The Development of an Audio-Visual Language for Digital Music Performance

by Masato Kakinoki

Canterbury Christ Church University

Thesis submitted

for the Degree of Doctor of Philosophy

Year 2017

Contents

Table of figures

Acknowledgements

This research was supported by Canterbury Christ Church University Graduate School, and partially supported by Canterbury Christ Church University School of Music and Performing Arts and Canterbury Christ Church University Faculty of Arts and Humanities.

I would like to thank Akihiro Kubota and Markus Miessen for their generous gesture of sending me the PDF files of their books, which I could not obtain. The advice given by Yuko Izumi has been a great help to me in structuring and organising the thesis. The earliest practices of the performance system in front of an audience would not have happened without support from Nick Luscombe and Mark Rappolt.

The research would not exist without the teachers I have had in the past: Muneya Kato, Takaaki Kumakura, Hiroshi Muto, Kiyoshi Yasutomi, Ed Hughes, Nick Collins, Tim Hopkins, and Sally-Jane Norman. I appreciate the support from Nicholas McKay, Robert Rawson, and the Graduate School at Canterbury Christ Church University. The development of the research would not have been possible without the critical advice and feedback given by my supervisors, Matt Wright and Panos Ghikas, who have always been passionate and encouraged me to keep improving on what I have achieved.

Special thanks to my family and friends for believing in me throughout the journey.

London, 30th October 2017

Abstract

This practice-based PhD consists of a portfolio of creative work and a supporting commentary. The portfolio illustrates the design decisions relating to my digital music performance system, and focuses upon the visibility and the fluidity of digital music performance. The goal of the design is to enhance the visibility without violating the audience's auditory imagination unnecessarily, and to enhance the fluidity without relinquishing the unique fixed nature of digital music.

The performance system consists of an audio engine, control mapping engine and visual engine. The audio engine and the control mapping engine were programmed with Cycling '74 Max. They let the performer deconstruct and reconstruct pre-recorded audio files with her/his hands via MIDI controllers during performance. The visual engine was programmed with Derivative TouchDesigner. In various ways, it visualises and exaggerates the performer's actions which cause sonic changes, and filters out the rest.

The works are presented as videos and the supporting commentary, deals with the contexts and thinking processes which determined the current performance system. By exploring theories of electronic music performance, audiovisual, visual music, acousmatic and medium specificity, I aim to explain the reasoning behind the performance system.

Introduction

> many musics can only exist through recording techniques, and the problem then becomes how to deliver such music in live settings (Collins, 2013, Chapter 13 Live electronic music, Live and recorded music, para. 4).

Non-real-timeness and non-bodiness are the significance and the medium specificity of digital music. My digital music pieces are produced through a recording and editing process. The process is non-linear, where I go back and forth on the macro time scale[1] of an emerging piece while producing. I also construct the piece on multiple time scales such as the macro time scale, the meso time scale,[2] the sound object time scale[3] and the micro time scale[4] continuously. This is the medium specificity of the DAW (digital audio workstation) timeline. The computer-based sound design of the process is not proportional or restricted to my physical body. With such music, we have to overcome some inevitable challenges if we desire to perform it live,[5] as physical time is definitely linear in a performance situation and it

[1] 'The time scale of overall musical architecture or form'
Roads, C. 2001. *Microsound,* Cambridge, Mass., MIT Press, p. 3.
[2] 'Divisions of form. Groupings of sound objects into hierarchies of phrase structures of various sizes'
Ibid.
[3] 'A basic unit of musical structure, generalizing the traditional concept of note to include complex and mutating sound events'
Ibid.
[4] 'Sound particles on a time scale that extends down to the threshold of auditory perception'
Ibid.
[5] The desire to perform live is sometimes based on economic reasons, especially with commercial music. As with the advent of the digital age the primary source of revenue has shifted from recordings to concert events. Another reason for this is the way the concept of 'live' emerged historically. Auslander states, 'It was the development of recording technologies that made it both possible and necessary to perceive existing representations as "live"'. A general example in society includes Snapchat which became popular because of its ephemeral content (pictures will be deleted after a while, without being archived), and the other SNS companies such as Facebook and Instagram introduced the similar 'Stories' feature (Facebook in 2017 and Instagram in 2016). These can be treated as one of the signs of the stronger necessity of 'liveness' in our latest society. But we should note that these commercial services only offer the 'now' part of the 'here and now' quality of liveness. On the other hand, live music concerts still socially function to deliver the 'here and now' quality to people. Such experiences are different from the upcoming Virtual Reality experience (for now).
Auslander, P. 2012. Digital Liveness: A Historico-Philosophical Perspective. *PAJ: A Journal of Performance and Art,* 34**,** 3-11, p. 3.

is impractical on stage to reproduce the hours or days of the whole music production process. Klara Lewis, a contemporary experimental electronic music producer, summarises as, 'I cannot improvise my tracks, because then the concert would have to last several months' (Sounds Of A Tired City, 2015). We could either pretend to reproduce the process (by replacing a computer with live musicians, for example), or perform a DJ-style set. However, I wondered whether there could be another approach to performing such music, and this led to building my own digital music performance system.

For my performance setup, I use the recordings and the deconstructed parts of my music pieces as core audio materials. When accepting that option, the extreme approach would be to push a button and let a laptop play the whole audio file of the piece being performed. Such a performance, which some people would call the 'push-play' (Kirn, 2012) approach, seems more like a listening session rather than a live performance to me. Throughout this research, I have attempted to understand, develop and hopefully actualise my ideal live performance of music pieces. This thesis explains how I ended up with my performance system, format, and concept.

The ideal live performance of my music pieces would be sonically different from the pre-existing recordings of them. The differences should reflect my decisions and actions during a performance, so that there will be the clear physical presence of a performer, and the differences will be unique with each performance. In terms of sonic fluidity, there is a continuum between the push-play approach and a full laptop improvisational performance. The contexts behind this concept will be discussed in Chapter 5.

Shah, S. 2016. *Facebook's first Live Video ad campaign encourages you to stream everyday life* [Online]. Yahoo. Available: https://www.yahoo.com/tech/facebook-first-live-video-ad-050322097.html [Accessed March 26 2017].

After having achieved such a type of 'live' quality sonically, presenting that quality visually to the audience is crucial in my concept. Simon Emmerson writes that 'appearances are everything: if in a musical discourse event A *appears* to cause event B *then it has done'* (Emmerson, 2007, p. 95). From this viewpoint, when event A *does not appear* to cause event B, *then* it *has not done*, even if A does actually cause B. It means that, even when the fact is that sonic differences and changes are made by a performer 'here and now' (Benjamin, 2008, p. 21), if the audience cannot perceive that fact, to them, the experience will be qualitatively the same as the situation where such a fact does not exist at all. In my performance, visuals are used to tackle that issue primarily, rather than to reflect musical content using direct audio-to-visual visualisation.

In this research, I attempt to clarify the issues concerned by looking into existing theories and practical examples. The core aspects which tend to be lessened in digital music performance, and thus my main interests in this research, are the visibility and the fluidity of performance. Both aspects have their background in the physical presence of a performer, which is suggested by Emmerson. As Emmerson examined 'live' electronic music, and Mark J. Butler expanded Phillip Auslander's idea of 'liveness' to the context of DJ and laptop performance, their ideas are treated as core theories in this research.

'Liveness' is the concept suggested by Auslander. He states as follows.

> 'liveness' is not an ontologically defined condition but a historically variable effect of mediatization. It was the development of recording technologies that made it both possible and necessary to perceive existing representations as 'live'. Prior to the advent of these technologies (e.g., sound recording and motion pictures), there was no need for a

> category of 'live' performance, for that category has meaning only in relation to an opposing possibility (Auslander, 2012, p. 3).

The technology of recording reveals 'the here and now—its unique existence in a particular place' (Benjamin, 2008, p. 21) of performance. 'Music performed on a laptop is lacking in one element: its unique existence at the place where it happened to be created' (Cascone, 2003, p. 102). When the experience of a particular performance is the same as or very similar to its recording, there would be less need to discern it from the recording, thus 'liveness' would be reduced accordingly. This situation is quite common in 'live' digital music performances, where recorded music pieces often are the music's primary entities. Then why do we still call it 'live'? Emmerson's 2007 working definition of 'live' is used to address how a performance should be different from its corresponding recording. The term 'liveness' or 'live' refers to Emmerson's definition in this research, which is 'The presence of a human performer: who takes decisions and/or[6] makes actions during a performance which change the real sounding nature of the music' (Emmerson, 2007, p. 90).

Chapters 1 and 2 deal with the use of visuals in digital music performance. Chapter 1 looks at the aesthetic views in relation to using visuals in digital music performance. The contrasting views from the acousmatic field and the audiovisual field are referenced in order to find the ideal audiovisual approach. Visual music will be visited for the purposes of providing historical context. Chapter 2 introduces the key visual aspects that the artist should be concerned with when using visuals in digital music performance. Chapters 3, 4 and 5 cover the liveness and the causality of digital music performance. Chapter 3 looks at the 'bodiness' in digital music

[6] As footnoted by Emmerson, there was a practice where actions were made without decisions, actualised by performance artist Stelarc, but I will not go further in that direction in this research.

performance. I will also explore what bodiness means in digital music in general. Chapter 4 tackles the ideas around using hardware devices in digital music performance. Additionally, how certain characteristics of hardware devices can contribute to an optimal flow state will be explored also. Chapter 5 defines the fluidity and the fixity of digital music performance, and attempts to find practical approaches to make digital music performance more fluid.

Visuals in digital music performance

Chapter 1: Using visuals in digital music performance

Digital music's non-visibility is one of its unique strengths. Its sounds are freed from physical and visible instruments in the material world. The entity of digital music is merely the combination of digits, and thus immaterial. However, when it comes to its performance, it is different. Real-life performance in a physical space (as opposed to virtual-life performance in an online virtual world such as Second Life) is inevitably material. If we desire to perform digital music, we need to tackle its inherent lack of visibility. Moreover, every music performance is technically audiovisual. We see something regardless of whether it is darkness or speakers. Robert Henke, a composer and the co-developer of Ableton Live music software, provides an account which helps illustrate the issue that I have focused upon:

> When listening to one of those more or less pre-recorded live sets playing back from a laptop, we have almost no idea of how to evaluate the actual performance […]. We have no sense for the kind of work carried out on stage. What we see is that glowing apple in the darkness and a person doing something we cannot figure out even if we are very familiar with the available tools. This scenario is not only unsatisfying for the audience but also for the performing composer (Henke, 2007).

'[D]igital technology makes experimentation very accessible to a wide base of artists, through the combination of the power of processing and the relative cheapness of hardware', and 'There is a proliferation of hardware and software for audiovisual

performance at the moment' (Barrett, 2007, p. 133)[7]. A music performance with visuals might seem a visibly richer experience than one without any such element, but the opposite is also possible. From the viewpoint of acousmatic[8] music practitioners, visual information is a distracting obstacle in music performance, which could constrain what the audience perceives from a live music performance. Stockhausen announced 'that it is *necessary* to close the eyes when listening to acousmatic music' (Emmerson, 2007, p. 168), 'before most of the acousmatic concerts he [presented]' (Emmerson, 2007, p. 168). The acousmatic approach helps us design the ways we should and should not use visuals in digital music performance. According to Kim Cascone, 'The laptop performer, perhaps unknowingly, has appropriated the practice of *acousmatic music* and transplanted its issues' (Cascone, 2003, p. 102). Dennis Smalley stresses 'the trans-modal perceptual nature imbedded in aural perception itself, and the vast expressive range of the purely sonic acousmatic ["]image["]' (Smalley, 2007, pp. 81-82) as the reason behind his following claim.

> There is no need to use visual images to direct the listening imagination, no need to serve out semiotic supplements that restrict the 'meaning' of the music, no need to hold the listener's hand (Smalley, 2007, pp. 81-82).

[7] The proliferation seems to be still ongoing today in 2017. This could be partly because while most of the digital audio processing can be realised with any laptop on the current market, many kinds of visual processing require the latest most powerful laptop. Barrett notes that developments in visual computer technology take longer compared to audio; see note 8 of the quoted chapter.
Barrett, N. 2007. 13 Trends in electroacoustic music. *In:* Collins, N. & D'Escrivan, J. (eds.) *The Cambridge Companion to Electronic Music.* Cambridge: Cambridge University Press, p. 260.

[8] Acousmatic, a word of Greek origin discovered by Jerome Peignot and theorized by Pierre Schaeffer, described "sounds one hears without seeing their originating cause".
Chion, M. 1994. *Audio-Vision: Sound on Screen,* New York, Columbia University Press, p. 57.

He also takes the telephone and the radio as examples, to show how well one can expand one's imagination through aural information (Smalley, 2007, p. 80). Akihiro Kubota's following view is relevant here.

> Using visuals that are not directly related to sound as a filling in space often results in only weakening the intensity of the sound. The more the impact the visuals have, the more likely the audience do not listen to the sound itself. The misuse of such physicality and visual image only promotes the shadiness of laptop performance where 'you don't get what she/he is doing' (Kubota, 2017, 第 2 章　素材から即興へ, ライブコーディングの可能性, コードを見せるということ).

When using visual elements in live music performance, it is crucial to be conscious about what aesthetic meaning will be added to the total experience. Otherwise, the performance might be more effective without any visual clues (in this context, the word 'visual' includes the presence of a performer, not only the visuals on screen). Pierre Schaeffer states that source identification is unnecessary, misleading, and distracted from the establishment of a potential musical discourse (Emmerson, 2007, p. 5). Emmerson writes that 'The acousmatic condition, in depriving us of what we have been told is the dominant sense perception of the late twentieth century media, and has engaged and encouraged that most essential faculty, the imagination' (Emmerson, 2007, p. 34). Stockhausen was a supporter of an acousmatic condition, writing 'The present fashion to add visual effects to almost all the music performed should diminish. Listening to music in the dark will become much more important in the future than today' (Stockhausen, 2007, p. 198). Clement Greenberg, disapproves

of synaesthetic art practices, focusing on visual arts' evolution towards a reductive purity apart from the influence of other genres (Greenberg, 1940, p. II).

