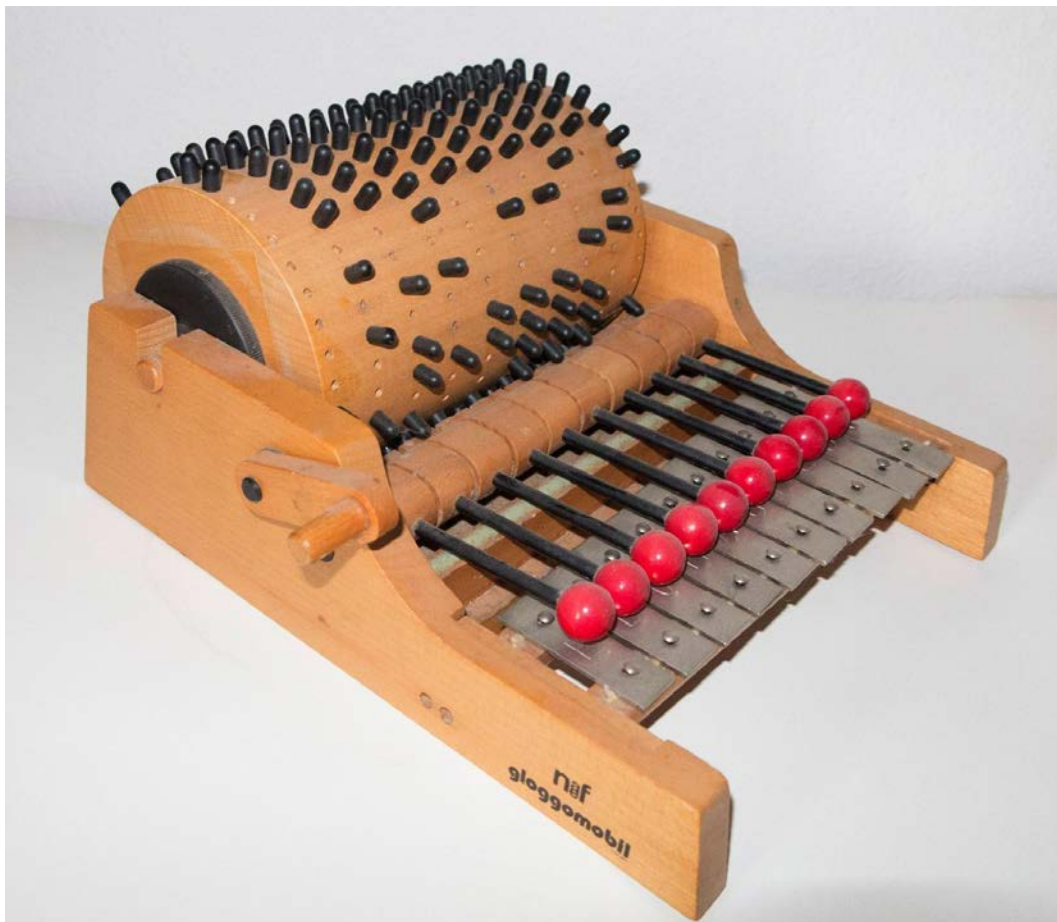
Assemble the parts step-by-step, as shown in the Instruction Booklet.
Build your own Music Machine and decorate it with your own paints or markers.



(Source: Smartivity.in [13])

Figure 2.3 A Mechanical Xylofun and its description

The mechanism of Mechanical Xylofun is actually nothing new, similar products like Gloggomobil(Figure) by Naef [14] and Musicon [15](Figure) can be easily found.

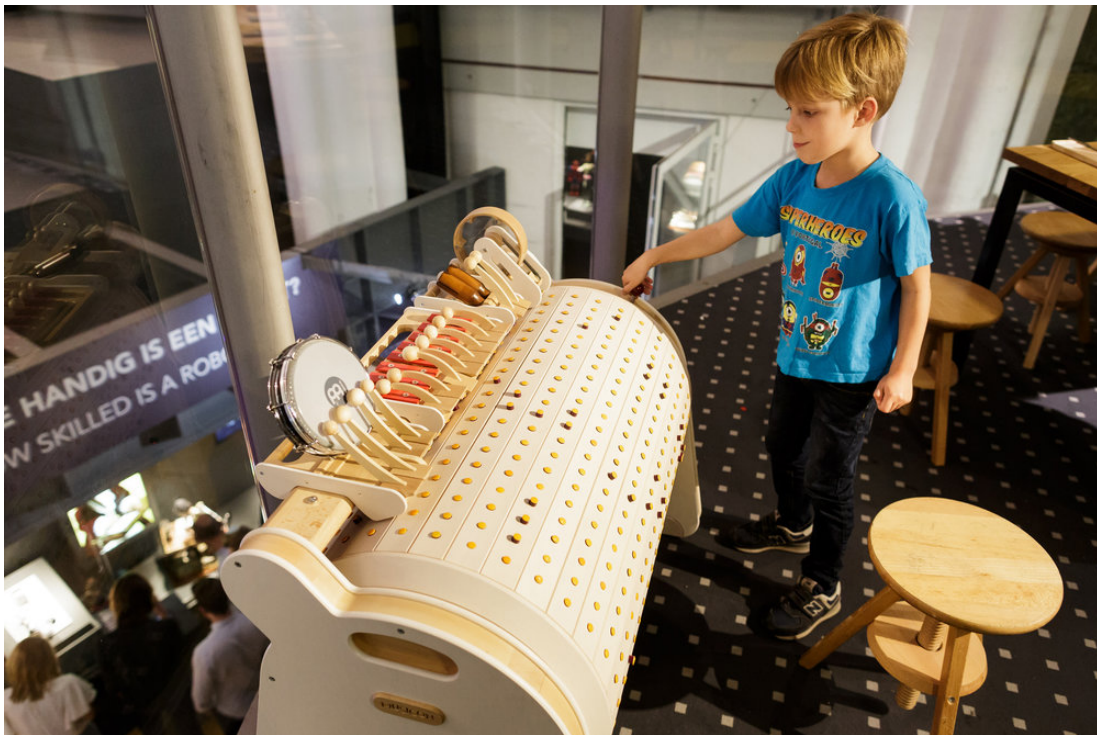


(Source: Ricardo [16])

Figure 2.4 An antique Gloggomobil

These three products share the same mechanism and all work quite similarly, except Mechanical Xylofun is the only one that needs to be built by its users before using it. In Mechanical Xylofun and Gloggomobil, users can create tunes by placing the black pegs into the indicated holes, while in Musicon, users can finish the same process by pushing the buttons on the machine.

These products are, for sure, all excellent for musical education. They give



(Source: Musicclub.com [15])

Figure 2.5 A boy is interacting with Musicon

users a sense of music notation and can help users easily understand the concept of harmony, which is the very basic knowledge that is needed in traditional music composition. But those identical pegs or buttons might restrict users' level of creation, there might not be enough configurable elements for users to interact with.

2.1.3 Otamatone

The Otamatone (Figure 2.6) is an electronic musical toy that can also be considered as a synthesizer. It was developed in Japan by the CUBE toy company and the Maywa Denki design firm, led by the brothers Masamichi and Nobumichi Tosa [17].



(Source: Otamatone.jp [18])

Figure 2.6 Otamatone Deluxe(Left) and the standard Otamatone(Right)

Otomatone has quite a few of different versions, while most of them are in fact, not so different from each other. Two versions of Otamatone will be mainly

discuss in this research is the standard Otamatone and the Otamatone Deluxe. They are very much similar to use, except the Deluxe version has a higher range of notes and be output to speakers or headphones.

Their ribbon controllers are deliberately delinearized to resemble a guitar, while their notes output resemble to a piano keyboard. When playing the Otamatone, users need to press the controller and squeeze the head of it to create different notes and sounds.

Although they are very easy to use, but they are still just more like musical instruments, instead of a kind of toy that is for everyone. Users would still need some extent of music knowledge to enjoying playing with them. And the deluxe version even has more notes, which might increase users' anxiety in the first place, not to mention for them to feel comfortable composing music was it.

2.2. Digital Art-related Music Tools

There are already many kinds of software for music composition, from the very traditional digital audio workstation to some other software with newer concepts, they are evolving constantly and becoming more popular because of their infinite possibility. People can create their own music as long as they have a computer, or in nowadays, they can even compose music by their phones. And for those just need some copyright-free sounds for background music, there are also many convenient random music generators.

In this research, the process of music composition in software, users sense of engagement during the process and the methodology used in software will be mainly focused and discussed.

2.2.1 Traditional Digital Audio Workstation (DAW)

A digital audio workstation (DAW) is an electronic device or application software used for recording, editing and producing audio files [19]. Having a history of more than 30 years, countless digital audio workstations had been produced. And in nowadays, one of the most popular example is Apple's GarageBand(Figure2.7).

GarageBand is extremely convenient for professional users, it can generate the sounds of many kinds of musical instruments, and can be used anytime and any-



(Source: GarageBand for Mac [20])

Figure 2.7 The interface of GarageBand)

where. Musicians would not even need have their musical instrument in hand to compose, many of musical instruments that they do not own can also be explored and even used in their music.

However, GarageBand does not seem like a very good product for people without much music knowledge. There is too much information and too many buttons in the interface. Tremendous amount of configurable settings are also very overwhelming for those who are not familiar with the software.

An other much simpler tool that is a bit like digital audio workstation is CHROME MUSIC LAB: SONG MAKER(Figure2.8), which is one of the experiments by Google's Chrome Music Lab and has a very simple interface, mainly just a grid for users to click on, and some other buttons for options like tempo and sounds of different musical instruments.



(Source: CHROME MUSIC LAB: SONG MAKER [21])

Figure 2.8 The interface of CHROME MUSIC LAB: SONG MAKER

With SONG MAKER, almost everyone can compose a piece of music. Users do not have to know anything about pitch, note, or music theory.

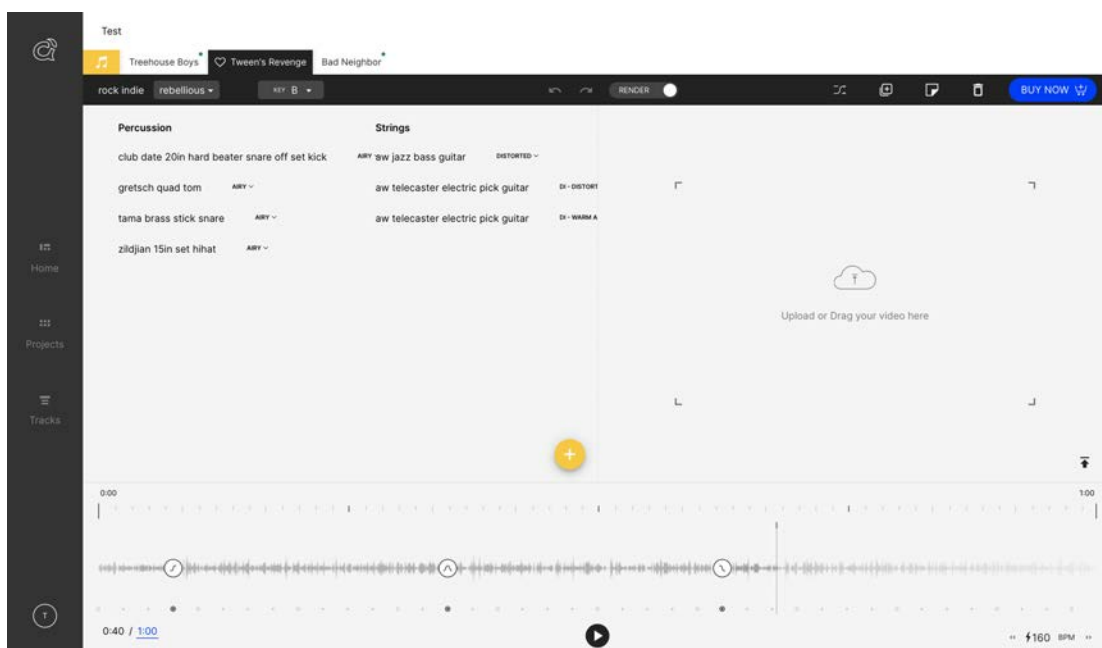
Also, using different colours for different notes might remind people of colour

based art at some point. Similar elements can also be found in some other experiments of Chrome Music Lab, is highly possible that they are trying to apply music and colour synaesthesia to music education purposes as well.

2.2.2 AI Music Composition Tool

Using artificial intelligence as a tool for music making has already started for a few years. While most of the software or services are still under development, there are still quite a few of them are being used by YouTubers or creators for fast generated background music.

Amper Music(Figure2.9), might be considered as one of the most easy to use AI music generators. It works based on prerecorded samples, users first need to choose one of the samples, and customise them for further use. Unfortunately, except from templates and musical instruments, there is not many things for users to change or modify.



(Source: Ampermusic.com [22])

Figure 2.9 The interface of Amper Music

Also, the process of using Amper Music and many other AI music generators might be a bit confusing. Since they are always first asking user about a specific feeling and music style, and then all of a sudden, a piece of music has been generated. They can definitely save a lot of time, but there is always something missing. Only by answering a few multiple choices questions can not help people actually relate what they want to what the AI generates. Lacking of engagement, this is one of the main disadvantages that can be found in most of the AI music generators.

2.2.3 Other Related Works without Melody Composition Purpose

As mentioned in the introduction, many artworks were influenced by Synaesthesia, therefore, some inspiring works that may not use for melody composition but are actually relating musical notes to visual colours were also looked into for references.

Specdrums [23] was a Kickstarter [24] project featured on a wearable device that can be connected to smartphone for audio output(Figure2.10).

Users can customised every colour tapped by the device into different sound, and then they tap on anywhere to get a musical-instrument-playing-alike experience by listening to the audio output on the smartphone.

It is definitely one of many very interesting projects relating musical elements to colours. But the differences of it being used by users with or without music background cannot be neglected. Users with music background can apparently have more fun and be more creative than those without. Although the movement of tapping by rhythm can be some sort of human natural, the area of tapping might be quite restricted. This behaviour were also observed in the field works which will later be mentioned in this thesis. Most people turned to tap on the same spot when they were trying to follow the beats. The idea of leading users to tap on different places for different sounds is actually not very easy for users without music background to carry out, since it is just a bit too like playing musical instrument, and in fact, not very natural for those users.

While one of another quite inspiring project was a music to graphic art trans-



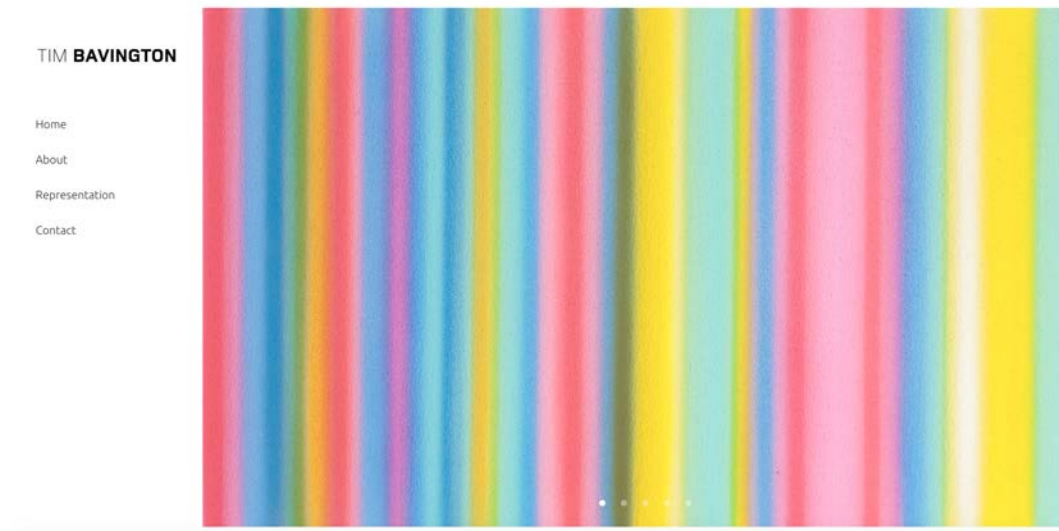
(Source: Specdrums: Music at Your Fingertips [23])

Figure 2.10 Specdrums being in used

lating project by the Las Vegas-based painter Tim Bavington (Figure 2.11). Bavington invented a colour-coded wheel that lets him translate songs into paintings. With each line representing a different note or chord, he brings music to life on canvas.

To draw a parallel between music and his art, Bavington sees his creative process as similar to how a musician transforms sheet music into a performance [25]. The artist first started from music scores printed on paper, which seems to suggest strict instructions but then became something completely different when interpreted. And then the actual painting process was, in fact, a more intuitive and improvisational process.

Bavington's vibrant works are, for not doubt, very fascinating and inspiring. However, the attempt of finding the analogy between seeing and hearing or music and painting have been studied a long time ago, which will be discussed in the next section.



(Source: TimBavington.com [22])

Figure 2.11 One of Tim Bavington's work on his website

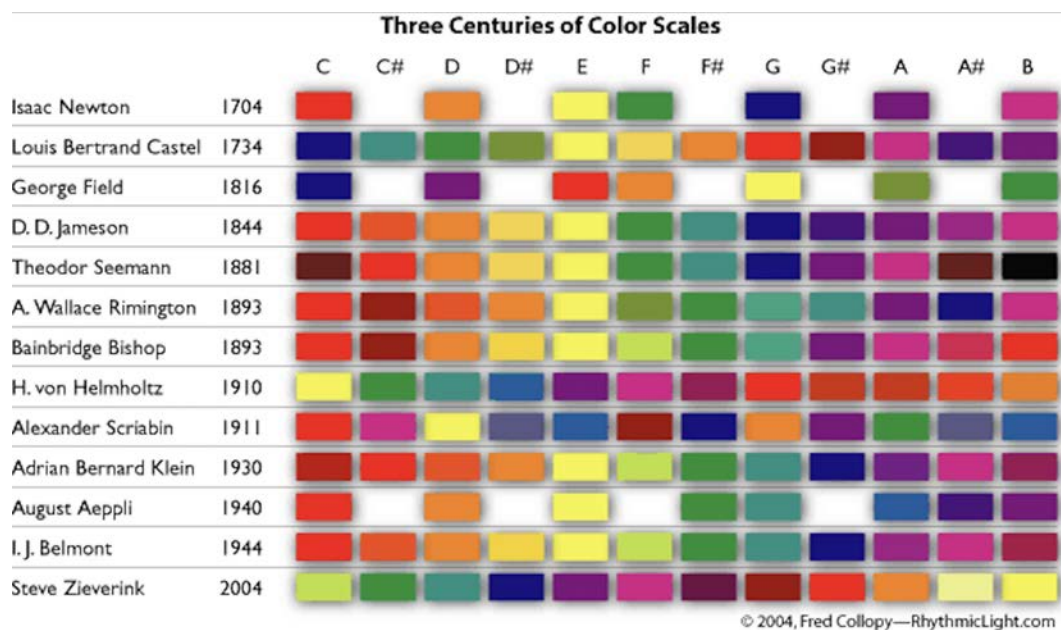
2.3. Existed Cases of Music and Colour Synaesthesia

Synaesthesia, first known as coloured-hearing, according to the Peacock's paper [26] focused on the past technological experimentation on performing colour-music and the timeline sorted by Collopy [27], the earliest theory of colour-music translating can be found was published by Isaac Newton [28] in 1704.

And it seems like, in every generation, the art of music-colour must be re-discussed or re-discovered. We can see the colour scales shows some similar patterns in most of the works. But some of their differences are still quite obvious. Of course, it is very hard not to suspect some of the colour scales were just following the former works, and how many of them were just arranged by personal preferences instead of the true music-colour synaesthesia.

On the other hand, research suggests that about one in 2,000 people are synesthetes, and some experts suspect that as many as one in 300 people have some variation of the condition [29], which also indicates the difficulty of finding out a specific colour scale that can be considered as the standard colour scale of music

notes.



(Source: Rhythmiclight.com [30])

Figure 2.12 Colour Scales based on timeline sorted by Fred Collopy

2.4. The Role of Colour and Music

The application of therapeutic use of art and music for patients actually has a quite long history already [31]. Art therapy and music therapy had been used for specifically patients with mental or cognitive problems like depression, autism and dementia [31] [32], and they have also been proved quite effective [33]. Colour and music not only plays an important role in people's leisure time, but also significantly helps people to remain mentally healthy.