The electronic music producer duo, Autechre chose such an acousmatic approach. They perform in complete darkness. In an interview, they gave two reasons for this environment. Firstly, they were never satisfied with working with external VJs or lighting technicians, and they could not afford to do so by themselves because they continuously manipulate sounds in real time (Ishii, 2005). They discovered the second reason after starting to perform in the darkness. They said that the darkness brings a sense of unity to the audience, and the audience are thus deeply moved by embracing listening, without any visual distractions (Ishii, 2005). This is, of course, reminiscent of the concerns of acousmatic presentation in electroacoustic art music. Like Autechre, Francisco López makes an effort to draw the audience's attention to the sounds themselves rather than to their visual sources; to do this, he asks that audience members wear blindfolds during his live performances (Cox and Warner, 2004, p. 82). Such a philosophy also exists in DJ culture. The legendary venue Plastic People was 'a purist space that [celebrated] sonic dominance' (Rietveld, 2013b, Performing Producer, para. 2). The dance floor was dark, except for a tiny emergency light, the desk-lump illuminating the record players and some incidental light from the bar.

At Autechre's performance on the 21st of November in 2015, contrary to their intention, I could not feel such an immersive experience. As they had described, the stage lighting system was turned off, but the environment was far from complete darkness because of several emergency lights, lit signs for toilets, a smoking area and a cloakroom, and the lights from a bar. Emmerson would suggest that they announce to the audience to close their eyes, as Stockhausen did before with his concerts

(Emmerson, 2007, p. 168). López would recommend them his approach of providing the audience with blindfolds. Soon after their set began, another issue emerged. Because there was no visual aspect to the performance, some audience members (who seemed unaware of the visual format of Autechre's performance) either did not realise that the performance had begun, or did not regard this as a live performance. The concentration level of the audience members (excluding serious fans) seemed lower than the one during the earlier act who had used full lighting. The couple on my right kept speaking loudly, as if they were talking during the interval DJ set between main acts (despite of the fact that the main act, Autechre was performing). I could not ask them to be quiet, because ironically, I was also not 100% sure if the performance had begun or not. I thought this possibly could be pre-act background music. Here, another issue reveals itself. Namely, my experience at the performance could be the same even if all the performing sounds were the simple playback of the recording of their past performance.

Squarepusher also chose to perform in 'a completely dark environment' (Hutchings, 2015) for a certain period.

> There was a phase of touring where I would just do gigs in the dark. I'd try and turn every single light off in the venue. I couldn't turn off the fire exits obviously, there are limits, but I'd do my best to make it a completely dark environment. That of course embodies a very stark aesthetic on its own, but what I wasn't doing was supplying any positive visual content' (Hutchings, 2015).

Now he does audiovisual shows. He explains that 'there was a very distinct attempt to integrate what I saw as imagery which is strongly corrected by the music; directly

stimulated by it'(Hutchings, 2015). Smalley and Emmerson would insist that his visuals limit the audience's imaginary visuals, and impose his own visual implementation on the audience. The audiences share the same externalised visuals, rather than visioning individual's own internal visuals in their mind. Determining the desired point of this parameter would determine the degree of communal quality and personal quality of performance. The way Matthew Herbert described his launch performance of his album 'Music' as unsuccessful could help explain the contrast between the communal and the personal (Kakinoki, 2017a). The album takes the format of a written book, and he wrote 'a description of record rather than [made] the music itself'(Herbert, 2017). As he read the book at the performance and the audience imagined sounds with their own implementation, he said that the audience's experience became too internal, where he preferred it to be more communal in the context of his current concerns with Brexit.

In contrast to the acousmatic practitioners, audiovisual performers and artists do not see visuals as redundant obstacles. Michel Chion expresses his doubt about the acousmatic approach. He states that even though Schaeffer thinks the acousmatic situation encourages reduced listening[9], 'the opposite often occurs, at least at first, since the acousmatic situation intensifies causal listening in taking away the aid of sight' (Chion, 1994, p. 32). Causal listening 'consists of listening to a sound in order to gather information about its cause (or source)' (Chion, 2012, p. 48). Chion, continues as follows:

[9] 'the listening mode that focuses on the traits of the sound itself, independent of its cause and of its meaning' Chion, M. 2012. The Three Listening Modes. *In:* Sterne, J. (ed.) *The Sound Studies Reader.* Abingdon: Routledge, p. 50.

> Confronted with a sound from a loudspeaker that is presenting itself without a visual calling card, the listener is led all the more intently to ask, "What's that?" (i.e., "What is causing this sound?") and to be attuned to the minutest clues (often interpreted [wrongly] anyway) that might help to identify the cause.
>
> […] Knowing that this is "the sound of x" allows us to proceed without further interference to explore what the sound is like in and of itself (Chion, 1994, pp. 32-33).

In digital music performance, a particular type of causal listening occurs when the performer uses a non-human sequencer to trigger sounds. This is quite a common scene (e.g. a performer and a laptop). As long as it calls itself as a performance, and the performer is presented as a participating actor of the performance, the audience would expect the performer to cause of affect it to some extent. Then the audience is led to causal listening to identify which sounds are changed, affected, or generated by the human performer on stage, and which sounds are triggered by the non-human sequencer. With my performance system, visuals are used to decrease the need for such causal listening. Since the audience have greater information about which sounds the performer is affecting, they can direct their attention to 'the inherent qualities of sounds' (Chion, 1994, p. 31) more.

In practice, with the increased popularity and familiarity of video-sharing web services such as YouTube, people are more used to experiencing music with visuals in their everyday life. Due to this shift, and also because of the relentless discussion on the lip-sync culture of this mediatised era, the value of seeing sound sources is appreciated. For instance, Pomplamoose, a group of two multi-instrumentalists, has been posting its performance videos on YouTube since 2008 and they have become a

successful indie act, as a large audience liked and shared their videos. These videos mostly take the form of 'VideoSongs', the medium the group define with two rules:

1. What you see is what you hear (no lip-syncing for instruments or voice).
2. If you hear it, at some point you see it (no hidden sounds) (Jack Conte, 2008).

There are art forms which integrate an audiovisual causality into their work, opposing the acousmatic approach. '[T]he live audio-visual sampling cut and paste descendant from the scratch video circuit (Emergency Broadcast Network, Coldcut, Addictive TV)' (Barrett, 2007, p. 135) is one of them. For example, the archived video of Addictive TV's performance titled *Orchestra of Samples [Hangman]* - Addictive TV live @ Watermans Arts Centre, London' (Addictive Addictive TV, 2013) shows that the visual presentation of who and what produced each sound is one of the key features of the performance. Sonically it can be experienced as sampling-based recorded music, but with the visuals, the performance provides a different quality with a clear aesthetic intention.

In a broad sense, classical piano concerts can be seen as audiovisual music performances, in terms of the fact that there are people who prefer to take a seat where they can see the movements of the pianist's hands. Moreover, 'in 2004, the New York Philharmonic, in a bid to attract a younger audience, began to experiment with using live-feed video in its concerts so that audiences could experience close-up views of the musicians and conductor' (Auslander, 2008, 2 LIVE PERFORMANCE IN A MEDIATIZED CULTURE, Is it live, or …?, para. 4).

As audiovisual performance and art have their historical roots in visual music, visual music can be treated as the historical context of the audiovisual approach in music performance. Visual music 'includes paintings, photographs, color organs, films, light shows, installations, and digital media', and 'Animating such physically, geographically, and chronologically disparate works is the idea of synaesthesia' (Strick, 2005, p. 15). Synaesthesia is 'the rare capacity to hear colors, taste shapes, or experience other equally strange sensory fusions whose quality seems difficult for the rest of us to imagine' (Cytowic, 2002, 1 Introduction , para. 4). In the context of visual music, the idea of synaesthesia is used more broadly as 'the unity of the senses, by extension, the arts' (Strick, 2005, p. 15). 'According to the principle of synaesthesia, sensory perception of one kind may manifest itself as sensory experience of another' (Strick, 2005, p. 15). '[T]he idea of synaesthesia served to mediate between music and visual art in the early twentieth century' (Strick, 2005, p. 16).

Before digital media, synaesthetic art practices were seen in abstract paintings, colour organs, abstract cinema, projected light shows, and installations. 'These media all treat music and visual art as separate but related entities, brought together for the listener/viewer. […] In digital media, by contrast, music and visual art truly are united, not only by the experiencing subject, the listener/viewer, but by the artist. They are created out of the same stuff, bits of electronic information' (Strick, 2005, p. 20). In the era before digital, the skill of making music (e.g. playing the piano or composing scores) and the skill of making visuals (e.g. drawing a sketch) were technically not related very much (Kubota, 2004, p. 37). It was not practical to train in the skill of oil painting in order to play the piano well. However, in our digital era, the skill of handling visuals and that of handling audio are much more closely aligned. They are

both basically the combinations of numbers, and the improvement of either often means the improvement of the other. In this sense, for a digital musician, the use of visuals for her/his artistic expression is more natural and straight-forward than was the case in the analogue era. Analogue musical notation can be seen as the visual translation of musical sound, but the visual appearance of musical notation is not usually designed as an artist's aesthetic expression. It works functionally rather than aesthetically. The visuals of my system work both functionally and aesthetically. They are functional as the video notation of the musical changes and the actions causing the changes during performance. The visual appearance of each visual was designed aesthetically, and the skills I gained through audio computer programming helped greatly in the process.

VJing ('improvising with visuals, specifically those rendered via projected light' (Spinrad, 2005, p. 13)) is one of the contemporary practices of visual music, and it is a real-world example of where visuals are used to fill the lack of visibility of digital music. One of the roles of VJs is to 'provide the focus missing from "watching" an electronic band' (Shaughnessy, 2006, p. 10), and 'the big deal about [VJing's] being live' is that 'every moment is unique' (Spinrad, 2005, p. 13). To paraphrase, VJs use visuals to enhance the 'here and now' quality of music performance, which is lessened by the non-visibility of digital music performance. The VJ Codec, aka Niklas Völker, makes a similar point as follows:

> The basic difference between concerts twenty years ago and concerts today is the virtualization of the process of musical creation. Audiences of acoustic and electrically amplified bands witness the production of sound, whereas in electronic music this process is concealed by laptops and controllers. The musicians behind their monitors could just as

> easily be checking their e-mail on stage. And so a visual vacuum develops that needs filling. This creates a demand for somebody to complete a concert or club night experience with visuals (Völker, 2009, p. 236).

Visual music is the most consistent 'mode through which music and the visual arts have interacted over the past century' (Strick, 2005, p. 18), and 'Its longevity can be explained above all by the fact that it required technology for its fulfilment' (Strick, 2005, p. 18). The first technological platform for visual music was painting.

> […] as expressions of musical analogy, these paintings always fall short in one important respect', the element of time. […]
>
> Abstract film developed as if in direct response to this shortcoming. […] As the technologies of color film and soundtracks developed, artists like Oskar Fischinger, Harry Smith, and the Whitney brothers, among others, brought color, form, and sound together to create extended compositions that bore occasional resemblance to the work of the earlier generation of abstract painters while taking full advantage of the crucial element of time and incorporating sound and music to create a fully synaesthetic experience (Strick, 2005, p. 19).

Fischinger's work is an early example of the use of the synaesthetic effect in filmmaking.

> […] the film *Radio Dynamics* (1941), by probably the best-known abstract filmmaker, Oskar Fischinger, was intentionally made without sound; Fischinger's intent was to demonstrate that non-objective imagery could work on its own. In fact, the film begins

> with a title slide that says, in large, handwritten letters. 'Please! *No Music* - Experiment in Color-Rhythm' (Fischinger 1942). In *Radio Dynamics*, as in most of Fischinger's films, the abstract forms create their own spatial and temporal rhythms (Alexander and Collins, 2007, p. 129).

Another artist who explored a synaesthetic effect, Bute, 'thought that art could leave a significant impression on modern life only as a multisensual experience' (Naumann, 2009, p. 53).

> One sense of perception such as sight or hearing is not enough to induce a strong reaction and to put our emotions in balance with the present highly developed intellect. To achieve strong emotional reactions we must charge our perspective sensual apparatus with greater and more intense exciters. In the field of art these stronger exciters are synchronized art forms (Naumann, 2009, p. 53).

There are contemporary audiovisual artists who attempt to give a synaesthetic (pseudo-synaesthetic, strictly speaking) experience to audiences through their work.[10] Ryoichi Kurokawa is a multimedia artist who exerts a synaesthetic effect in his work (Kurokawa, 2010).

> The phenomenon of synaesthesia is one of the main themes for my work. Embracing audio, visuals and space, and synaesthetically constructing a three dimensional approach pertaining to sensitivity from every angle and direction, trigger the audience to have an experience which is similar to synaesthesia. Most of my work involve visuals and audio,

[10] Some would argue that it is not real synaesthesia, as historically and academically synaesthesia is the term for 'rare capacity', but I will not go into that discussion in this research.

but for either, my mindset is close to that of sculpting time. I also consider an architectural factor, in terms of giving dynamism and volume to space by controlling the texture, the movement and the behaviour of audio and visuals (Ueno, 2012).

I am trying to generate an effect which is similar to synaesthesia by stimulating the audience auditorily and visually simultaneously (Hadfield, 2014).