Also, art and music appear together quite often. Some artists listen to music when they are trying to create artworks, while some musicians might stare at some paintings when they are trying to compose. And according to some researches, using colour-coding, can efficiently help people learn about music theory rudiments, aural skills, and keyboard skills [34]. Colour coding might be a bit far away from

art, but most of arts are created by colours. And if we try to connect colour and music, synaesthesia might also be one of the results we can get. Therefore, in this research, the using of colour-coding in music composition will be highly focused.

2.5. Summary

There are many wonderful existed project about encouraging people to compose their original music. Some of them really achieve to do so, while some of them might not be very ideal in some ways.

From Monome Grid and Yamaha Tenori-on, their very simple interface and wonderful interactions are honestly very inspiring, and will become some very important references for this research.

The example of Xylofun and other similar music machines show us the core of music composition, notation and harmony. It also showcase a very simple but interesting interaction during its process of music composition.

And Otamatone reminds us to pay attention to the anxiety of learning, anxiety comes from being afraid to try something new for fear that it will be too difficult, that we will look stupid in the attempt, or that we will have to part from old habits that have worked for us in the past. Learning something new can cast us as the deviant in the groups we belong to. It can threaten our self-esteem and, in extreme cases, even our identity [5].

Specdrums can be a really great example of applying colour elements to music-related products. And its feature of letting users to customise the sounds of colours is also very brilliant.

Various types of digital music tools shows us the possibility of software and online services, and remind us once again about the importance of "being less professional" and the sense of engagement when designing the new music composition process.

Existed cases of music and colour synaesthesia show the difficulty of actually reproducing the same experience of the synaesthesia. And also remind us not to cling on to the process of reproduction too much, while adding more freedom might be an alternative solution.

Literature reviews of music and art therapy, psychology and the application of

colour-coding in music education certainly arouse more of our thinking, and will be further considered and apply to this research as well.

In brief, this research studied from all the related works above and more other works to come up with an alternative solution for melody composition combining some of positive effects and interesting characteristics from those works. Inspired by the colour and music synaesthesia, the solution is providing a more relaxing process for melody composition, by transferring the process into a more emotion-led process, colour-based art creation.

Chapter 3

Design

Melodia is a project designed to provide an alternative solution for melody composition that is user-friendly enough for even people without much knowledge of music.

After the process of a simple colour based artwork creating, users will not only obtain their artwork as the final result, but also a piece of melody. The melody they created can then be further adjusted and modified for other use. Users can choose to focus on only the artwork creation or listen to the audio output in real time.

Since the whole creating process is based on users' aesthetic sense and intuition, no necessary knowledge will be needed. Therefore, the anxiety of learning is less triggered.

The simple and stress-free process should be relaxing and also be able to express a connection between music and colours, which is similar to synaesthesia. By the approach that resembles to music and colour synaesthesia, the overall goal of this project is to encourage people to embrace or enjoy music composition in their leisure time, just like how people enjoy listen to music.

And on the other hand, taking the advantage of the effectiveness of colour-coding in music education, the project is hopefully to also plays a part in early stage of music education.

3.1. Fieldwork

In order to understand more about music lovers or music amateurs, a few field trips to live houses and music bars were carried out.

People paying visits to places like live houses and music bars, under most cir-

cumstances, are trying to enjoy their leisure time. And most of them are apparently, fans of music. They might or might not have much music background, but their interests for music in common brings them together to these places. Therefore, many of them might be the potential users for Melodia.

Also, environment like these places is very suitable for conversations, which makes it easier to conduct the observation and interviews.



Figure 3.1 The stage setting of live house before the live performance started

3.1.1 Observation

The observation was conducted from before the performances and lasted until the time most of the audiences left.

Both the environment and people in the environment were observed. Photos for research use were taken under permissions in a way that would less likely to effect the performances.

- Environment

Before the performances, the live house was not with many people. Random music was playing in the background in a comparatively lower volume, which was easy for people to talk to each other. The lighting in live houses was darker, from the audience area to the stage. Meanwhile, in music bars, there was not quite much of changes of the lighting.



Figure 3.2 The lighting of one of the music bars

During the performances, of course, there was not any background music playing anymore. And most of the live houses provide different styles of lighting for the artists to suit their music styles and performances. For example, for bands that performing an upbeat and lively song, the lighting is usually brighter and more colourful, while when a sad or slower song is performing, the colour of lighting is usually darker and in some more peaceful colours like blue or or white.

After the performances, the lighting and background music was then set back to the same as how they were before the performances.



Figure 3.3 The lighting when an upbeat song was performed

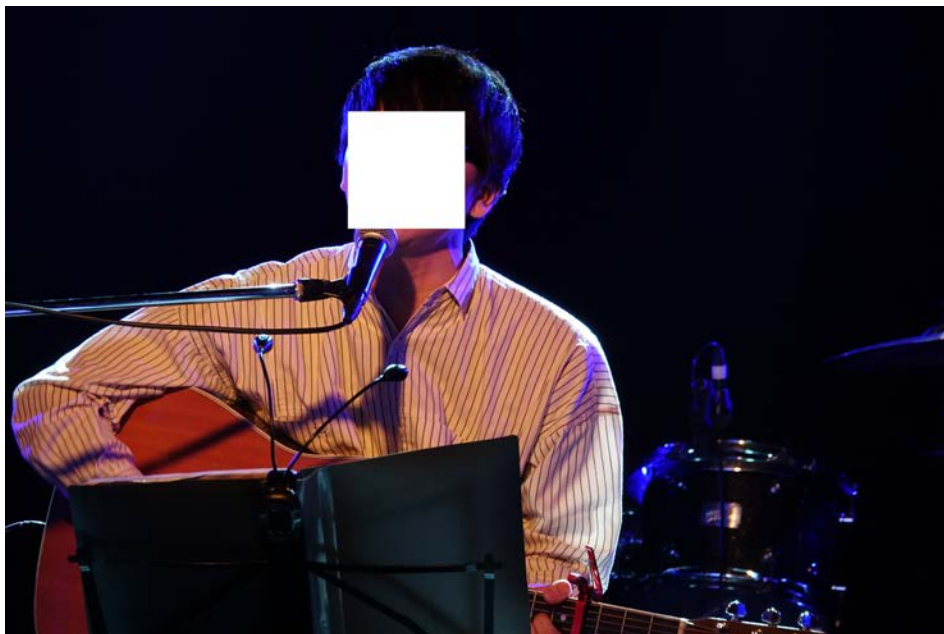


Figure 3.4 The lighting when a slow acoustic song was performed

Also, colour elements were not just found in the lighting, but also in the buttons of the audio control deck (Figure 3.3) which is probably for the staffs to easily control all the audio settings in a dark environment.

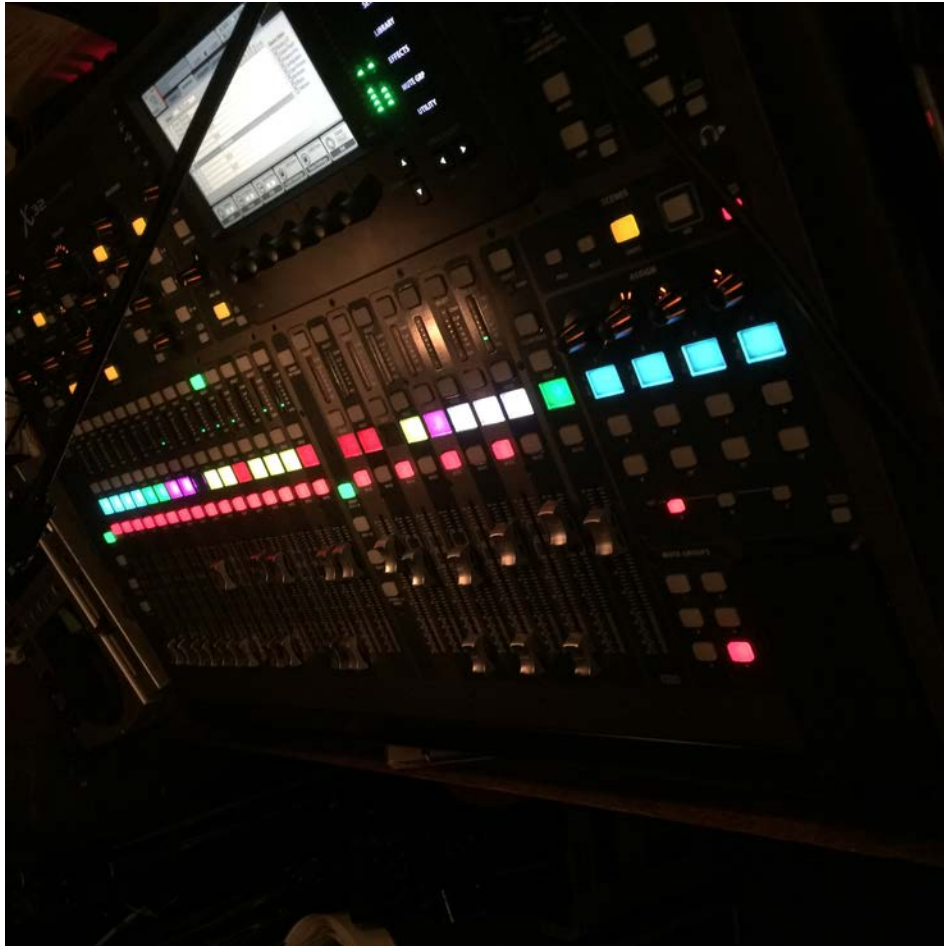


Figure 3.5 The audio control deck in one of the live houses

- Audiences

Before the performance, in the live house, most of the people were talking to others. The audiences chatted with their companions, the staffs, and some of the artists.

During the performance, most of the audience moved to the beat, some of them nodded their head, some of them tapped on the floor, and the rest of

them just mildly shook their body with the rhythm. It showed that beatings might be one thing that can be easily accepted and followed in music.

After the performances, some of them just returned to what they were doing before the performances, while the other just left.

And on the other hand, in the music bar, although most audiences do have the similar movements, they were more focus on their food, drinks and conversations.

- Performers and Staffs

Only a few of performers showed up before the performances.

During the performances, some of them just joined the audiences and listened to other artists' performances, while some of them went out of the live house. They also had similar movements like other audiences, moving some part of their body to follow the beatings of the music.

And after the the performances, they stayed at the live house to talk to some of the audiences and wait for the after party.

And the staffs were just basically doing their job almost all the time, pouring drinks for audiences, busy with the lighting and audio controls, assisting artists.

Both performers and staffs were acting similarly in music bars as well.