Carsten Nicolai 'constructed some installations (wellenwanne, 2000/telefunken, 2000)' 'In terms of synaesthetic perception' (Nicolai, 2007, p. 83). Yuko Hasegawa, the previous chief curator of Tokyo Contemporary Art Museum, describes Ryoji Ikeda's audiovisual work as 'like listening to music or sound by eyes' (Tokyo Art Beat, 2009), which is a simple explanation of the synaesthetic effect that exists in a certain type of audiovisual work. Kubota suggests a slightly different approach in his digital materialistic audiovisual expression, which he termed 'synmaterial'.

With the approach [synmaterial], the heterogeneous senses emerged from the different formats of expression which are generated from the same (numerical) material simultaneously, will not be fused, but rather made to run heterogeneously in parallel, so that the gap between the senses will be retained, or the generation of the third sense which is different from the both will be attempted—I believe there is another possibility of audiovisual expression where the audio and the visual exist independently (Kubota, 2017, Interlude A, 共感覚と共素材).

Regardless of whether a particular performance calls itself an audiovisual performance or a tape music concert, as long as it happens in a physical space, to the audience it is a multisensory experience, including a visual aspect. This is why we have to care about visuals in digital music performance.

Historically, digital music had its uniqueness in its non-visibility. The music sounded new when it was born, because its sounds were freed from physical and visible instruments in the material world. The entity of digital music is merely the combination of digits, and it is immaterial. But when it comes to its performance, things are different. Real-life performance in a physical space is inevitably material. If we desire to perform digital music, we need to consciously think about how we treat the inherent lack of visibility of it. What I am attempting with the visual engine of my performance system is to complement and enhance the visibility of such a performance. With audiovisual performance, it is tempting to exert a direct audio-to-visual visualisation approach, but in order to address the issue, such an approach should not be our main focus. That approach is equivalent to visualising the sound at a classical guitar concert, and it does not contribute to solving the issue which is particular to digital music performance.

The ideal visual state of digital music performance can be summarised into two conditions. Firstly, the audience should be able to sense a performer's physical actions 'which change the real sounding nature of the music' (Emmerson, 2007, p. 90) strongly enough to believe the causality between the actions and related sounds. Secondly, the audience's multisensory audio experience should not be distracted by eye-pleasing but unnecessary visual elements. As quoted above, the primary reason acousmatic musicians avoid visual elements in their concerts is 'the transmodal perceptual nature imbedded in aural perception itself' (Smalley, 2007, pp. 81-82). In

this sense, the rationale behind acousmatic music performance and the one behind audiovisual performance are the same. Smalley is not 'against audiovisual arts, given a properly considered trans-sensory conception' (Smalley, 2007, pp. 81-82). When a particular music performance works most effectively as a multi-sensory experience with the audience's eyes covered with eye masks, visual information would merely impair the experience. When visuals are designed not to restrict the audience's auditory imagination as much as possible, and the value the visuals add to the performance are greater than would have been otherwise, audiovisual music performance then makes sense. With my performance system, to minimise any detrimental effects to the audience's auditory imagination, an unnecessary direct audio-to-visual visualisation (such as iTunes visualizer) approach is avoided, and visual information is designed to be least when not necessary. To maximise the values, visuals are primarily designed to enhance the physical presence of the performer, which is crucial for music performance but digital music performance tends to lack.

Chapter 2: Key visual aspects

1. The performer's physical body and her/his actions as visual information

In the previous chapter, the 'why' of using visuals in digital music performance was the main focus. In this chapter, 'what' key visual aspects that the performer should be concerned with when using visuals in digital music performance is our interest. A performer's physical body is one of them. Butler writes that 'the direct relationship between technological mediation and liveness that necessitates this giving and receiving of visual proof' caused 'DJ and laptop sets' to 'become so visually oriented' (Butler, 2014, p. 105). He summarises that 'the greater the incursion of recording techniques and technologies into performance, the stronger the need for performative displays of involvement' (Butler, 2014, p. 105).

Not only whether there exists a visible physical action, but also the degree of visibility of each action affects the 'here and now' quality of performance. The visibility is affected by several factors. Firstly, when a performer's live involvement is visible to the audience, there are varied levels of visibility. Technically, typing or clicking actions of laptop-only performances are still live involvements. However, there 'the standard visual codes disappear into the micro-movements of the performer's hand and wrist motions, leaving the mainstream audience's expectations unfulfilled' (Cascone, 2003, p. 102). In the context of live coding, the practitioners admit that 'Typing is hardly the most visually exciting interfacing method – you'll be bent over a screen for the night unless you code in further external controllers'

(Collins et al., 2002, p. 322).[11] Tad Turner states that 'Post-digital performative gesture, even with the expressive aid of hardware controllers, is unlikely to be highly dramatic, unless it chooses to think of itself in an extra-musical context such as dance' (Turner, 2003, p. 87). Butler argues that 'For electronic dance musicians and their audiences, these connections between liveness and improvisation become visible through and on interfaces' (Butler, 2014, p. 151). However, in many cases they are not visible enough. In relation to that, I would like to share my experience as an audience member. When I went to see Mount Kimbie's performance on the 14th of November in 2013, there were the actions of playing a sampling pad such as Roland's SPD-SX with drumsticks, of finger drumming a pad controller, and of playing an MIDI keyboard, during the performance. To me, playing a sampling pad felt more 'live', evocative and exciting than finger drumming a pad controller and playing an MIDI keyboard. This personal impression was something I did not expect to have. In retrospect, one difference was that the involvement with a sampling pad and drumsticks was more 'visible' and the others were less, by looking at the size of the physical space occupied by the actions. Butler analyses Apparat's large performance gestures 'marking certain moments as expressive or significant' (Butler, 2014, p. 101). With the visual engine of my performance system, micro-movements are designed to be exaggerated visually.

Secondly, the complexity of a performance affects the visibility too. To the audience, the simpler the sounding of a performance is, the clearer the causality between visual actions and the resulting sounds becomes. When the complexity is too

[11] Kubota suggests that in live coding, 'What correspond to the movement of a pianist's fingers is not the movement of the fingers of the coder, but the functions of the algorithms described by the codes'. In his idea, a computer screen is the physical body of live coding performance.
Kubota, A. 2017. *遙かなる他者のためのデザイン—久保田晃弘の思索と実装 [Design for Distant Others - Study and Implementation of Akihiro Kubota] [Japanese],* Tokyo, BNN, 第 2 章　素材から即興へ, ライブコーディングの可能性, コードを見せるということ.

great, there is a risk that we can 'see' that the performer is doing something, but we cannot tell how the performer's actions affect her/his sounds. Henke, notes this point as follows:

> A rough sounding performance simply seems to match so much more the visual information we get when watching a guy behind a laptop. Even if we have no clue about their work, there is a vague idea of how much complexity a single person can handle (Henke, 2007).

This aspect is related to the fluidity of performance as well, which is discussed in Chapter 5.

With my system, instead of designing a hardware device so that the interaction between the performer and the device becomes more visible, I designed a visual engine which emphasises the micro-movements between the performer and the hardware device, and filters out the actions which are not related to sonic changes. Since the sounding nature of my system is not designed to always be simple, such emphasising and filtering helps in restoring the causality between visual actions and the resulting sounds. Please see video example 1.

The decision not to present a performer's body is one of the options regarding visibility, where the physicality of the sounds is more featured than that of the performer. Nicolai states that '[…] it comes close to an ideally autonomous Gesamtkuntwerk [total artwork], which could prospectively, as a consequence, allow me to disappear' (Nicolai, 2007, p. 84). As a contemporary example, So Kanno, a multimedia artist, told Ryoichi Kurokawa in an interview 'I used to think about

bodiness in various ways at that time [when he read *Post-Techno[Logy] Music*], now I have gained my interest in "resulting sounds" themselves. […] I can relate to the approach of omitting "the subjectivity of an artist". For example, in the case of sound installation, we can produce the experience which has the similar quality of live performance, without the presence of an artist.' (Tsukada, 2014) The artists quoted above regard non-sonic objects as merely distractions, and that includes a performer's body. Ikeda took this approach too. With his 'datamatics [ver 2.0]' audiovisual performance in 2013, he decided not to be on stage. The audience could not see Ikeda, apart from the projected visuals on a large screen and speakers (ryoji ikeda studio, 2013). With his 'superposition' performance, he was again not on stage; instead, two percussionists performed his piece on stage, along with visuals on a screen and computer monitors (ryoji ikeda studio, 2012). Henke's following view could explain the advantage of performing offstage to a certain extent. He suggests that ideally electronic musicians should perform at a spot where they can hear the PA: (Henke, 2009)

> […] We know that a Roland TR-808 bass drum does the job in a club. Fine, let's find a less overused sound. How can we do so, if we cannot hear it?
>
> Club music could be far more advanced if the creators would have more control over their work. However, this means investing time and effort in convincing promoters and PA guys. And it means questioning the usual routine. Do I need to be on stage? Do I need to have monitors? Can I find a space in the middle of the room? Am I comfortable not to be seen as the untouchable star far away? (Henke, 2009).

Not only to be able to hear the PA, but the idea of performing offstage starts to seem quite natural when looking at the historical linkage between electronic music and DJ music. The DJ is the laptop musician's 'immediate ancestry' (Turner, 2003, p. 84). The motionless 'performance stance was completely acceptable inside a DJ booth, which, by design, physically distances the "performer" of the music from the dance floor. In the context of electronic dance music, this distance is one of the equalizers of the dancer's role in a highly interactive experience' (Turner, 2003, p. 85). When performing on stage, 'an audience focuses immediately on the unintended signifiers, trying to place them within their horizon of expectations, with little success' (Turner, 2003, p. 85). 'Several musicians indicated a further specific preference for being at the same level as the audience rather than on a stage above them. 'Apparat, explained that such a placement facilitated "feeling" the feedback without always having to look, while Henke spoke in terms of a desire for intimacy and closeness to the audience' (Butler, 2014, p. 104).

In the discussion at the symposium of 'Techno Culture/The Internet Culture' in 1998, Toshio Iwai said that he felt the 'loss of bodiness' towards the symposium-related concert (Ikeda was one of the performers at the concert, along with Oval & Christophe Charles, Alva Noto a.k.a. Carsten Nicolai, and Thomas Köner & Porter Ricks). Iwai described the concert, saying:

> Yesterday's concert was just the audience sitting and listening quietly all the time, and the performers were fiddling with the mixer on the stage. Frankly speaking, I wondered what the meaning of performing it live was, other than the live feeling of mega volume and low frequency. I would like to ask Mr Ryoji Ikeda about that, as we have him here (Kubota, 2007, pp. 149-150).

Ikeda responded:

> […] Regarding 'the meaning of seeing live', you said that only 'the live feeling of mega volume and low frequency' is boring, but if I dare to say simply, I wonder what the problem is only with it.
>
> Or rather, I wanted to pursue that. When I perform solo, I would like to exclude the things which let people have the physical experience by integrating multimedia, or the things which are visually interesting, so I did the performance with only 'sound'. Because especially low frequency cannot be experienced visually, yesterday's concert might be boring visually, but I would rather pursue the direction of 'interesting by listening and experiencing' (Kubota, 2007, p. 150).

However, he added, 'I do not want to take the format of 'live' [concert]. I want my sound to be heard in the situation with the high level of freedom, for example, like an installation of something else' (Kubota, 2007, p. 150). In the same discussion, Atsushi Sasaki, the producer of the concert, agreed with Ikeda in terms of the point of 'what's wrong with only sounds?' He continued that 'While I am not sure what that "bodiness" is, if I use that abstract word "bodiness", I think the materialistic approach which faces the "bodiness of a sound" could exist, in other words, the materiality of a sound itself' (Kubota, 2007, p. 152). When an artist's body disappears from stage, is it still a live performance? Or does it become a sound installation, or a listening/screening session? To me, Ikeda's concert in 2013 felt like a screening event of his audiovisual work, rather than a live concert or a live performance. In accordance with Emmerson's definition of liveness, I could not feel any 'liveness' because there was

no impression that Ikeda was '[taking] decisions and/or makes actions during a performance which change the real sounding nature of the music' (Emmerson, 2007, p. 90).

The lack of bodiness does not only free electronic musicians from bodily and temporal restrictions in terms of music production, but it also frees them from 'continuous concentration on producing "the notes,"' thus it gives them more room to experience and evaluate their performance as it happens (Butler, 2014, p. 108). Butler describes such a situation as enabling the performer to become a better listener and more reflective, but I would argue that it also means that the performer starts becoming more a part of the 'audience' and less of a 'performer' then. '[T]he technologies of electronically mediated performance […] make it possible for the performer to create and experience a musical event at the same time' (Butler, 2014, p. 108), but there are performance instances where the performer lets a computer create all or most of the musical events and she/he only experiences them on stage. When the performer becomes an observer who does not cause or affect changes, liveness is not there.

I have been looking at the increased use of non-human technology in music performance in terms of the decrease of human body presence, but there is another view which regards the phenomenon as the extension of a human body, a kind of cyborg (Fontanari, 2013). The digital era is 'posthuman—the era in which humans are transformed/eliminated by machines' (Kubota, 2017, 第 2 章　素材から即興へ, Design　3.0：デジタル・マテリアリズム序論,　三つのキーワード). At Squarepusher's band set in 2015, all the band members were wearing white masks, so that the audience could not see their faces at all. All we could do was to assume that the bass player should be Squarepusher himself, on the basis of our knowledge about

his bass guitar skills. In his solo set, he was wearing a white mask and a white body suit, which enabled the performer to become a human screen. There were 5 projectors, 4 large screens, and the performer as the fifth screen for live-generated visuals. There were two laptops and a MIDI interface controller.[12] Squarepusher was mainly playing and tweaking the controller with his left hand, and one of the laptops with his right hand. Occasionally he moved to the other laptop to control something. Multiple floor and ceiling stage lights were emitting strong white lights syncing with the screens, when the music became intense. In both cases, the performer and the bassist were presumed to be Squarepusher himself, but because of the mask, they could have been somebody else who had the knowledge and the skills to do the performance.