3.1.2 Brief Interviews

Some brief interviews were also conducted with random people in live houses and music bars before and after the music performances. Data collected was as below:

Table 3.1 Music Background

	Number of people	Percentage
Without much music knowledge	23	65.7%
With a certain level knowledge of music	5	14.3%
Professional musicians	7	20%

Table 3.2 Compose Experience

	Number of people	Percentage
Yes	6	17.1%
No	29	82.9%

Table 3.3 Have Ever Thought about Composing?

	Number of people	Percentage
Yes	32	91.4%
No	3	8.6%

From the data, we can know about more than a half of people who visits live houses or music bars do not have much professional music background, some of them even was just visiting places like these for the first time, but they all showed their affections towards music, and a small percentage of people were there mainly for meeting new friends or talking to their old friends.

82.9% of them have never composed music in their live, although more than 90% of them have thought of composing music before.

Some of them also shared the reasons why they never tried composing. A 26 years old salary man said he does not have much time to learn about music and music composing, while a 19 year old female student showed her concerns of music composing might be very difficult to learn. The rest of most of people just simply do not where to start and do not want to invest too much of time and money for it.

We can also confirm the potential needs for a new alternative solution of music composition for people without much music knowledge from the interview results as well.

3.2. Ideation

After the pre-study of existed related works and a few field trips, the target users of the design of this research were finally settled to people who are interested in music composition while do not have much professional music training.

The ideation of the design of the new user-friendly alternative solution of mu-

music composition by the simulation of colour and music synaesthesia started with a mood board and ended up to a simple sketch of the possible prototype. The design includes two main parts, a placing board and many pieces of small tetrahedrons in various colours. Users interact with the design by placing different colours of tetrahedrons on the board to create a piece of two-dimensional artwork. Meanwhile, each of the colours represents a note from the notes that resemble to the piano keyboard. Users can set each colour as different notes or can just simply use the random setting. Therefore, after users finishing creating their two-dimensional artwork, they will also have a melody as the outcome.

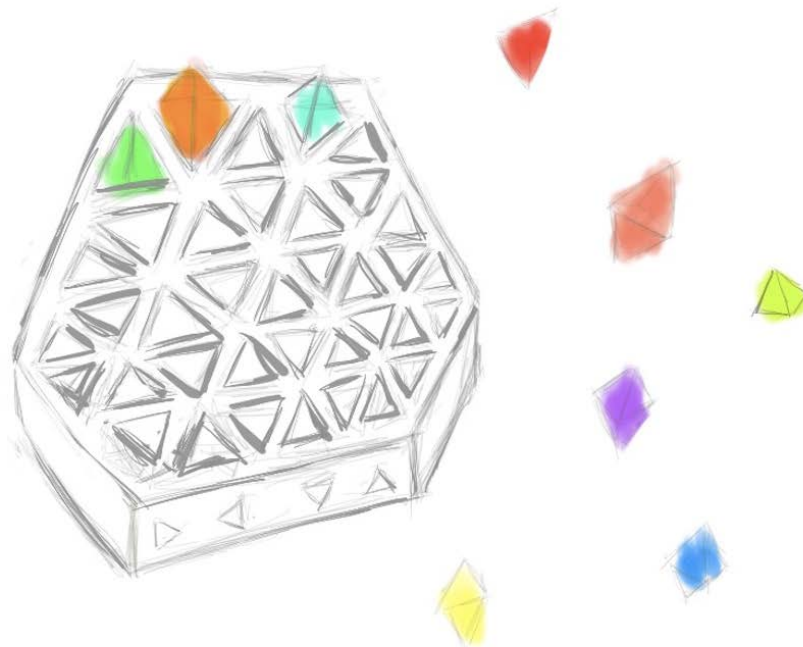
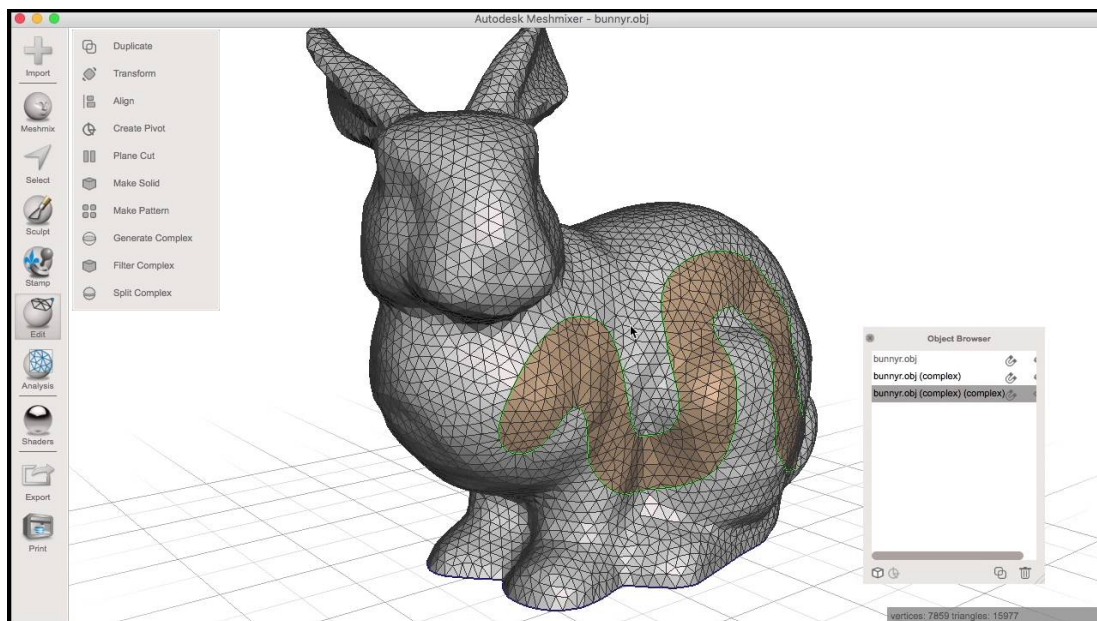


Figure 3.6 The simple sketch of Melodia

The idea of the sketch was also inspired by some other famous colour-cubic building projects like LEGO [35] and Minecraft [36].

And the reason of why choosing tetrahedrons as the shape is as below:

- Almost all the shapes can be broken down into of multiple triangles
- Equilateral triangles can be connected with each other endlessly, so as tetrahedrons
- Being different from the existed building projects
- Inspired by the mesh-display in modeling software



(Source: Youtube Channel of Autodesk 123D [37])

Figure 3.7 The mesh-display of a bunny model in Autodesk Meshmixer

3.3. Summary of Concept

Melodia is an interactive experience design focusing on transferring the traditional melody composition process to a simpler process of colour based artwork creation, which mainly led by users' aesthetic senses and intuition, instead of their music knowledge, and also providing users with a sense of connection between music and colours.

Chapter 4

Prototype

Multiple prototypes had been produced for the research. Unfortunately, during to certain amount of situation and condition restrictions, some of them had to be set aside for now and might be later modified or restarted. User test of the very first prototype will also be mentioned in this chapter, since the latter prototypes were mainly modified based on the result and feedback from the test.

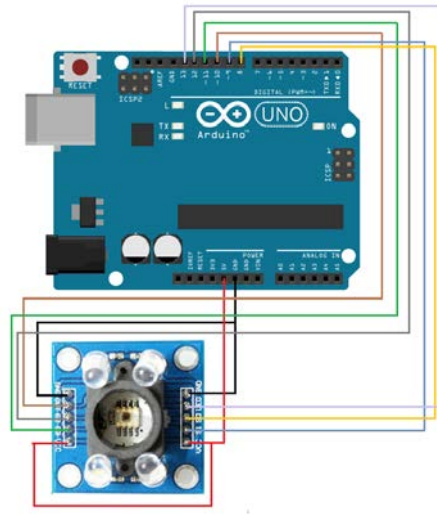
4.1. First Prototype

4.1.1 Sensor

In the first prototype, sensor that first considered to be used for detecting different colours of tetrahedrons was TCS3200 color sensor(Figure4.1). By placing objects above the sensor, the sensor can detect and differentiate between the colors white, blue, green, and red. Different frequencies of colours will then be input to the arduino for further use.

By the difference of each data, different colours can be defined and detected to output certain instructions. And in the case of Melodia, the output can be playing the audio of different sounds of the notes on a piano keyboard, and also record the notes to later be put together as a melody.

However, considering of the size of the sensor itself and the design of the placing board and without enough time, funding and knowledge of using the TCS3200 color sensor, this idea was then set aside.



(Source: Learningaboutelectronics.com [38])

Figure 4.1 The circuit of the TCS3200 color sensor and an Arduino board

4.1.2 Application

After giving up on using sensor and arduino to manufacture a working prototype, an interactive Android platform application was then made to demonstrate the concept of Melodia. It can be considered as a simpler version of the original design.

As is shown in Figure 4.2, the interface of the application consisted of 7 colours of square buttons and a corner at the bottom. Each colour of the buttons represent a note for the piano keyboard, when user tap on the buttons, a square that is the same as the button will fall down and stop by the corner, and the audio of the note will be played at the same time.

The two-dimensional artwork creation process was also simplified and interpreted as the stacking of different colours of squares in the corner.

After artwork creation, users can tap on the note mark to play the melody.

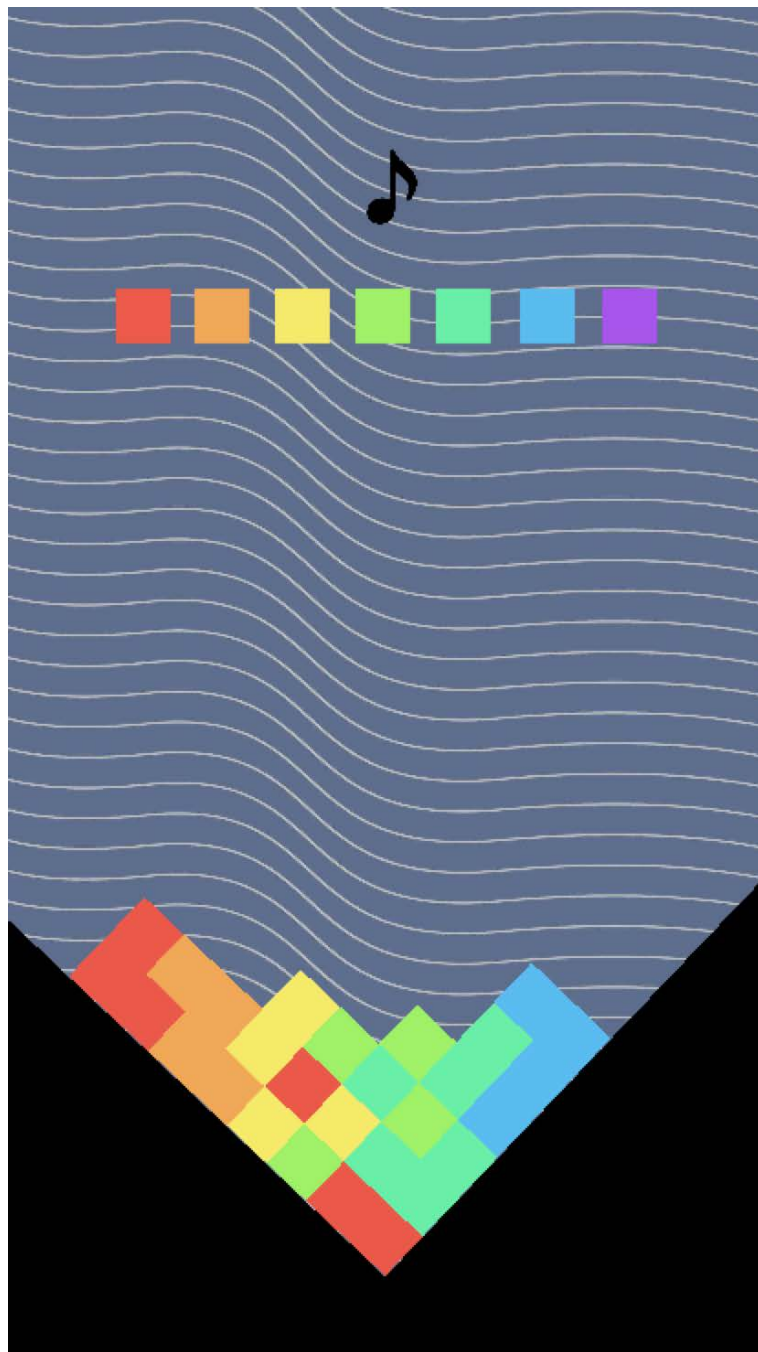


Figure 4.2 The interface of Melodia: Fall

4.1.3 Modeling

The appearance of the main part of the first prototype was very much alike what it was on the concept sketch.

The board of Melodia was modeled using modeling software and manufactured using a CNC machine.

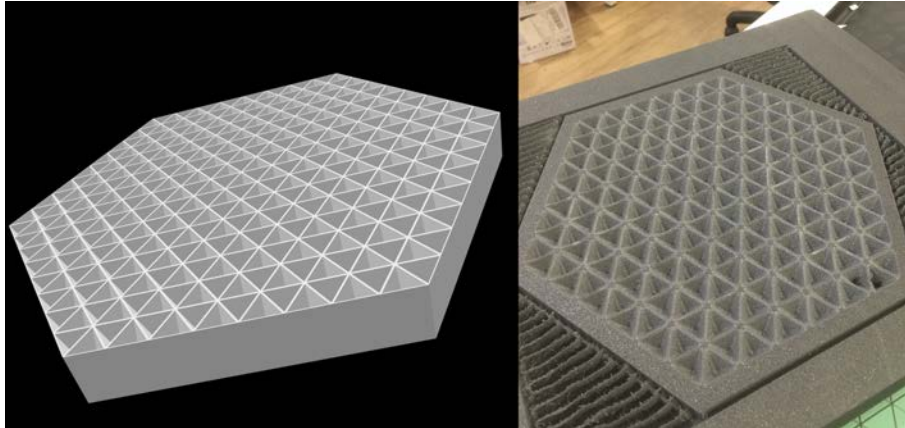


Figure 4.3 The digital(right) and physical(left) models of the board part of the first prototype



Figure 4.4 The tetrahedrons with colour made by paper

And the tetrahedrons with colours were just simple paper models.

4.1.4 Final Implementation

So the final implementation for the first prototype was conducted with the main part of the model of Melodia, which includes the board and the tetrahedrons, a PC playing the demonstration video of Melodia: Fall, a project poster and a working application on an Android smartphone(Figure4.5).

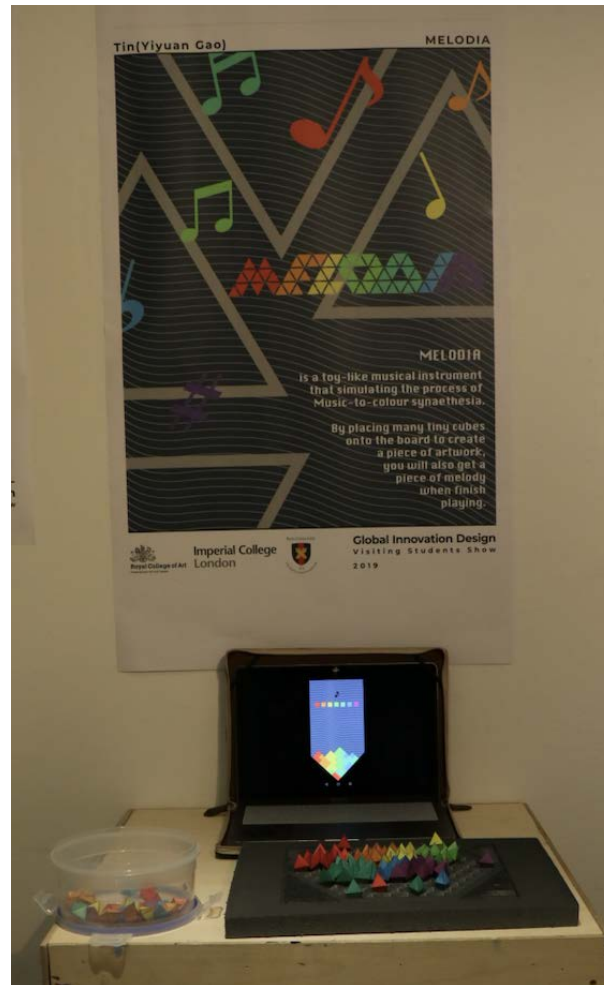


Figure 4.5 The final implementation for the first user test

4.1.5 Testing and Feedback

The flow of the first user test was as below:

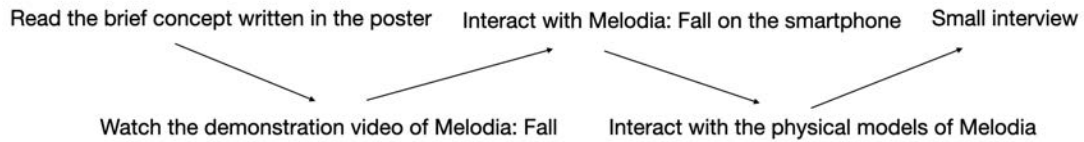


Figure 4.6 The flowchart of the first user test

And the feedback collected from the users can be categorised as below:

- Interesting but not enough.

Two participants said: "The idea itself is very interesting, but what provided in the user test were not interesting enough because of too many restrictions." The restrictions they mentioned referred to the restricted options of colours in the prototype and also how they can interact with the prototype. "We do not have much control of the arrangement of the blocks, it is very fun to watch them falling down and tumbling, but it is not that much fun if we are trying to use these blocks to create something in the corner part", another participant commented to Melodia: Fall.

One participant also questioned the melody composition part in the design. "Can we really call a bunch of random notes a melody or even music? Should not harmony and tempo be also taking to consideration? There are a lot of other other things can be explored in this project, but the current result might be a bit too simple", he criticised.

- A bit confusing.

Quite a few questions were asked during the test. It was apparently the test might be a bit confusing because "Too many things are going on", according to one of the participant.

Most of people's attention was first drawn by the physical model of Melodia, which was not actually functioning. Some of them also tried to create

something on the board, but after that, nothing else happened. Therefore, after disappointed by the model that did not work, most of the participants started asking what the project was about. Which was totally not the procedures as planned in the user test flowchart.

Some other participants were also confused by the multiple sections of the test. One participant asked, "Why is the test in so many sections? And why were we interacting with an app before the physical model when the physical one was going to be the final outcome of project?"

- Looking forward to further development.

Most of the participants had showed positive responses to the further development of the project in the future. "The idea of using Synaesthesia is fascinating, the app was a nice try, but I am more looking forward to the working prototype of the main part of the project", one participant said. "The looking of the model is cute and very eye-catching, it would be better if the model is the working prototype, instead of using an app to describe the project concept", another participant said.

4.2. Other prototypes

Other prototypes including Melodia: String and Melodia in Unity were also been considered or tried to produced.

4.2.1 Melodia: String

Inspired by string instruments like guitar or bass, and the move of swiping through all the keys on the piano keyboard, the concept of Melodia: String was designed. The part that coloured in this concept is the string. By bonding different colours of strings onto the wooden base, users can create some sort of simple and abstract artworks. And after the bonding all the strings onto the base, users can use their fingers to swipe over all the strings to play the melody they created.

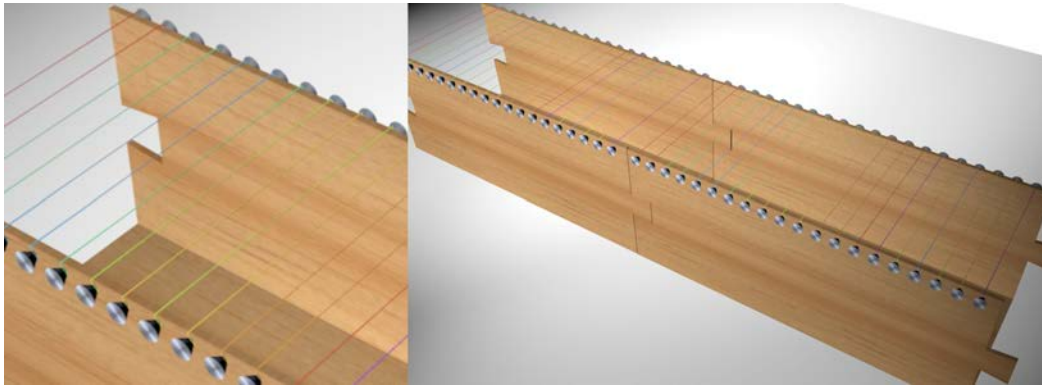


Figure 4.7 The rendering of Melodia: String

4.2.2 Melodia in Unity

In order to deal with all kinds of restrictions, the idea of creating a digital version of Melodia in unity was born. But unfortunately, this prototype was also set aside because of time and technical restrictions.