> [Squarepusher] [Wearing the mask was] to be able to project visuals well. Wearing the mask was aimed to create the even plane for projection. The uneven feature of human face will disturb the visuals.
>
> [Interviewer] But because your face is not visible, there is a possibility that some people start to say, 'the inside is not Tom [Squarepusher's real name], but someone else', isn't there?
>
> [Squarepusher] I'm not doing that because I think it's funny (laughs) (Nakinishi, 2015).

In another interview, he explained the idea behind the approach further.

[12] The setup for an audio aspect was explained by Squarepusher in the following:
Mettler, M. 2015. *SQUAREPUSHER DOESN'T JUST MAKE ELECTRONICA, HE MAKES THE SOFTWARE TO MAKE IT* [Online]. Digital Trends. Available: http://www.digitaltrends.com/music/squarepusher-interview-the-software-behind-damogen-furies/ [Accessed 6 November 2015].

> Having the attention from hundreds or thousands of audience is quite hard. I even think, in what way I could perform without being on stage. As one solution, I ended up with the idea being on stage as part of a visual aspect. It was the idea emerged from the negotiation against my reluctance to be 'seen' (Fukami, 2015).

Squarepusher was physically integrated with technology in his performance, and his ideal state is performing offstage and unseen. His human physical presence can be seen as being decreased, but also can be seen as extended by infusing with technology, as a cyborg performer. Jonathan Yu goes even further. 'By using an actor-network approach in his analysis of DJ practices in Melbourne, Australia, Jonathan Yu […] shows that the crowd, technology and DJ are of similar, even equal, importance in establishing the ["]fact["] of a dance event's existence' (Rietveld, 2013a). While for Kraftwerk, machines are human-like beings to collaborate with (Poschardt, 1998, p. 31). With my performance, I prefer to project the visuals over my body. In this way, the visuals generated from my actions function as the extension of my physical body. Thus, the perceivable causality between the actions and the visuals are strengthened for the audience.

Yu suggests that 'DJ/producers are constantly redefining electronic dance musicianship through their practice and authenticating discourses' and 'the new practices we are seeing within electronic dance music production and DJing can be regarded as the latest in a set of relations between musicians and technologies that have always been in transition' (Yu, 2013). When DJing with CDs emerged, some people insisted DJing with vinyl was more legitimate and 'natural'. Nowadays, laptop DJs are commonly seen and there are DJs who insist CDJing is more legitimate than DJing with a laptop. To borrow Bolter and Grusin's words, 'earlier technologies are

struggling to maintain their legitimacy by remediating newer ones' (Auslander, 2008, 2 LIVE PERFORMANCE IN A MEDIATIZED CULTURE, Is it live, or …?, para. 1). A similar shift can happen to the human presence of a DJ or a performer. We have already seen such a shift to a certain extent, considering how audiences reacted to laptop performance in the 1990s. In 1997, during Jim O'Rourke's performance, an audience member walked up to him and asked when the next band was on. It was assumed that she thought '"that guy with the computer must be one of the organizers of the event" or something, that is, computers are tools for organising information […], but not for making art' (Turner, 2003, pp. 82-83). On another occasion, an audience member threatened to punch an Australian promoter (Turner, 2003, p. 83), as the audience felt cheated, because the laptop musician appeared to be simply playing back sound files stored in their hard drive (Cascone, 2002). At that time, 'The laptop's signifier as a business tool [was] so ingrained in the public consciousness that its use as a musical instrument [was] considered a violation of the codes of musical performance' (Cascone, 2002). In contrast, today, more people are aware and accepting that the laptop can be used for music and art. The way people regard the laptop has shifted and it is regarded as an element of performance with less resistance. In the near future, a dominant format of digital music performance could possibly be an AI robot performing on stage, and a human performer might be like today's vinyl DJs, where a minority group of people regard it as a superior form with nostalgia and controversial authenticity. Squarepusher's robotic band project and Rhizomatiks Research's AI DJ project have already shown the actualisation of such a direction. In that possible future, the permeated definition of 'live' could be different, and it might not include 'human' anymore, unlike in Emmerson's definition which I draw on in this thesis.

Squarepusher's robotic band, his other band with live instrumentalists with their faces masked, Blue Man Group, Rhizomatiks Research's AI DJ project, and the musicians dancing while leaving their laptops in charge of the show, may point to a common direction, consciously or unconsciously: the absence of human beings as performers. Just like CDJs replaced a substantial number of vinyl turntables in clubs globally, human performers could be replaced by humanoid robotic performers with AI. In such a scenario, in the way that DJing with CDJs gradually started to be regarded 'proper DJing' when laptop DJs emerged, the performance by humanoid robotic performers with AI might be regarded as 'proper live performance' when the next technology comes along. It is impossible to predict what the next thing is, but it might be a form of AI which can produce new music and visuals 'live' on stage. Google's Magenta project, which started from the question of 'can we use machine learning to create compelling art and music?' (Eck, 2016), composed its first musical piece on the 1st of June 2016 (Brandom, 2016). This perhaps could be the sign of such a change. If that happens, human artists and musicians could respond by directing their creativity towards the concept behind performances. But what happens if AIs start to come up with an artistic concept with deep learning? In such a situation, Emmerson's definition of 'live' becomes obsolete, and people would use the word 'live' in a different sense. Or, like vinyl discs which have increased in value in recent times (in the UK, vinyl album sales outstripped digital downloads for the first time in week 48 of 2016) (Spice, 2016), the people in the future who see AI performers as their ordinary scene, might similarly appreciate or desire the human presence in live performances more.

The lack of bodiness in 'non-visible music' performance can be tackled more effectively with a visual approach, rather than with an audio one. Without visual

information, it can be difficult for an audience to distinguish between the playback of a pre-recorded performance, and the music performed by a live performer's physical body. In this context Butler states that 'For audiences, establishing connections between physical gestures and their musical effects is a key strategy for understanding the performance. Musicians accordingly seek to maximize the legibility[13] of their actions through the ways in which they interact with interfaces, as well as through the interfaces they choose to use' (Butler, 2014, p. 102). Also, such a visual approach can be supported by the historical context of VJing and house music as well. VJing came into existence sporadically via several people around the world at the end of the 1970s.

> This synchronicity points towards a necessity, related to certain typical characteristics of house parties. Because of the absence of a stage act there was a demand for a new visual experience. VJing therefore came into existence purely from a pragmatic basis […] not from some conscious development within the arts. […] The religious aspect of these ["]parties["] comprised of a leader and followers, and the visual 'presence' of a single DJ alone on a stage could not fulfil that need (Crevits, 2006, p. 14).

In the history of house parties, people 'replaced the lost power of a leader by placing the emphasis on a ["]total["] spectacle', with 'The use of multiple screens, located haphazardly throughout the space' (Crevits, 2006, p. 14). In my performance approach, I am trying to restore and strengthen 'the lost power of' a performer, with the use of the visuals generated from and via the performer's physical involvement themselves. With my visual engine, the physical presence of a performer is enhanced using various means of visualisation. Please see video example 2.

[13] Legibility will be discussed in Chapter 5.

2. Theatrical actions

Not all the physical actions in a performance cause sounds. We occasionally see actions which do not actually cause any changes to sound. In this thesis, I call such actions 'theatrical actions'.[14] In instances where it is apparent that there is no technical link between an action and sonic results, the theatrical action can be seen as a communication tool between the performer and the audience, or a non-musical artistic expression. The latter has some quality in common with a conductor, who 'gestures and the music pours forth – just as the conjuror uses elaborately choreographed hand motions to ["]bring forth["] the image or transformation required' (Emmerson, 2007, p. 112). Emmerson also refers to 'the soundless conductor's closed eyes and ecstatic look' in the context of 'expressive body language' (Emmerson, 2007, p. 113). In the other case, where it 'seems' there is a link, at least to the audience, what the actions create is an 'imaginary relationship' between the performer and sonic results, which Emmerson states as the opposing concept to an real relationship (Emmerson, 2007, p. 93). The topic of theatrical actions is discussed by Butler as well, along with his observations on 'passion of the knob' moments.

> Another very important site through which liveness is communicated is the musician's body. Note, for instance, how Pole interacts with the mixing board during the passage shown in video example 2.6. Near the end of the clip in particular, he seems to put his whole body into the extended turning of a knob. I have seen many such instances in performance; in my field journal I began to call them "passion of the knob" moments.

[14] Butler calls the moments where 'liveness is communicated through the musician's body 'passion-of-the-knob moments'. I did not use this term because it would signify slightly different phenomenon in terms of that the passion-of-the-knob actions could cause changes to sound more or less, through the 'knob'.
Butler, M. J. 2014. *Playing with Something That Runs: Technology, Improvisation, and Composition in DJ and Laptop Performance,* New York, Oxford University Press, p. 101.

> This term evokes the strange incongruity that arises when a musician directs exceptionally intense expressivity toward a small, technical component associated with sound engineering. Passion-of-the-knob moments communicate through intensely exaggerated gestures; they are performative enactments of "performance" as a culturally situated behavior (Butler, 2014, p. 101).

During Squarepusher's solo performance on the 24th October 2015, he occasionally raised his arms and sometimes beckoned passionately, seemingly in an attempt to interact with the audience, and the audience made a noise in response. Apart from those moments, the audience generally remained quiet regardless of sonic events. Ironically, to me, his theatrical actions worked to weaken the sense that he was controlling everything live, and to strengthen the presence of a sequencer. From my personal experiences as an audience member, hands-off actions of a performer (so that her/his hands are off from her/his controller), including dancing, generally indicate the likelihood that a sequencer is being used. In Butler's words, it 'highlights the recorded nature of the medium at hand: one is dancing, after all, to one's own tunes'. Another function of dancing is to '[reveal] a general level of engagement' (Butler, 2014, p. 102), which was supposedly Squarepusher's intention. Butler also points out that 'As a dancer responding to the sounds that have been created, the performer enacts the role of the audience on the stage' (Butler, 2014, p. 102). Butler summarises the functions of theatrical actions as follows:

> First, such behaviors may communicate a broad sense of "expressivity." On the part of the performer this communication may be intentional, although it is entirely possible for an action to be perceived as expressive without it having been intended as such. As a

> whole, performers' movements run a gamut from the fully deliberate to the unconscious. Although audiences generally regard the gestures they see as meaningful, their interpretations may or may not align with the performer's intent. […]
>
> Second, musicians' performative actions serve additional purposes that might be described as demonstrative or rhetorical. A chief function is *proof*: the performer's movements on stage, and all of the hardware that is manipulated, shows that she is really doing something, that she is actively engaged in music making rather than email checking. At the same time the performer demonstrates *agency*: *he* is the author of these sounds, recorded though they may be. A further quality is exertion. This should be familiar enough as a conveyor of authenticity in other contexts, and it works in the same way here: signs of physical exertion tell us that these sounds are produced through the musician's own labor; they are not easy to come by, but rather require both work and exceptional skill. The musician's efforts on stage validate the audience's exertions on the dance floor (Butler, 2014, p. 103).

The digital music performers who take theatrical actions are contextualised within the electronic dance music scene, rather than the academic electronic music community. In the academic context, the audience usually do not expect dramatic movements from the performer. Also, it is natural for the performer to perform offstage, which can be regarded as a tape music concert style, and not much attention is paid to the performer's physical body. It is not much different to the electronic dance scene context, as long as the performer is visually hidden inside a DJ booth. But when the performer is placed on a stage, non-dancing audiences expect something spectacular to look at, like the way they do with other kinds of popular music concerts. To meet such an expectation, some digital music performers take theatrical actions because there are no dramatic movements happening in digital music performance by

virtue of its intrinsic non-bodily nature. Theatrical actions function as additional non-musical artistic expressions in this sense. As we have seen earlier, theatrical actions are also taken as a communication tool between the performer and the audience. This is related to the commercial and entertainment aspects of popular music.

With my practice, I do not take theatrical actions because I instead present visually dramatised non-theatrical micro-movements to the audience. Additional theatrical actions would confuse the legibility[15] of performance, or impair the real relationship between the performer and the sonic results. Rather, I designed my visual engine to digitally exaggerate the micro actions to enhance the physical presence of the performer.

3. Parameters of mediatised visuals

The parameters of mediatised visuals (e.g. screened visuals) is the second key visual aspect. When using mediatised visuals in music performance, the performer should be aware of how their different parameters affect the music performance. The degree of abstractness (or figurativeness) is one such parameter. The pioneer of abstract art, Kandinsky (Voss, 2013), wrote of how he envied and learned from music. 'With few exceptions music has been for some centuries the art which has devoted itself not to the reproduction of natural phenomena, but rather to the expression of the artist's soul' (Kandinsky, 1914, p. 41). The artist and experimental filmmaker Mary Ellen Bute uses abstract form by stressing 'that the corresponding effect on the visual sense was only possible with the help of abstract form, because of this, in contrast to representative symbol, is aimed not at the intellect but rather directly at the emotions' (Naumann, 2009, p. 50). Lewis chose abstract imagery for her live visuals because of

[15] Legibility will be discussed in Chapter 5.

the aesthetic view of her music, where she prefers to ‘capture a mood, but to leave it quite open to what people may perceive’ (Manning, 2014). Compared to figurative visuals, abstract ones are less likely to become ‘semiotic supplements that restrict the [“]meaning[”] of the music’ (Smalley, 2007, pp. 81-82), as the uncertainty of what they signify is higher. They can function as clues for the audience’s free interpretation. By not providing the audience with answers, but only clues, we can encourage the audience to be ‘engaged in a contemplative mode of “active reception”’, where ‘Electronic music is best appreciated’ (Cascone, 2003, p. 101).

In my performance system, some visual layers have figurative materials, such as the photographs of insects and planktons, or the real-time captured imagery of the performer’s hands. But they are processed and manipulated to be more abstract, in order to stimulate the audience’s imagination rather than limit it and impose fixed images on the audience. Please see video example 3.

I designed my visuals to be not unnecessarily narrative, and to be a black screen when there is no conceptual necessity relating to physical presence. The reason behind this design can be related to Chion’s account, which is that ‘each audio element enters into simultaneous vertical relationship with narrative elements contained in the image (characters, actions) and visual elements of texture and setting. These relationships are much more direct and salient than any relations the audio element could have with other sounds’ (Chion, 1994, p. 40). With that in mind, when using visuals in music performance, we need to be careful not to let them detrimentally affect the musical transitions of sounds over time. Visual elements can easily connect to simultaneous audio elements, and the connection can break the relationships between succeeding sonic events, because of the salient relationships between visual and audio events. While some ‘VJs are beginning to experiment with

narrative' (Spinrad, 2005, p. 14), Adrian Shaughnessy states that 'VJ didn't have to tell a story; didn't have to make sense; wasn't even sure that the audience was looking at what was being shown: all they had to do was add to the ["]tumult["]' (Shaughnessy, 2006, p. 11), assuming that the music critic Simon Reynolds calls such tumult 'the Dionysian tumult' (Shaughnessy, 2006, p. 11).

As mentioned previously, early abstract painting developed with an admiration for music's characteristics. Kandinsky states that 'Musical sound has direct access to the soul. It finds there an echo, for man ["]hath music in himself["] (Zilczer, 2005, p. 25)' Emotional intensity is one of the elements which abstract painters in the early twentieth century borrowed from music (Zilczer, 2005, p. 25). In my performance system, emotional intensity is not directly used as an expression, but by having the physical intensity of the performer generate and affect abstract visuals, I use the aspect of emotional intensity indirectly, as the intense emotion can intensify physical actions. The 'speed layer' of the visual engine of my performance works in such a way. Video example 4 shows how the frequency and the continuation of the value changes caused by the performer are visualised. At 0:00, the value changes are not frequent and the duration of the continuous value changes is short. At 0:06, the value changes are not frequent and the duration is long. At 0:33, the value changes are frequent and the duration is short. At 0:39, the value changes are frequent and the duration is long. Video example 5 shows the different visualisation between when the performer changes more than one control unit at the same time, and when she/he changes one control unit. From 0:00 until 0:20, only one control unit is changed at once. From 0:26, two control units are changed together. When the performer changes the values of two control units at the same time, it naturally leads to the doubled

frequency of value changes. Thus it affects the ‘speed layer’, which we looked at in video example 4.

Colour is another crucial parameter of visual content. In the context of visual music, ‘color is a core element of sensory perception. Immediately apprehended without much effort from the subject, color requires no interpretation or decoding, yet can act directly upon the emotions’ (Strick, 2005, p. 18). ‘For art that aspired to the condition of music, that sought synaesthetically to call forth musical associations, the key paring was with color’ (Strick, 2005, p. 16). Bute would agree with this. ‘The more careful the survey of art forms the more apparent the possible relation between mobile color and sound as art material becomes. Perhaps their most striking point of resemblance is in their close connection with pure sensation—a much more direct connection than we find in any of the other arts’ (Naumann, 2009, p. 50). In my performance system, basic scenes are set to be monochrome in order to retain consistency throughout its layers, and not to distract the audience’s attention unnecessarily. Colour is introduced only occasionally, corresponding to the physical intensity of the performer (when she/he changes two or more knobs or buttons at the same time). Please see video example 5.

Using a black image does not necessarily mean that performance becomes a pure sonic performance for the moment. The black screen ‘remains perceivable and present for the spectator as the visible, rectangular, delimited place of the projection’ (Chion, 1994, p. 67). Particularly when using a projector, a black screen does not hide the presence of a rectangle screen completely. In order to produce a black screen, the projector attempts to stop its light from being emitted, but usually the attempt is not 100% successful. The audience still can perceive a dim rectangle. In the VJ context, a reasonable black screen, i.e. blankness, is occasionally appreciated as it ‘creates

tension and draws the audience in' (Spinrad, 2005, p. 195). In addition to being aware of the effect of nothingness on the audience, we can consciously make use of it as one of the tools for expression. In a similar structure to that with which 'the sound film made silence possible' (Chion, 1994, p. 56), the use of visuals in music performance allows us to use visual silence (i.e. a black screen). Visual silence could be created not only with a black screen, but also as 'the product of a contrast' (Chion, 1994, p. 57), by using the same analogy with sonic silence. While 'In the silent cinema, everything just suggested sounds' (Chion, 1994, p. 57), we could say that in acousmatic music performance, everything suggests imaginary visuals. From this perspective, when we use visuals during performance, we can make use of the absence of visuals more effectively than acousmatic performance. In my performance system, the visual engine is designed to show a black screen when the performer is not taking any sound-related actions. By doing so, visually exaggerated actions can be highlighted even more in clear contrast to the black screen. Please see video example 6.

In the live performance of commercial electronic music, lighting usually plays a spectacular visual role. These are the visuals that do not affect sonic results, but they are aesthetically related to them. In that sense, they have similarities to theatrical actions. The difference is that while the agent of theatrical actions is a performer, the agent of the lighting tends not to be one. It is an off-stage lighting technician in most cases. This is interesting when considering lighting can be the most visible visual component in the live performance, and affects the audience's experience relatively strongly. Autechre chose not to use any lighting or visuals in their performance, and there are several musicians who treat and design lighting as their core performance aspect, such as NONOTAK studio. In the case of Atsuhiro Ito (Collins, 2013, Chapter 13 Live electronic music, Live performance examples, para. 2), lighting is his primary

instrument as well as playing a visual role.[16] Squarepusher used a lighting system in his band performance in 2015. The band was surrounded by 10-15 standing fluorescent light tubes. The tubes responded to the sounds (supposedly to the drums and the guitar sounds), and changed their colour and brightness.

When generating visuals with a digital projector, the signal sent from a computer is basically the combination of different-coloured lights (red, green and blue). The brightness of each light determines the resultant colour of the light.[17] When all three lights are at their brightest, the colour becomes white. When they are at their darkest, we get black. Considering these factors, it is obvious that we can express brightness with the use of colour, and vice versa. This technique was used at the aforementioned Squarepusher's performance too. When the venue (Troxy, London) was filled with the flood of sounds or noises, it was also filled with the flood of bright visuals (often the colour was white) and lights. My visual engine has the capability to output extremely bright visuals (stark white colour). When projecting such visuals on a large screen, the audience can perceive them as lighting. Please see video example 7.

Audiovisual counterpoint is 'the sound film's ideal state as a cinema free of redundancy where sound and image would constitute two parallel and loosely connected tracks, neither dependent on the other' (Chion, 1994, pp. 36-37), and an 'Audiovisual counterpoint will be noticed only if it sets up an opposition between sound and image on a precise point of meaning' (Chion, 1994, p. 38). Chion suggests that there are two types of audiovisual counterpoints. One is counterpoint-as-contradiction (or audiovisual dissonance) (Chion, 1994, p. 38). It uses sounds which contradict or negate concurrent images. Chion explains the problem of such a practice,

[16] He uses a fluorescent light tube not only for a visual purpose, but also uses it as a noise-generating instrument.
[17] The technical description of how projectors work is not blending of different coloured-lights, and it differs depends on the types of projectors, but I simplified that for the purpose of discussion.

as ‘it reduces the audio and visual elements to abstractions at the expense of their multiple concrete particularities, which are much richer and full of ambiguity. Thus this counterpoint reduces our reading to a stereotyped meaning of the sounds, drawing on their *codedness* (seagulls = seashore) rather than their own sonic substance, their specific characteristics in the passage in question’ (Chion, 1994, p. 38). In the context of digital music performance, direct audio-to-visual visualisation without a considered concept likely to falls into such weak counterpoint. The other audiovisual counterpoint practice does not formally contradict or negate the image, and ‘carr[ies] the perception of the image to another level’ (Chion, 1994, p. 38). With such a practice, the audience ‘do not hear them as "wrong" or inappropriate sounds’ (Chion, 1994, p. 39), and they sense a dialectic audiovisual effect, which cannot be achieved either if there is only audio, or only visuals. Such a state would be one of the characteristics of successful audiovisual performance. Otherwise, visual elements would be merely redundant, or interfere with audience’s trans-sensory ability to visualise the artist’s audio-based expression in their mind. Collins warns of the possible redundancy of the audiovisual performance exerting direct audio-to-visual mapping. ‘There are new problems with the introduction of other channels. Concentration on multiple modalities can split attention, and a lack of quality in one can undermine the other. Equality of treatment is rare, whether through compositional design or the specifics of venues; not all audio and visual actions have to follow one another precisely, and differences of meaning can arise (Collins, 2013, Chapter 13 Live electronic music, Live audiovisuals, para. 6).’ Alexander and Collins note that ‘Such direct one-to-one mappings are not necessary […] Whilst certain novel techniques might favour injective mappings of this kind, such mappings can often become tiresome if overused’ (Barrett, 2007, p. 137). Carsten Nicolai, also known as

Alva Noto's audiovisual performance at Ars Electronica 2010 is an example of direct visualisation from audio to visuals (Derivative, 2011).

In my performance practice, there are visual moments where the transformation between insects and Arabic numerals are seen, while the manipulation of pre-recorded musical pieces is heard. In the audio engine of the performance system, there are 12 tracks of pre-recorded materials, and the visual engine has 12 different image files of insects and planktons. The image files can be seen as pre-chosen or prepared materials in the same manner as the pre-recorded audio materials. The transformation of the prepared image materials indicates the performer's action at that moment, which is the manipulation of the pre-recorded audio materials. The act of fluidifying[18] is presented as the transformation of the insect images. In the sense that these two events are not related materialistically, it can be regarded as an audiovisual counterpoint. However, together, the images and the sounds reveal the artist's aesthetic concept of fluidifying. The images of insects themselves are the metaphor for transformation through their ability of metamorphosis. Some plankton metamorphose too, but not the ones I use in my system (Daphnia). Having something expected to metamorphoses transformed, and having something expected not to metamorphoses transformed, could create the aesthetic tension between the fixed and the fluid. Also the insects, the planktons, and the wobbling numerals (by random noise) are the metaphors for 'live' things, contrasting to the 'dead' (or inorganic) nature of digital numerals and digital audio files. The physically complex structure of the insects' and planktons' bodies can be regarded as the metaphor for the complexity fixed into the pre-recorded digital music pieces. Please see video example 8.

[18] Fluidity will be discussed in chapter 5.

4. The nature of the media used for mediatised visuals

Another visual aspect the artist should be concerned with is the nature of the media used for mediatised visuals (e.g. a projector and a computer). The rectangle lit screen is part of the unique and irreducible medium specificity of the projector, when borrowing Clement Greenberg's idea (Greenberg, 1960). Greenberg writes that 'The limitations that constitute the medium of painting […] Under Modernism […] came to be regarded as positive factors' (Greenberg, 1960, p. 2). By determining each art forms' (painting, for example) unique and irreducible nature, 'it would make its possession of that area all the more certain' (Greenberg, 1960, p. 1). In other words, he states that, by doing so, each art will be 'rendered "pure", and in its "purity" find the guarantee of its standard of quality as well as of its independence' (Greenberg, 1960, p. 1). Kubota addresses the similar point as follows:

> Each material has a suitable format and usage (process), and the insight into the selection and the combination of them is essential to create an expression that stands out (Kubota, 2017, 第 3 章　コードから知覚へ, コンピュータアートの今日的展開, 素材としてのプログラミング言語).

We have seen practices challenging that medium specificity of the projector in history. 'With the use of multiple screens, there were people [who] tried to 'break out of [the medium's] frame' (Crevits, 2006, p. 14). This phenomenon was called Expanded Media. Also, 'in avant-garde circles from the First World War onwards, especially in America, filmmakers were projecting random and non-linear imagery in an attempt to break away from the rigid rectangle of conventional, narrative-based cinema. They

projected their films on to the human body and on to unlikely surfaces – anything other than a white canvas rectangle' (Shaughnessy, 2006, p. 11). With my practice, the visuals of a white-coloured screen (when the feedback effect of white-coloured numerals works to its maximum) and a black-coloured screen (when there is no performer's action involved) can be regarded as determining the projector's unique and irreducible nature which is basically the projection of light (video example 6 and 7). Similarly, the use of non-continuous numerals in my system, in a certain sense, determines digital art's unique and irreducible nature which is essentially the collection of non-continuous numbers (video example 9). 'In digital media, […] music and visual art truly are united, not only by the experiencing subject, the listener/viewer, but by the artist. They are created out of the same stuff, bits of electronic information, infinitely interchangeable' (Strick, 2005, p. 20). Under digital expression, every output format (e.g. audio, images, videos and texts) can be handled equally. Ikeda expanded this idea through his work, such as in $V \neq L$ (Ikeda, no date-b) or *datamatic* (Ikeda, no date-a).

The use of Arabic numerals in my practice can be related to digital materialism, an idea explained by Kubota, which treats the computer as material for digital expression, rather than as a tool. He suggests that by knowing the characteristics of the computer as material and the way of handling it, and by creating things led by the material, the rich possibility hidden inside the computer would be revealed. He asserts that because of its complexity, the computer should be seen as being like (natural) materials such as paper, trees, metal or stones, rather than as a tool like scissors or knives. To him, the computer's complexity is another nature (Kubota, 2007, p. 38). The interface is a medium for the access to digital information; therefore, it cannot hold reality, but instead digits themselves are reality (Kubota, 2007, p. 39).