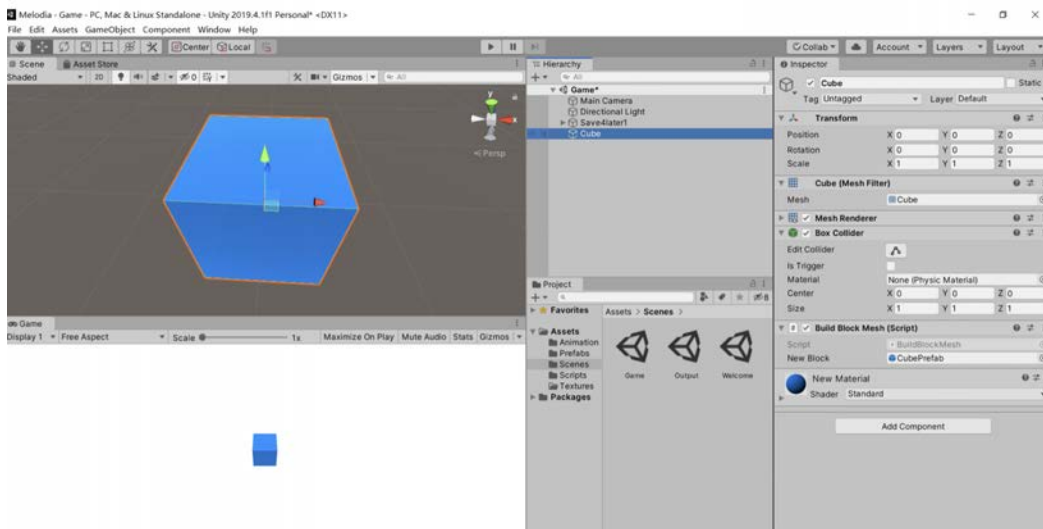


Figure 4.8 The unity interface of the project Melodia

4.3. Final prototype

After coming across the failures in producing other prototypes, the final prototype of this research decided going back to the first prototype and coming up with solutions to modify the prototype.

4.3.1 Modifications

- Model Rebuilding

Since the CNC machine was no longer accessible, the model of the original design were rebuilt by hand, using cardboard for the board part, and still, paper for the tetrahedrons.

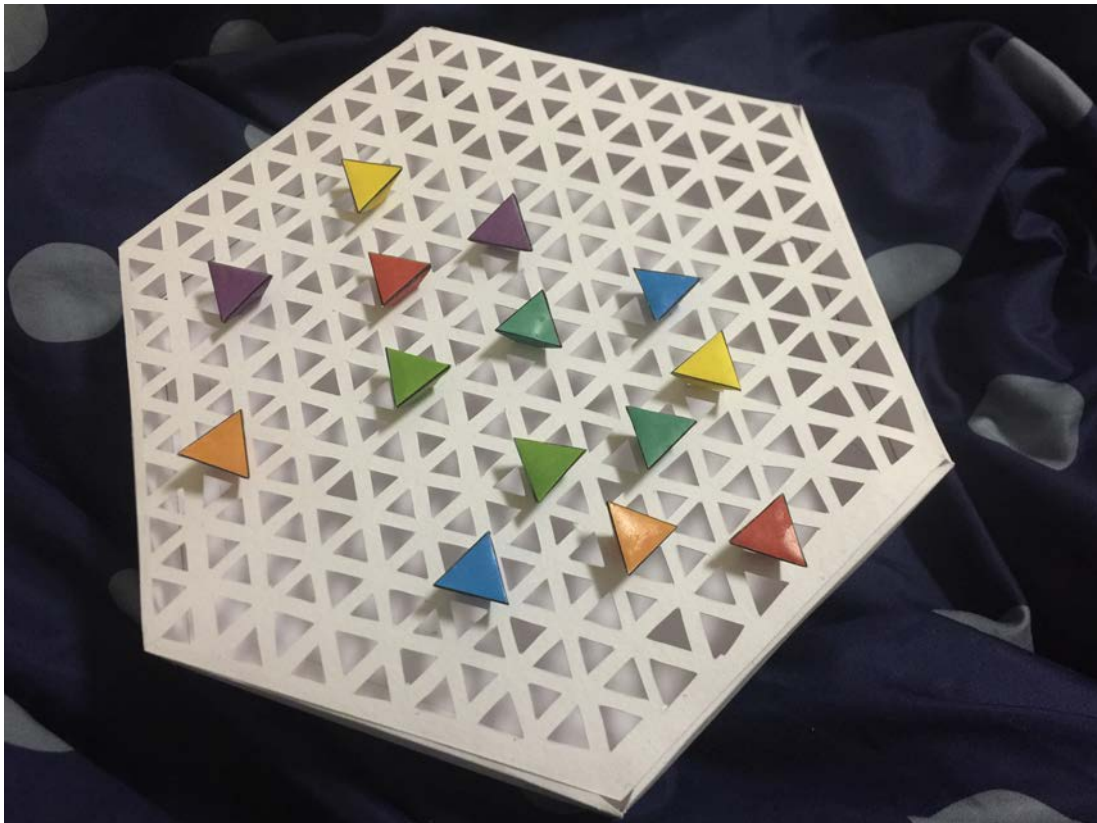


Figure 4.9 The rebuilt model of Melodia

- Working Principle Redesign

According to the feedback from the first user test mentioning about being confused by too many sections in the system, the final prototype of the design will focus on only the main part, the model of Melodia. And the solution to make up for the actual function was to input the colours and output the audios manually via a PC. Figure 4.10 shows the working principle of the final prototype.

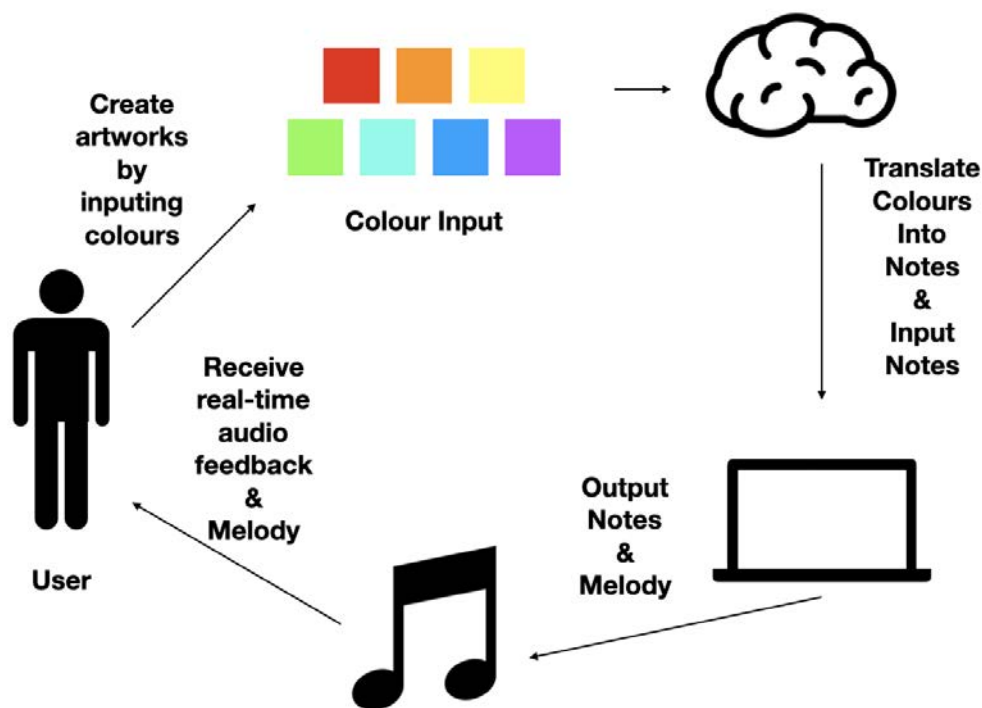


Figure 4.10 The flowchart of the working principle used in the final prototype

Firstly, users create artworks by putting tetrahedrons with different colours onto the board. Then the colour input will be manually translated into notes from a piano keyboard and be input to the PC. Finally, the PC will record the notes and output the audios of notes and melodies via a speaker or headphones for the users.

- Application of Basic Music Theory

Elements of music includes not only melody but also rhyme and harmony [39]. In order to improve the seriousness of the melody composition, which was also criticised in the first user test, the other two music elements: rhyme and harmony, were added to the final prototype.

- Rhyme

The sound of a metronome was added to be played in the background during the experience. It can indicate a sense of rhyme, and might be able to lead people to place their tetrahedrons on the board at a more music-like timing and even hence the feeling of the simulation of music and colour synaesthesia.

And of course, users can choose to mute the sound during the experience.

- Harmony

Harmony was one thing that had not been considered in almost all the previous prototypes. But without the restrictions of harmony, melodies that randomly created might not very much sound like actual music.

Therefore, a model of how the original input notes can be modified base on the patterns of harmony was designed(Figure4.11).

The notes translated from the colour input will first be simplified, too many of continuous identical notes will be removed and only one or two notes will be kept.

Then some random decoration notes in the same chord as the input note would be added to the simplified melody, especially between those input notes if they were not from the same chord.

Finally, other music features like strong and weak beats and overlaps can also be chosen to add in the melody as well.

This feature is also optional for users, users can choose to output their melody in any stages mention above: the original notes, the randomly-simplified notes, the melody with random decorative notes added, and the melody that go through all the processes.