> Usually, the digits are hidden behind expression. And many people pay attention to reproduce the various expressions outside the computer world as accurate to the original as possible by digitalising (converting to numerals). The word ‘digitalising’ connotes the meaning of ‘reproducing (mimicking) the original’. Let’s flip such stereotype. Instead of digitalising some images, texts, or sounds, we could think that we can produce various expressions from the digits as material (Kubota, 2017, 第 2 章　素材から即興へ, Design 3.0：デジタル・マテリアリズム序論, デジタル・マテリアリズム).

This view is linked to the way I experiment with various visual expressions using the raw digits taken from the real-time data of my physical interaction with the controllers. Also, the algorithm of the visual engine occasionally behaves in a way I did not expect (e.g. the disappearance of the webcam layer and the highlighting of the speed layer at 0:54 of video example 4, or the washed-out white screen at 02:19 of video example 9). Uncontrollability such as this reminds us of nature. The structure of digital materialism can be compared to Heidegger’s views on modern technology. Heidegger states that modern technology sets upon (*stellt*) nature to yield energy (Heidegger, 1977, p. 15). Under digital materialism, technology (the computer) reveals itself as nature, which artists harness to yield contemporary artwork (Kakinoki, 2017b).

Liveness and causality of digital music performance

Chapter 3: Bodiness in digital music performance

With digital music production, musicians became freed from both their physical bodies' restriction and a real-time restriction. It is possible to produce a recording of electronic music without any performance aspect. This point is noted by Robert Henke as follows:

> If you replace a musician [with] a sound generating device directly controlled by a score, you get rid of the unpredictable behavior of that human being and you gain more precise control over the result. A great range of historical computer music and certainly a huge portion of the current electronic (dance) music has been realized without the involvement of a musician playing any instrument in real-time. Instead, the composer acts as a controller, a conductor and a system operator, defining which element needs to be placed where on a timeline. This process is of an entirely different nature from actually performing music, since it is a non-real-time process, and is therefore much closer to architecture, painting, sculpting, or engineering (Henke, 2007).

'While acoustic instruments inhabit bounded sound spaces, especially constrained in terms of timbre, tessitura and physical mechanism, computers are theoretically capable of producing any audible sound' (Jordà, 2007, pp. 89-90). Considering how electronic music developed in history, the lack of bodiness in electronic music is natural, and it can be regarded as its essence.

> To discuss any electronic music ('live' or 'fixed') we need to start with the 'acoustic revolutions' of the nineteenth century. From that time, slowly but surely, the production of music started moving away from the mechanical universe with its specific set of causal relationships – all based on well-understood Newtonian mechanics of action and reaction, motion, energy, friction and damping. (Emmerson, 2007, p. xiv).

> to overcome the fallacies of a musician's body or the limit of a traditional acoustic instrument intervening during the sonic realisation of a composer's (supposedly unbound) sonic imagination was one of the driving ideas behind the modernist aesthetic preceding some electronic music aesthetics (Peters et al., 2012, p. 1).

But in digital music 'performance', the 'bodiness' of the performer plays a role in delivering the physical presence of a human performer. Due to its bodiless and timeless nature, digital music is not primarily suitable for live performance, which generally is a bodily and real-time art form. Collins's, Henke's and Emmerson's quotes illustrate the issue:

> A powerful perspective from which to view the history of electronic music is the role of live performance. The nature of liveness quickly presents dilemmas. When recordings and computers allow the automation of every aspect of music generation and playback, why deal with live human action anymore? (Collins, 2013, Chapter 13 Live electronic music, para. 1).

> If the tape concert is not an option, the key questions are: how can I really perform and interact on stage and, how can I make the audience aware of what goes on without having

them read a long statement or start the concert with a ten[-]minute introduction... (Henke, 2007).

more and more music is being made and listened to without any recourse to *mechanical* production beyond the vibrating loudspeaker cone. Most music now heard appears to present little evidence of *living presence*. Yet we persist in seeking it out. From grand gesture to a *no*-like shift in the smallest aspect of a performer's demeanour, we attempt to *find relationships* between action and result (Emmerson, 2007, p. xiii).

As with Emmerson's use of the expression of 'presence', for music critics, 'criticism centers around a lack of "presence" that (probably correctly) is an essential component of musical performance on a proscenium stage witnessed by a non-dancing audience. Furthermore, these post-digital laptop performers are accused of understanding the "problem" and not doing anything about it' (Turner, 2003, p. 83). This 'presence' is what I aim to deliver with my performance system.

Emmerson suggests that '– for those wishing to retain a link to the live acoustic music world – ideas of ["]local["] and ["]field["] help partition the spacescape and can help re-establish perceivable causal links of performance gesture and sound at the local level' (Emmerson, 2007, p. 116). He defines them as:

- *Local* controls and functions seek to extend (but not to break) the perceived relation of human performer action to sounding result.
- *Field* functions create a context, a landscape or an environment within which *local* activity may be found (Emmerson, 2007, p. 92).

He claims that the ‘definition aims to separate out the truly live element as clearly the [“]local agency[”] in order to re-form more coherently the relationship with this open stage area, which may surround the audience and extend outside’ (Emmerson, 2007, p. 92). With the premise of the local and field distinction, Emmerson puts forward the idea of ‘real and imaginary relationship’. He claims that ‘appearances are everything: if in a musical discourse event A *appears* to cause event B *then it has done’* (Emmerson, 2007, p. 95). This idea served as one of the core theories which helped me in designing my performance system.

> Appearances can be deceptive. Performer-triggered real-time computations give no guarantee that the listener will *perceive* that a real human being has initiated or influenced a musical event. The *fact* that our local protagonist may trigger events, or processes, in the field is not our concern, only what *appears* to be true to the listener […] (Emmerson, 2007, p. 93).

In order to make A appear to cause B, the careful consideration of the visual/corporeal aspects of the performance is necessary (Schloss, 2003, p. 239). In other words, it is crucial ‘to consider the *observer’s* view of the performer’s modes of physical interactions and mappings from gesture to sound’ (Schloss, 2003, p. 239). With digital music performance, energetic and complex sounds can be produced on stage simply by pressing a button once. Not every musician does so, but this is one of the options to perform electronic music pieces. EDM (electronic dance music) producer Deadmau5, Joel Thomas Zimmerman, talked about the plight of EDM artists’ performances.

> "David Guetta has two iPods and a mixer and he just plays tracks – like, 'Here's one with Akon, check it out!'," he says. "Even Skrillex [a friend of Zimmerman's] isn't doing anything too technical. He has a laptop and a MIDI recorder, and he's just playing his shit ... People are, thank God, smartening up about who does what – but there's still button-pushers getting paid half a million. And not to say I'm not a button-pusher. I'm just pushing a lot more buttons." (Rolling Stone, 2012).

With the invention of the microphone and the loudspeaker, instruments' 'sonic presence could become greater than its physical size suggested' (Emmerson, 2007, p. xiv). Thanks to the further technological development since then, now we can emit the most enormous epic sounds by pushing a single button (or even with no action). In Keane's words, 'Electronic music generation makes possible sonic gestures which are not proportional to the physical bodily force exerted to produce the gesture (Collins, 2013, Chapter 13 Live electronic music, Novel interfaces, para. 6).' Julio d'Escriván uses the expression 'effortless' to describe this situation (d'Escriván, 2006, p. 6). He argues that the people 'who have been brought up with personal computers and video-games could be more open towards *effortless* performances' (d'Escriván, 2006, p. 6). Despite surely being a member of the generation brought up with video games, I nevertheless designed my performance system to present perceivable effort to the audience because it helps in enhancing the physical presence of a performer. The appropriately strict system where slightly different inputs lead to significantly different results, requires performer's effort to use it well. Such interface creates human concentration and tension, from which we can achieve unique and large range of expression (Kubota, 2017, 第 2 章　素材から即興へ, プログラミングと演奏,

集中するインターフェイス). We could also say that this type of performance system is risky. Kubota argues as follows:

> Live performance needs risk. It creates tension and uniqueness there, and the performance becomes unique and ichigo ichie[19] (Kubota, 2017, 第 2 章　素材から即興へ, ライブコーディングの可能性, パフォーマンスのリスク).

The function of presenting effort was built as a visual layer that corresponds to the amount of physical involvement with a hardware MIDI controller over a certain period. The intensity of this layer is proportional to the intensity of the performer's physical involvement, namely the performer's physical effort. Serji Jordà compares computers and traditional instruments in terms of their control mechanisms:

> In traditional instrumental playing, every nuance, every small control variation or modulation (e.g. a vibrato or a tremolo) has to be addressed physically by the performer (although this level of control is almost automatic and unconscious in a trained musician). In digital instruments, all parameters can indeed be varied without restriction, continuously or abruptly, but moreover, the performer no longer need to control directly all these aspects of the production of sound, being able instead to direct and supervise the computer processes that control these details (Jordà, 2007, pp. 89-90).

These features of digital instruments are advantages when considering the possibility of sonic result, and disadvantages when considering the physical causality between

[19] Ichigo ichie is the Japanese proverb meaning that treasure every encounter, for it will never reoccur.

action and the result. It is obvious that the causality is much less clear in digital music performance when compared to traditional instrumental performance.

> A classical non-electronic musical instrument relies on a constant user-interaction in order to produce a sound. The instrument has specific physical properties, defining its sound and the way it wants to be played. The music is a result of the properties of the instrument and the skills of the player. The listener has a sense of what goes on, even if they do not play any instrument themselves. […] Now explain to someone why pressing a space bar on a computer sounds like Bruce Springsteen one time and the next time you try it makes no sound at all... With "real" instruments it is also obvious that precision, speed, volume, dynamics, richness and variation in sound are the result of hard work, and that becoming a master needs training, education and talent. Without the player doing something there is nothing but silence (Henke, 2007).

As Smalley suggests, 'if you stay too close to the traditional gesture-model, electroacoustic potential is not explored; if you go too far away you destroy the notion of ["]performance["]' (Smalley, 1996, p. 104), we should not completely abandon the 'connections between physical gestures and their musical effects' (Butler, 2014, p. 102), which we inherited from the traditional gesture-model. In the archived video of Carsten Nicolai's audiovisual performance at Ars Electronica 2010 (Derivative, 2011), the audience can see that he is doing something physically on stage, but what he does and how he affects the audiovisual elements is a black box to the audience. The audience could feel that they may be able to experience the same audiovisual result with or without the existence of the performer on stage. Kubota would question this type of performance as he suggests that 'In order to bring some persuasiveness and

necessity to live performance, it is good to make all the things being done in it open' (Kubota, 2017, 第2章 素材から即興へ, ライブコーディングの可能性, コードを見せるということ). Cascone's following account can be related to this view:

> The more skill (hence authority) the performer can demonstrate, the more value is received by the audience. However, it is difficult for an audience to perceive the value of a performance where the artist could simply be playing back sound files on a device more suited to an office cubicle than a stage. Consequently, the standard codes of musical performance are violated: the laptop is doing the work, no skill is required or demonstrated, and the artist could just as easily be any one of the audience faking a performance (Cascone, 2003, p. 103).

For my performance system, the instalment of the feature allowing the performer to drastically change sonic results with a single button push was possible, but I avoided that option in order to maintain the physical causality between action and result. Because the main mechanical function of the controllers is the rotation of knobs, I designed most of the sonic changes to be gradual, matching to the gradual movement of the rotation. The parameter changes of the hardware controllers are visualised, in order to help the audience sense the performer's ongoing physical actions. To maximise the perceivable causality, the actual numerical values the performer changes, the information about the speed and the scale of the changes, and the types of musical changes, are given through visuals. On a different visual layer, the amount of parameter changes of the controllers in a certain time frame is visualised, in an attempt to show the physical effort of the performer's actions (which

was described as physical intensity in the previous chapter). Please see video example 10.

As mentioned earlier in the Introduction that the sonic changes caused by controlling actions should be obvious to the audience. It is not hard to imagine that if the causality is immediate, it is likely to increase the clarity of the causality for the audience. However, in the context of electroacoustic music performance, Emmerson suggests that the opposite ('cause-effect chains beyond short-term memory') may also work, and can be learnt 'through repeated listening' (Emmerson, 2007, p. 96). Some visualisations of my system are immediate, but there are others which are abstract and gradual (e.g. the visual layer which corresponds to the intensity of the performer's actions) where it is not possible to grasp the causal relationship at once. Instead, it is understood by repeated observation during the performance. Having the different levels of immediacy in terms of causality adds another depth to the audiovisual performance.

In digital music 'production', the producer should be freed from bodiness, as non-bodiness is one of the medium specificities of digital music (Greenberg, 1960). Physical actions and sonic results are not proportional compared to traditional instruments, and physical effort is not necessarily required. But in digital music 'performance', the bodiness of the performer plays a role in delivering the physical presence of a human performer. We can use the visual information of the performer's body and actions, as we have seen in Chapter 2, but the perceivable causality between physical actions and sonic results can be used too. In my system, sonic changes and the visualisation of the parameter changes are designed to maximise such causality. The former was achieved by matching the nature of physical action and the behaviour of sonic changes (they are both gradual in my case). The latter was done with visuals

by presenting ‘how and what’ the performer is changing at that moment to the audience.

Chapter 4: Hardware devices

While having looked at the tendency of digital music performance to lack bodily actions in the previous chapter, the possibility of incorporating bodily actions into such performance through the use of hardware devices is huge. 'Digital instruments […] are only limited by the imagination and know-how of their constructors' (Jordà, 2007, p. 96). Kodwo Eshun states that 'Sonically speaking, the post-human era is not one of disembodiment but the exact reverse: it's a *hyperembodiment*, via the Technics SL 1200' (Eshun, 2004, p. 159).[20] The use of hardware devices, such as MIDI controllers, is one of the ways in which a 'performer maintains an influence – a *real* cause – over the sounding result […] through physical gesture directly [affecting] the overall sound which is processed (as in most early ["]live electronic music["])' (Emmerson, 2007, p. 93). Butler asserts that such hardware devices 'reveal that they are not mere technical auxiliaries to the laptop's digital environment, but rather physical manifestations of the principles of interactivity and visible performance' (Butler, 2014, p. 97).