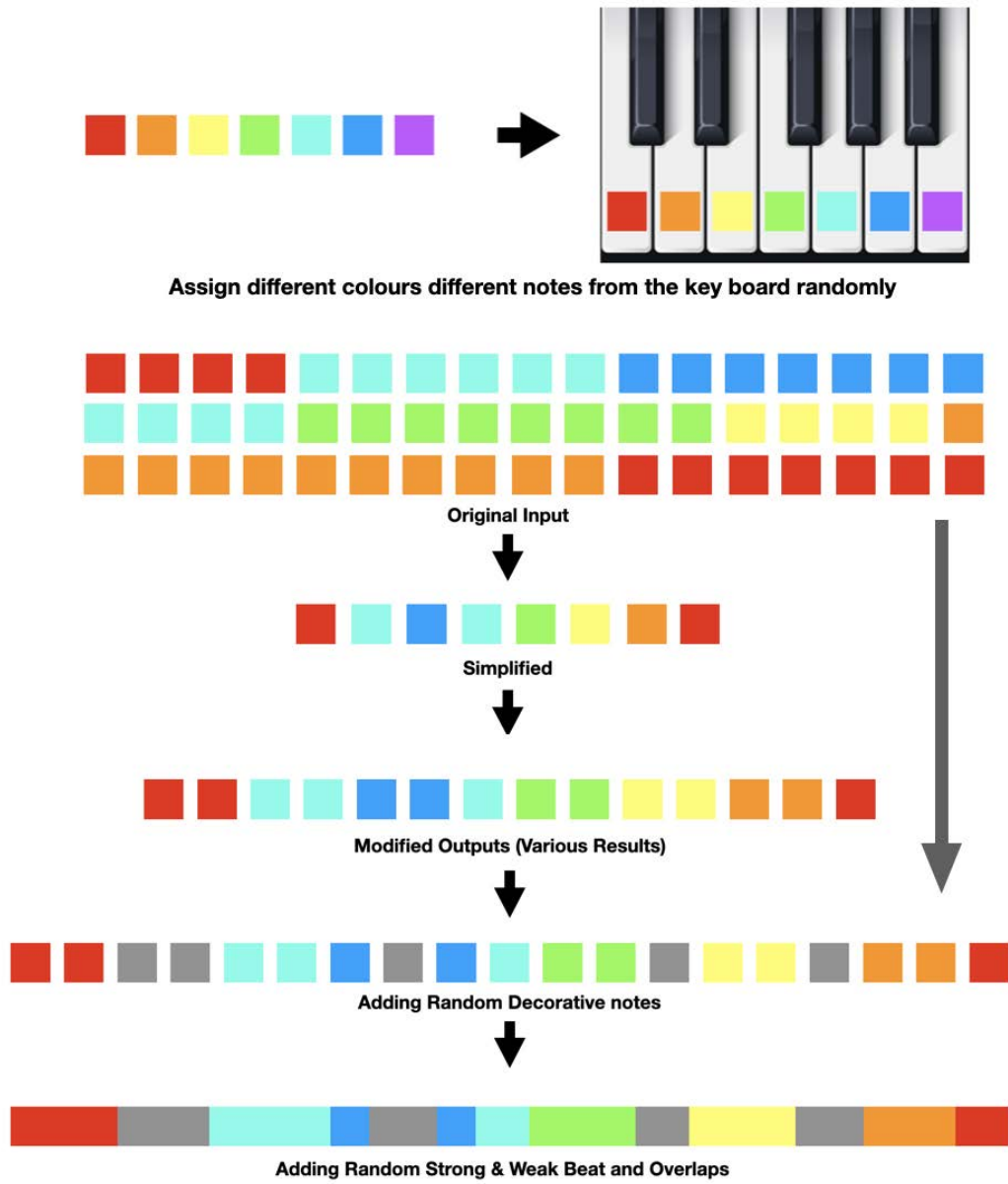


Figure 4.11 The process of translating the colour input into final melody

4.3.2 Implementation of the Final User Test

The final user test was carried out with the model of Melodia, a speaker and a PC. The test was conducted in a quiet environment, which is for participants to better focus on the audio during the test as well.

3 participants, A(24 years old), B(21 years old), and C(56 years old) took part in the final user test, and accepted the after interviews. They were all without any music composition experience but very interested in it.

The flowchart of the final user test is as below:

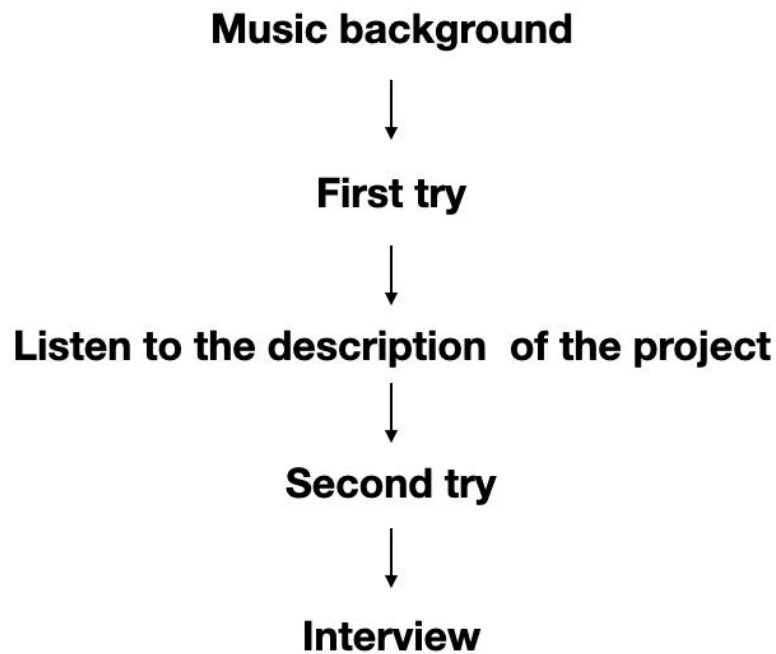


Figure 4.12 The flowchart of the final user test

Participants were first asked a few questions about their music background and interest towards music composition.

Then they interacted with the final prototype for the first time and played around with it by their intuition.

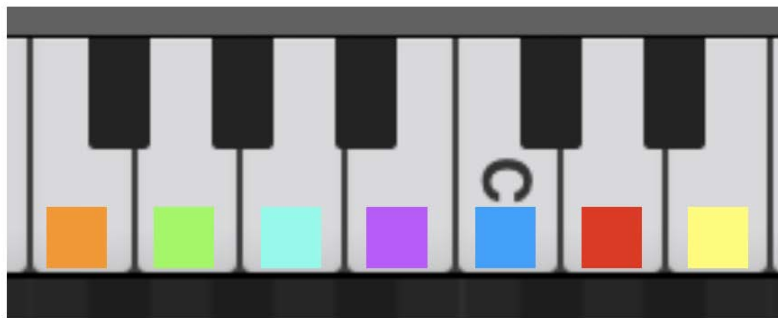
After they done with the first interaction, they listened to the description of the project, including the concept and the goal of the project. Their questions had also been answered in this section.

Then the participants were told to interact with the prototype for one more time. They all created something on the board and listened to the melodies outcome.

At last, the user test ended with a deep interview about participants feelings and thoughts about the experience.

4.3.3 An Example of the Test Outcome

Below is the setting and outcome from one of the participant.



Random colour setting for user test

Figure 4.13 Random keys from the piano keyboard were assigned to different colours in the final user test

The participant used small tetrahedrons with different colours to create a piece of simple artwork on the board(Figure4.14). The order of the colour of tetrahedron was put on the board was recorded. And if the user removed one of the tetrahedrons, the record of the colour of that tetrahedron would also be removed. In order to simulate real-time responses, these records were manually input to the

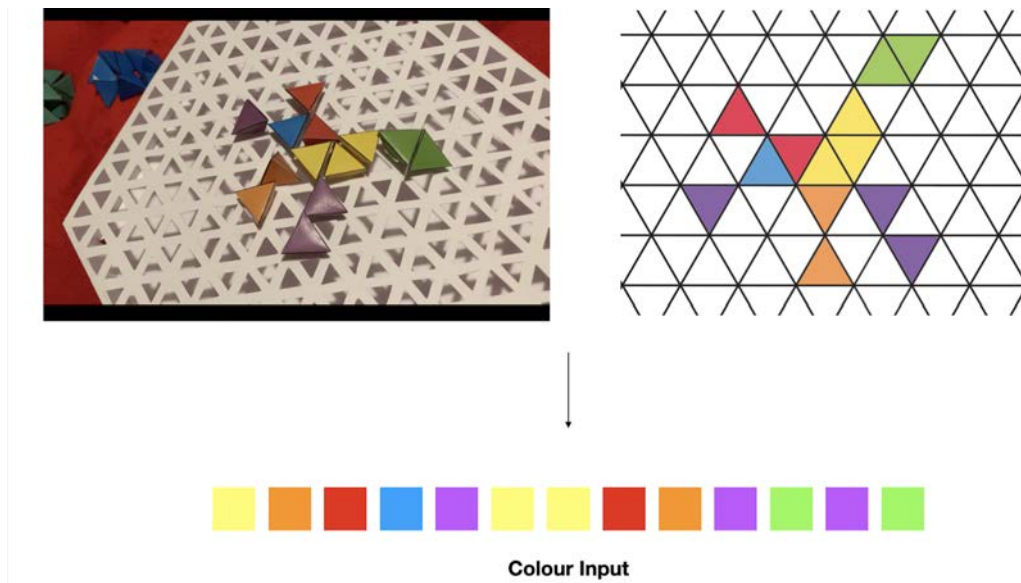


Figure 4.14 The simple artwork created by the participant

PC in real-time, and the audios of the related notes were played in real-time as well.

After the interaction with the prototype, the melodies generated (Figure 4.15) were then played to the participant.

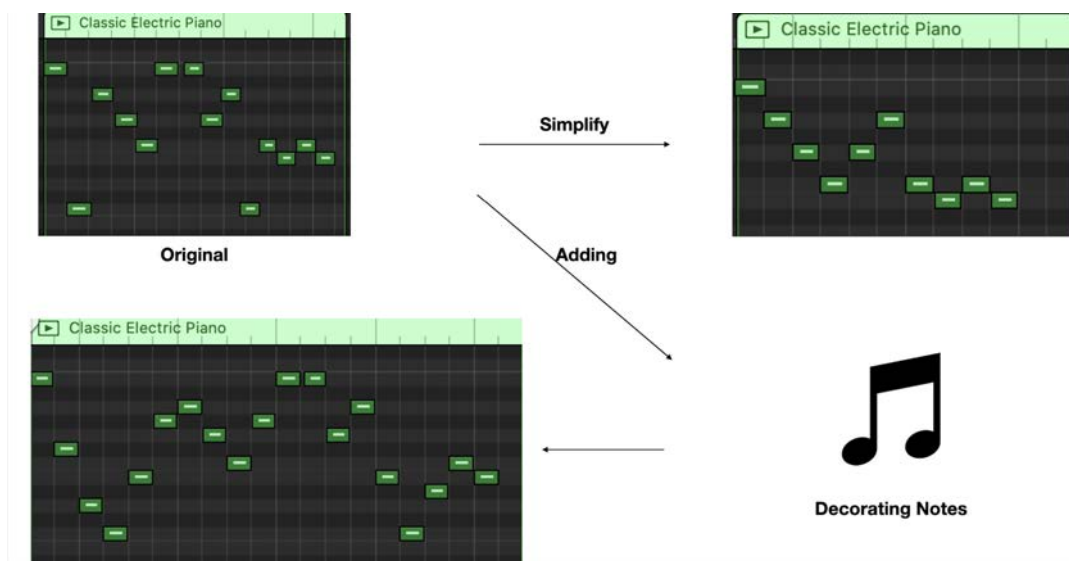


Figure 4.15 Three audio files of melodies were generated

Chapter 5

Validation

The method used to validate this research was a qualitative test. Three volunteers took part in the final user test and accepted detailed interviews towards their feelings and thoughts after using the prototype.