In the earlier stage of my research, I was experimenting with Leap Motion (a sensor device which fetches the location and movement data of fingers and hands) for my performance system. The decision not to use Leap Motion for my current performance system can be related to F. Richard Moore's insight about 'Control intimacy' (Moore, 1988, p. 21):[21]

> For subtle musical control to be possible, an instrument must respond in consistent ways that are well matched to the psychophysiological capabilities of highly practiced performers. The performer must receive both aural and tactile feedback from a musical

[20] Technics SL-1200 is a series of turntables.
[21] The writing is under the title of 'The Dysfunctions of MIDI'. OSC protocol can achieve a higher resolution, but most marketed controllers support MIDI protocol, but not OSC. Monome Arc OSC controller is one of the exceptions.

> instrument in a consistent way—otherwise the instrumentalist has no hope of learning how to perform on it in a musical way (Moore, 1988, p. 21).

Even though the response speed of Leap Motion is high enough when it is working well, the detection of the current version (Leap Motion V2) is not 'consistent' enough for real-time musical performance purposes (it occasionally fails to detect fingers and hands). Secondly, the accuracy of sensor is not good enough to deliver the performer's subtle expression. Also, obviously it cannot give the user 'tactile feedback'.[22] Moore states that control intimacy, which 'determines the match between the variety of musically desirable sounds produced and the psychophysiological capabilities of a practiced performer' (Moore, 1988, p. 21), is one of the conditions for a musical instrument to perform musically. While the point of Moore's discussion is that the control intimacy of a MIDI device is not high enough for a musical performance, the control intimacy of Leap Motion is even lower than a MIDI device's one. Eventually, a MIDI Fighter Twister was chosen as a performance controller (I use two of them). It has 16 pushable knobs with coloured LED lights, and six side buttons. As the controller is not designed to work with any particular software application (unlike APC40 mkII, which is designed to work with Ableton Live), the user can programme how it behaves to meet her/his needs. When programmed appropriately, LED lights can help the user recognise what is happening with the system, without looking at a laptop screen. All the knobs are the same size and placed at regular intervals. It is the same for the LED lights and the buttons. Please see video example 11. The important effect of the minimalistic design of the controller is 'openness', which facilitates diverse uses, according to Brian Crabtree and Kelli Cain

[22] Relevant feedback is crucial to enter a flow state, which will be discussed in the next section of this chapter.

(Butler, 2014, p. 97). Because of this openness, the balance between functionality and usability can be determined by an individual user. The appropriate level of usability is crucial to gaining muscle memory, which will be discussed later. However, Kubota warns that 'Interface can be simple, but it should never be intuitive. […] Discovering signposts from the ocean of parameters one by one over time, becomes the reference point for deviation' (Kubota, 2017, Interlude A, 即興のパラドックス). If the performer feels that the control intimacy of the MIDI protocol is not appropriate for her/his performance as Moore suggests, she/he could consider using the OSC protocol instead. With the OSC protocol, the performer could communicate with higher resolution, and there is a way to make the communication faster than the MIDI protocol theoretically (Klose, 2017).

1. Mapping

When performing with a controller connected to a laptop (a typical example is a USB-connected MIDI controller), we can map any control unit to any data. While this opens performance possibilities greatly, it also can cause an issue around causality. In Smalley's words, 'The causal connection between gesture and sound is undermined or destroyed, and performance gestures previously visible become invisible' (Smalley, 1996). With the performance of a traditional acoustic instrument, a turntable, or a hardware analogue synthesiser, the audience have some idea of what are affected by the performer's actions. The audience expects guitar-related sounds when the performer plays a guitar, changes in the running sounds when the performer scratches a turntable, changes in the sound character of the synthesiser-related sounds when the performer plays with the knobs on an analogue synthesiser. But with a MIDI controller, such an expectation can be easily subverted or may not exist at all. Thus

‘standard visual codes disappear’ and ‘the unfamiliar codes used’ prevent ‘audiences from attributing “presence” and “authenticity” to the performer’ (Cascone, 2003, p. 102) in this kind of mapping. The ‘standard visual codes’ are audience’s ‘expectations that the musician will produce meaning through spectacle’ (Cascone, 2003, p. 102), which brought from traditional musical performance when performance occurs in ‘in the traditional proscenium setting of concert halls, theaters and galleries’ (Cascone, 2003, p. 102). An audience still can guess the causality from the physical and visual characteristic of a MIDI controller because the standard visual codes are updated when newly emerged technologies prevail in society. The knobs and faders of a MIDI controller might remind the audience of the ones on a mixing board, and in such situation, some audience members might expect changes in volume, panning, EQs, filters, or effects. It is up to the performer whether she/he follows such audience’s expectations or not. And when she/he decides not to do so, and starts controlling the wider range of sonic results via the MIDI controller, the audience will be lost in terms of the causality between the performer’s actions and the sounds. In this situation, physical actions do not have any meaning to the audience, who cannot be certain whether the sounds they are hearing are affected by the performer’s actions. With this type of mapping design, a MIDI controller contributes more to the expressivity for the performer, than to the audience’s experience. As a result, to the audience, the level of mystification of ‘the process by which music is performed’ (Cascone, 2003, p. 104) becomes the same as that of laptop-only performance (without any external hardware controllers). These issues are discussed by Smalley as follows:

> MIDI-controllers can break the gesture link by permitting the performer to articulate sounds that are not the idiomatic property of the 'instrument" (percussion from a wind-

> controller, environmental sounds from a guitar-controller etc.); MIDI-controllers permit the remapping of parameters so that the watching listener may be confused about or oblivious to the sound-gesture link; signal processing can transform a sound so far that it is no longer connected to its visible, instrumental source. Thus we can arrive at a situation where sounding spectromorphologies do not correspond with perceived physical gesture: the listener is not adequately armed with a knowledge of the practicalities of new "instrumental' capabilities and limitations, and articulatory subtlety is not recognized and may even be reduced compared with the traditional instrument […] (Smalley, 1996, p. 104).

In my practice, such problematic and free (from an average audience's expectation) mapping design is chosen for the sake of fluidity (which is discussed in the next chapter), and the use of visuals plays a role in relieving the resulting problems. In the beginning of the same paper, Cascone states that 'Spectacle is the guarantor of presence and authenticity' (Cascone, 2003, p. 101). In Smalley's words, the visuals in my performance system are not only the performer's artistic expression, but also function as the clues for the audience to grow 'a knowledge of the practicalities of new "instrumental' capabilities and limitations' (Smalley, 1996, p. 104).[23] The visuals present the ongoing actions the performer takes, and imply affected sounds on another visual layer. Video example 12 and 13 show how different control groups have different visual results in my performance. Video example 12 shows the visualisations of physically different control units. From 0:03 to 0:30, a knob unit is rotated. From 0:36 to 0:50, the knob unit is pushed. From 0:55 to 01:09, side button units are pushed. Video example 13 shows the visualisations of sonically

[23] The audience does not need to grasp the knowledge completely. This will be discussed in the Legibility section of the next chapter.

different control unit groups (for example, some unit changes the volume of track 1, and some unit changes the room size of a reverb effect). Thoughtfully designing the mapping between actions and visuals helps the audience perceive the presence of a performer in digital music performance.

2. Cockpit-type hardware

The MIDI Fighter Twister's physical controls are knobs and buttons. Kubota categorises this type of controller as a 'cockpit-type' user interface, in contraposition to controllers with hierarchical menus on an embedded display.[24] 'The various dimensions of the cockpit-type controller are determined by physical constraints such as the shape and the kinetic characteristics of fingers and hands […]. Thus, skills obtained over practice and the dynamism where a human body is adapted for the interface play important roles there. Even though occasionally we need ergonomic design which fits the human body and its kinetic characteristics, the ability and the flexibility with which a human being adapts himself for environment, and the possibility and the pleasure born from them, cannot be ignored (Kubota, 2007, pp. 25-26).' Please see video example 11 to see the controllers in action. The transition through which 'a human being adapts himself for environment' can be seen as the transition whereby a human being develops his skills to match challenges, which is one of the conditions to enter a flow state (Csikszentmihalyi, 1998, 2 The Content of Experience, para. 35). The idea of a flow state is explained by Mihaly Csikszentmihalyi as follows:

[24] A MIDI Fighter Twister has 16 physical pushable knobs, and four internal layers, so the user can make use of 64 pushable knobs virtually. My system makes use of the four layers, but if one wants to maximise the advantages of the cockpit-type user interface, virtual layers should not be used. Rather, she/he should lay out four physical controllers to have the same functionality. This approach also helps the performer gain the muscle memory with her/his performance system, which will be discussed in the next section.

> When goals are clear, feedback relevant, and challenges and skills are in balance, attention becomes ordered and fully invested. Because of the total demand on psychic energy, a person in flow is completely focused. There is no space in consciousness for distracting thoughts, irrelevant feelings. Self-consciousness disappears, yet one feels stronger than usual (Csikszentmihalyi, 1998, 2, The Content of Experience, para. 36).

An optimal flow state helps a performer take decisions and/or make actions during a performance most effectively. It is crucial for fluid performance, where instant decisions and actions are required. Also, there is a chance that the completely focused performer's actions could reach the point of being as highly dramatic as a traditional virtuoso instrumentalist's ones, which would challenge the prevalent view over the micro-movements of digital music performance.

3. Muscle memory

Regarding the relation between hardware devices and a flow state, the muscle memory of the way our performance system works also helps the performer get into a flow state. With such muscle memory, performers become able to 'relinquish their agency during performance by "losing themselves" in optimal flow states' (Butler, 2014, p. 223). Obviously this kind of muscle memory is essential to a trained traditional instrumentalist, but it is not the case with electronic musicians because their performance system varies from individual to individual, and even from performance to performance of the same musician.[25] However, Apparat's claim 'that he knows the program [Max] so well that he can "play it like a guitar"' (Butler, 2014,

[25] 'In fact, in comparing performances by the same musician on different occasions, I have often seen a surprising variety of materials used.'
Butler, M. J. 2014. *Playing with Something That Runs: Technology, Improvisation, and Composition in DJ and Laptop Performance,* New York, Oxford University Press, p. 93.

p. 99), and Tim Exile's account on his performance system, called Flow Machine, in which he says that

> it's all… basically has become kind of muscle memory over the six years… and I don't really know what I'm doing. I don't really know what I'm doing when I get up there to play. That's kind of why I call it Flow Machine, because it's not… it just flows. I can't really say what's happening. I don't really know what I'm doing. It's just stuff, you know like kind of arms end up somewhere with all the combination of always different functionalities (Factmagazine, 2015).

resonate with this so-called 'ideal performance environment' (Butler, 2014, p. 125) significantly.

> In order to improvise successfully, musicians often seek to release their agency—in other words, to lose themselves. Decisions and the actions they entail become intuitive and immediate rather than conscious and considered. In the ideal performance environment, notes Robert Henke, "you don't need to think; you just do." (Butler, 2014, p. 125).

With my performance system, I have found that a thorough memory of the functions and relationships of the knobs and buttons of my performance system is crucial so that I can concentrate on my performance. Before practising enough, I frequently had to check the computer screen to remember the links. The frequency of the need to do so decreased as I practised. The performer needs to practise well enough to be able to enter the flow state with her/his performance system, but the practice should be about

the relationship between she/he and the performance system, not about her whole performance set. The more she/he practises the same set, the more fixed the performance set starts to become. Kubota states that 'Practice fixes skills, which is a type of physical exertion, by repetition. Improvisation requires the response to situations without being obsessed with predictions, and the deviation from established structures' (Kubota, 2017, Interlude A, 即興のパラドックス). The fluidity and the fixity of performance are discussed in the next chapter.

4. Unpredictability

When a human performs with hardware devices using their body, inevitable unpredictability naturally emerges because 'the musician's performing body is, crucially, an unpredictable entity' (Peters et al., 2012, p. 1). That unpredictability contributes to make each performance a unique 'here and now' (Benjamin, 2008, p. 21) instance. The performer can control the amount of unpredictability with her/his intention and techniques, but they cannot remove it completely. Just as we have seen that we can learn from traditional gesture-model of music performance in the previous chapter, we can also learn from traditional instruments about what characteristics a hardware device in digital music performance should have.

> Good new instruments should learn from their traditional ancestors and not impose their music on the performers. A good instrument should not be allowed, for example, to produce *only* good music. A good instrument should also be able to produce 'terribly bad' music, either at the player's will or at the player's misuse.[4] Only if these condition are sufficiently fulfilled, will an instrument allow its performers to *play* music and not only to *play with* music. (Jordà, 2007, p. 104).

> [Footnote 4] Misuse should not be interpreted here with ideological, moral or aesthetical connotations. What we suggest is that only when a performer is capable of relating unwanted results (effects) with the action taken (causes) will this performer be able to learn and effectively progress (Jordà, 2007, p. 259).

Jordá's requirements for a 'good instrument' can be interpreted as the capacity of accepting the performer's unpredictability, turning it into sonic results, and letting the performer observe these results. These conditions can contribute to helping a performer enter a flow state, as providing immediate feedback to make clear how well a person is doing is one of the conditions for flow activities (Csikszentmihalyi, 1998, 2 The Content of Experience, para. 35). A similar point is made by Butler, too. 'Musicians seek devices that facilitate *directness* of control, that enable them to touch one part of the machine and receive an instantaneous, audible response' (Butler, 2014, p. 99). The software design I programmed for my performance system's MIDI controllers follows these principles. Thus the degree and the timing of all the physical interactions with the controller result in corresponding sonic results regardless of whether they sound good or bad.