The result and feedback can mainly be discussed from the following aspects: Music Composition, Relaxation , Synaesthesia and Other Feedback.

5.1. Melody Composition

For the music composition feature, 3 participants all shared mainly positive feedback.

- They were first asked to rate their outcomes of the prototype from 0 to 10.

Table 5.1 How much do you like your outcomes?

Participant	Rating
A	9
B	7
C	8

- Participant A said 9, because she thought she did a great job on the artwork creating and the melodies finally generated can showed the characteristics of the artwork as well. "I am especially fond of the last version(random decorative notes added) of the melody. What I had been created is a mysterious animal, and that melody sounds just like a theme song of my animal! The only thing that is a bit of a flaw was

the size of the tetrahedrons was not quite fit to the holes on the board, it was a bit hard to set them” she commented.

- Participant B gave a 7, since he thought the colours provided were not enough for him to actually create a decent artwork that can satisfy him. ”But the melody outcomes were quite amazing, I never thought they would be like this, but they do sound like piano music actually.
 - Participant C rate 8, ”The idea of using tetrahedrons to create two-dimensional artworks is very interesting, and the final artwork outcome is not just a bit abstract but also conveys a futuristic feeling. The melody outcome, to be honest, I first thought it would be a bit weak due to there were only seven keys from the keyboard, but the result sounded just fine”, she commented.
- The sense of engagement and ownership was then discussed.
 - Participant A thought both the artwork and melodies can be considered as her creations. She also showed a willingness and looking forward to making use of these melodies in proper situation one day. ”I think it is a bit hard for me to talk about the reason why I feel these melodies were my creations, since I just simply take that for granted. They were created during the time I was using the prototype, if there was me, they will not be created. I guess this is my answer.” She explained.
 - Participant B also showed his agreement with Participant A, ”It is not like that you can get the melody for nothing. For example, you can get a toy if you buy a happy set from McDonald’s, but the process in the user test was nothing alike to that. I did invest my time, my imagination, and my efforts to it, it definitely should be considered as my own creation. Since you won’t doubt whether a digital artwork I created in Photoshop is my creation or not. I think these two situations are just the same” , he commented.
 - While Participant C were not as assure as the others, ”I guess the audio feedback just drew too much of my attention, the moment I knew it was making the sounds from a piano keyboard, I started treated it

more like piece of musical instrument, not an artwork creating tool. So I then just randomly placed the tetrahedrons on the board, to try out which colour represented which notes. I might not consider what I've done can be called artwork creation, but the outcome did feel like I created this artwork and the melodies” , she said.

In conclusion, the goal of transferring the process of music composition to artwork creation can be considered achieved. Melodies created were valued highly, except of Participant C's being uncertain, the other two participants also consider the melodies were part of their creation from the user test. A sense of achievement can also be found in their words towards the melodies.

5.2. Relaxation

The sense of relaxation was also discussed, in order to prove the feature of being user-friendly.

- Observation of facial expression was conducted.

During the test, participants facial expressions were observed. Most of the time, they looked quite relaxed, even with mild smiles on their faces. Some peaceful expressions can also be found in their faces.

- Then Participants rated and talked about their actual feelings during the test.

Table 5.2 From 1-10 how much would you rate you stress level during the test?

Participant	Rating
A	0
B	1
C	0

- Participant A said, ”The whole process was pretty relaxing for me. I enjoy doing handcrafts during my leisure time, and I think the two processes are kind of alike.””But the audio might be a bit annoying for me, so I muted it when I was trying to create my artwork”, she added.

- Participant B showed his sense of relaxation as well, he he chuckled and said, "I am a design student, and creating something is just some part of my daily life. But unlike creating a poster or slides for homework, the process of the user test just remind me of doodling on my notebook when I wasn't paying attention to my teachers on the class."
- Participant C said, "I think, as I mentioned above, I was kind of doing the test mindlessly. This is how relaxing the process was to me. I felt like I was back to my childhood and playing with some toys", she commented.

According to the feedback from all of three participants, the design of Melodia can also be considered achieved in being user-friendly enough for people to use in their leisure time.

5.3. Synaesthesia-like Experience

The third part of the interview focused on the participants' experience through the user test and whether they obtained a sense of music and colour were connectable.

Table 5.3 How much would you rate the connection between colours and music notes?

Participant	Rating
A	6
B	8
C	7

- Participants were told to first talk about their experience during the user test.
 - Participant A said, "I was first not very sure of what the background audio was about, so in the first time, I play around with the tetrahedrons to see what sounds they can made. Then after the description, I understood the intention of the project and chose to focus more on

my artwork creation by muting the background audio. Therefore I was not sure whether I had sensed the connection during the user test.”

- While participant B thought he did sense the connection, ”I was very surprised that the notes actually echoed in my mind when I picked up the tetrahedrons that are of same colours as those I had already put on the board. I am not sure whether this happened because of the repeat of the audio or not, but I actually felt it that way”, he recalled.
 - Participant C also shared her experience, ”I thought I accepted the setting that different colours means different notes during the user test pretty well. I felt like I was interacting with not only the tetrahedrons but also the notes as well. The prototype for me is an art tool and a piece of musical instrument at the same time”, she said.
- Participants were then talked about their experience when they heard the output melodies.
 - Participant A kind of senses the connection when the melodies were playing, ”As I said earlier, I felt like the 3rd version of melody was a perfect theme song for my mysterious animal. I can already picture it slowly walking into my sight when the melody was played”, she said.
 - Participant B also had a similar experience to participant A, he said, ”I was a bit surprised by the melodies at first, cause I never thought these melodies could be created by me, a guy that hadn’t been studying anything relates to music ever since graduated from high school. Then the second thing I found was I can simply related what I created on the board to these melodies.”
 - While participant C might had a different experience to the other two, ”It is interesting that I was not trying to actually create something at the first place, but when I listened to the melodies, they actually reminded me of what I had made. I guess that was because I focused more on the audios?” she shrugged slightly after sharing the experience.

All participants suggested they had sensed the music and colour’s connection

for at least one time during the user test, which indicates Melodia also succeeded in providing a colours and music synaesthesia-like experience.

5.4. Other Feedback or Suggestion

Other feedback or suggestions were also shared by the participants during the interviews.

- Adding more colours to the tetrahedrons.

All three participants mentioned the restriction of colours might also restrict them from being more creative. Participant B also suggest to use lighter or deeper colours to represent same notes from different scale.

- Making the placing board bigger.

Mentioned by participant C, she shared her idea of it would be great if the device can be played by more than one person at the same time. She suggested to just simply make the board bigger or it would be cool to make it even extendable. Participant B also shared his opinion of the board being too small might be a restriction for him to created bigger works with more details.

- Adding more visual effects. Participant A agreed with the idea that the device might be used as an educational tool but also suggested that it can be more eye-catching for young children or elderly if adding some light and flashing effects. Participant C also thought that the device might be used for performance, therefore, adding some light and flashing effects might add more fun and aesthetic feeling to the performance.

Chapter 6

Conclusion and Future Works

6.1. Findings and Validations

From the study of related works, the important roles of music and art in people's leisure time were once again confirmed. While existing music tools nowadays might not be able to help non-music-background people to actually create their own music very well. The past works of music and colour synaesthesia not only showed a long history of people trying to find out the analogy between hearing and seeing, between music and visual art, but also gave us a hint of not to cling on finding one specific colour scale of music notes, while freer usages of colours can also be considered as another possibility due to the difficulty of find one "standard" colour scale.

During the field trips to live houses and music bars, the potential needs for a new solution for music composition were confirmed. The application of different colours in the lighting for different songs, musicians and audiences' small movements following the rhythm, the relaxed facial expressions were also noticed in the observation part in the field trips.

After the all the preliminary investigation, the final target users and goal for this research were settled to people who have interests in music composition while lacking of corresponding background and a new stress-free solution for melody composition by transferring the traditional melody composition process to colour-based art creation. And the hypothesis was decided to: By transferring traditional melody composition process to colour-based art creation, people can create their own melodies in a stress-free way.

And after manufacturing and testing the prototypes, the hypothesis of this research can be considered validated.

Melodia was tested achieved in its goals of transferring the traditional music

composition to a user-friendly colour based artwork creation and can produce reasonable melody outcomes. At the same time, the process of art creation can actually keep people's engagement during the music composition process, which is able to hence their sense of ownership.

Melodia was also tested can barely trigger users' anxiety according to users feedback in the deep interviews and also their facial expression through the user test.

And finally, Melodia was also succeed in providing a connection between music and colours, which can be considered similar to music and colour synaesthesia.

6.2. Possible Improvements

There are quite a lot of things can be modified in the current research.

First is the number of user test participants. More participants should be involved in the user test, current participants' opinions might be not various enough to be convincing.

Second is about the working prototype. It is believed that working prototypes can actually produced. But during the pandemic of COVID-19 [40], there were too many of restrictions. A fully working prototype can definitely be more straightforward, and easier for users to understand its attempt. And being able to add more colours to the tetrahedrons and more placing spaces to the placing board can, for sure, be more helpful for users to create some more decent artworks using the prototype.

Last is about the environment control during the user test. Again, due to the situation of the pandemic, the environment for the user test were not very ideal. The user test should be carried out at a more peaceful and quite place, while the final user test ended up happened in a bedroom for one. The stress level might also be affected by the environment.

6.3. Future Works

The current work can be further developed to a fully working physical prototype or extended as a concept that includes both physical and digital sections.

And the idea of making the device a stackable can be further experiment, since three-dimensional works are, of course, have more freedom than two-dimensional works. It might help users to feel more relaxing and help them to be more creative.

Also, the idea of applying the system for musical education use can be further studied and testified.

And the materials using for the final tangible product should be considered as well.

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