5. Mistakes

The state of unpredictability can increase the probability of unintentional human errors. This can be seen as an advantage rather than an a disadvantage, as Emmerson wrote: 'One slip and the continuity of the ritual might be lost – although ["]recovery["] is a skill in itself as all the best performers take risks' (Emmerson, 2007, p. 112). Moreover, mistakes are the performer's unconscious 'actions during a performance

which change the real sounding nature of the music' (Emmerson, 2007, p. 90). It also adds the 'here and now' quality because 'If we experience more detail and perfection we most likely will suspect we are listening to pre-prepared music. And most of the time we are right with this assumption' (Henke, 2007).[26] In Collins' words, 'imperfect blemishes which would not work for polished recordings only go to show the liveness of the moment' (Collins, 2013, Chapter 13 Live electronic music, Live and recorded music, para. 3). This view is supported in the context of music improvisation too. T.Carl Whitmer writes 'An error may be only an unintentioned rightness; good, but not what "you meant to do"' (Whitmer, 1934, p. 2). This similar attitude is stated by live coders as follows; 'We certainly contend that music-making is more compelling with elements of risk' (Collins et al., 2002, p. 322). David Zicarelli says that 'I would only observe that in most high-profile gigs, failure tends to be far more interesting to the audience than success' (Cascone, 2004, p. 393). Markus Miessen, emphasises 'failure as that fundamental condition of surprise', and 'If one's priority is to resist failure at all cost, the potential of surprise is never played out' (Miessen, 2010, pp. 188-189). Later I will discuss the accidental in relation to indeterminacy, and specifically the work of John Cage.

6. Laptop

The laptop itself is a hardware interface in digital music performance. But James Blake, a contemporary singer-songwriter and an electronic music producer, expresses how he sees the laptop as problematic for performance:

[26] Henke's this view is a little simplistic, considering 'improvisation is not a process of "making it up as you go along" or creating something out of nothing. Rather, it always brings real-time musical processes into dialogue with certain pre-existent constraints, be they a repeating chord progression, the form and melodic structure of a Tin Pan Alley song, a raga, or a particular kind of rhythmic cycle'.
Ibid.

> I fucking hate laptops, I really do. I like using them but to me they've got no place on a stage. You're like a moth to a flame looking at that bright light. And especially with complicated musical things, there's always something that could go wrong on a computer. You don't get that when you just buy a synth and plug it in (Pytlik, 2011).

'Music performance with the laptop looks like checking email' is a cliché but still probably the most frequently heard phrase among academics and musicians on this topic. Auslander quotes contrasting views on the topic.

> Whereas W. Andrew Schloss argues that performers of electronic music should find ways of making the causal relations between gesture and sound evident to audiences, Caleb Stuart, by contrast, argues that audiences for laptop music should be educated to surrender their desire for spectacle and accept that its performativity exists only on the aural plane (Auslander, 2008, 3 Tryin' to make it real: live performance, simulation, and the discourse of authenticity in rock culture, I want my MTV, footnote 39).

The problem with Stuart's view is that convincing the audience of liveness (making actions during a performance which change the real sounding nature of the music (Emmerson, 2007, p. 90)) 'only on the aural place' would not be successful. 'The *fact* that our local protagonist may trigger events, or processes, in the field is not our concern, only what *appears* to be true to the listener' (Emmerson, 2007, p. 93). In my performance system, laptops are used, but via two small MIDI controllers. In this way, they can be hidden away behind the performer, and I do not need to hide myself behind a laptop. Being freed from the laptop's optical interface, GUI, allows a performer to strengthen her/his focus on listening to sounds. 'The most important

thing is to look at an object. To make sounds, the prerequisite is to listen to sounds […] The interface of musical instruments has to be non-optical, thus tactile and physical' (Kubota, 2017, 第 2 章 素材から即興へ, プログラミングと演奏,集中するインターフェイス). Please see video example 10.

To an audience, hardware devices are the visual bridge between a performer's physical body and the sounds in digital music performance. Their visual existence allows the audience to assume that the performer causes results when she/he is involved with the hardware device. In this aspect, the level of legibility for the audience is affected by the mapping design between the performer's action and sound result. There are standard visual codes which the audience can use to link the artist's actions to presumably related sounds. It is about determining the balance between following the standard visual codes to convey the performer's physical causality, and dismissing the codes to maximise the flexibility of the hardware system. When the performer chooses the latter, she/he should provide the audience with an alternative way to restore the ruined visual codes. In my system, the visual engine plays this role. The visuals present the ongoing actions the performer takes, and imply affected sounds on another visual layer.

A well-designed hardware device helps the performer enter a flow state. Considering that a flow state requires a person to match her/his skills with challenges (Csikszentmihalyi, 1998, 2 The Content of Experience, para. 36), an ideal hardware device for digital music performance is one with which the performer can learn and improve her/his performance skills. It should not be something which can be mastered instantly. Aural and tactile feedback, 'a consistent and clearly perceivable ["]cause-

effect[”] relationship’ (Emmerson, 2007, p. 94), cockpit-type hardware design and minimalistic hardware design all can contribute to such learning ability. These characteristics of a hardware device allow us to accumulate our muscle memory of our performance system. With such muscle memory, we become able to ‘[lose ourselves] in optimal flow states’ (Butler, 2014, p. 223). When in flow, a person’s focus on the task is maximised. Thus instant decisions and actions which are required in fluid performance can be taken most effectively.

When a human being performs with hardware devices using their body, inevitable unpredictability naturally emerges because ‘the musician’s performing body is, crucially, an unpredictable entity’ (Peters et al., 2012, p. 1). That unpredictability contributes to making each performance a unique ‘here and now’ (Benjamin, 2008, p. 21) instance. The ideal hardware devices used in digital music performance should have the capacity for responding to this unpredictability. In this sense, mistakes should be welcomed. They can be regarded as the performer’s unconscious ‘actions during a performance which change the real sounding nature of the music’ (Emmerson, 2007, p. 90). My performance system follows these principles.

Chapter 5: Fixed digital music performance and fluid digital music performance

> Considering the interplay of recording, performance, composition, and improvisation within EDM praxis exposes a number of related conceptual binaries that pervade the intellectual histories of these activities; these include fixed/fluid, pre-recorded/live, work/performance, static/dynamic, material/immaterial, permanent/ephemeral, and even technological/human. (Butler, 2014, p. 5).

Fixity is one of the valuable medium specificities of digital music recordings. Fluidity is the opposite state, and it is the medium specificity of live performance. I aim to find the optimal balance between them through my performance system. As Butler summarises, 'the desire for liveness, and the very existence of such a concept, could not exist without its recorded Other' (Butler, 2014, p. 6). 'For many musicians, recording technology and live music are now thoroughly intertwined' (Collins, 2013, Chapter 13 Live electronic music, Live and recorded music, para. 7). Butler elaborates as follows:

> Prior to these infinitely repeatable, rewindable, pause-able objects, performance was more strongly characterized by evanescence. Now, while musical events continue to move forward through time as always, there is also a novel sense in which we can "hear," or understand in an auditory manner, the disruptive effects of recording on the linear flow of time (Butler, 2014, p. 109).

This view is the historical context to why I would like my live music performance to sound different from its corresponding recordings. The concept of liveness emerged with the necessity to discern 'live' performance from its recording. If the performance sounds the same as or very similar to its recording, there is much less need to call it 'live', thus 'liveness' is decreased. The electronic music producer Pacou states that 'Every time, every live act will sound different. That's the thing' (Butler, 2014, p. 129).

There are music performances in which the sonic experience is not much different from its recording. Deadmau5's quote, which was quoted in Chapter 3, implies this aspect too. 'David Guetta has two iPods and a mixer and he just plays tracks – like, ["]Here's one with Akon, check it out![”] (Rolling Stone, 2012)' With these performances, there is likely to be a performer somewhere in the venue, adjusting her/his fixed pre-recorded sounds like a PA engineer, and this kind of format has been dominantly regarded as live performance in the tape music context:

> Studio-created music par excellence, such as the beautiful, if seemingly rigid, works of electroacoustic tape music, can still be amenable to a form of live delivery. Electroacoustic performance practice centers on sound diffusion, inspired by the realization that not all acoustic playback environments are the same and that tweaking to individual concert rooms is a pragmatic necessity (Collins, 2013, Chapter 13 Live electronic music, Live and recorded music, para. 5).

Lewis takes such approach in her performance. She says that 'The live situation is about the possibilities of presenting the work in a new context. The acoustics of every venue, the sound systems, etc., affects the tones and therefore the entire tracks - and

what I do live is dependent of these factors' (Kent, 2014). Her views will be introduced later in the 'Sequencer and pre-recorded materials in music performance' section in this chapter. Technically, there are changes caused by the performer's decisions or actions in such concerts, but often it is very difficult to discern the real-time changes from the changes existed in the recorded materials. Therefore, the audience have more difficulty in experiencing liveness, compared to performances where the causality between a performer's actions and resulting changes are clearly presented (sonically and visually). From this viewpoint, such a performance is closer to a listening session, than to a 'live' performance. This chapter looks at the fixity and fluidity we should consider when we 'perform music on stage which does not initially work as performance, and which has never been "performed" or "played" during its creation at all' (Henke, 2007).

1. Fluidity

As Butler discusses, one of the characteristics of DJ and electronic dance music[27] performances is that 'Recordings—objects that are strongly associated with musical fixity and permanence—become malleable and fluid in his hands' (Butler, 2014, p. 3). Butler defines 'the fixed' as 'musical outcomes that are specified fully ahead of time' (Butler, 2014, p. 8), and 'the fluid' as 'those determined entirely within the time frame of performance' (Butler, 2014, p. 8). What I aim to achieve with my performance system is turning fixed digital music pieces into fluid entities in performance. For Christian Marclay, 'working with records as a performance activity'

[27] Although Butler uses 'EDM' in his writing, considering the current common usage of the word, I have decided to use 'Electronic Dance Music' instead, as 'EDM' tends to be related with the specific type of strongly commercial-oriented party dance music, which is quite different from the music the artists exemplified. The artists have some experimental and underground outlook. One of the obvious differences is that commercial 'EDM' almost always has a 'traditional buildup' (Butler uses the same word in his context, but the contemporary party-oriented EDM's buildup tends to have a more genre-specific character), and the artists interviewed by Butler do not have such a musical tendency.

is about his interest ‘in using “dead” records in a “live” situation’ (Maclay and Tone, 2004, p. 346). From this viewpoint, the act of fluidifying recorded (fixed) music pieces is making them come alive. As Butler notes, different music performances can be situated on the continuum between them, rather than clearly defined as either of them. In his words, it is ‘a continuum measuring the relationship of musical specificity to time’ (Butler, 2014, p. 8). The level of fluidity differs depending on ‘factors such as which sonic outcomes are specified (and which are not), the level of detail involved, and the manner and means of specification’ (Butler, 2014, p. 8).

Cage’s ‘indeterminacy’ can be the historical context which helps us understand fluidity, in terms of both differences and commonalities between them. What I aim to achieve is to have more fluidity in digital music performance, rather than to have Cage’s ‘indeterminacy’, which he defines as ‘the ability of a piece to be performed in substantially different ways’ (Pritchett, 1993, p. 103). Fluidity is enhanced through a performer’s will, choice and intention of changing music so that the audience can feel a greater psychological presence of a performer (Emmerson, 2007, p. 2). Enhancing fluidity naturally brings in some amount of indeterminacy, but not in the strict sense of Cage’s. Having Cage’s indeterminacy is not my primary concern in this research. Also, because Cage’s indeterminacy of performance could be realised either by a human or a computer, such an approach does not contribute to enhancing the psychological living presence of a performer.

However, the shift in which Cage ‘found flaws in the conception of Music of Changes, as he revealed in “Indeterminacy”’ (Pritchett, 1993, p. 109) resonates with Emmerson’s psychological presence of a performer (Emmerson, 2007, p. 2), and also the ‘here and now’ (Benjamin, 2008, p. 21) uniqueness of performance. ‘Cage realized that no matter how inclusive his system of composition, so long as it

produced a specific, fixed score, the result would be closed and unchanging from performance to performance' (Pritchett, 1993, p. 109). By replacing 'score' with 'recording', we can see a relevant commonality between the issue that Cage saw in the conception of Music of Changes, and the issue we see in the live performance of recorded digital music. Recorded digital audio files are 'closed and unchanging' in their primary state. To sum up, the approaches of fluidity and of indeterminacy are different, but the ideal state of performance I am aiming to achieve in terms of fluidity, and the one Cage envisioned regarding indeterminacy, have some commonalities.

In Cage's Music for Piano series and 'The Ten Thousand Things', 'the various individual structural units can be rearranged into any vertical or horizontal combinations in performance' (Pritchett, 1993, p. 109). This approach can be seen as the historical context of the way I deconstruct my music piece into different functional layers (vertical structure, e.g. rhythmic layer, bass layer, or harmonic layer) for my performance system, and manipulate the song time (horizontal structure) of each piece drastically during the performance. The horizontal fluidity relates to Pacou's suggestion 'that making decisions during the performance imbues it with an essential liveness that is missing from overly pre-planned sets' (Butler, 2014, p. 129). An overly pre-planned or practised performance set is fixed at a macro structural level. When attempting to make performance fluid, the performer should consider the fixity and fluidity of the whole performance set too. Making the macro structure of a performance set fluid helps in maximising the 'here and now' quality. As Derek Bailey quotes Whitmer's advice, 'Don't look forward to a finished and complete entity. The idea must always be kept in a state of flux' (Bailey, 1993, p. 33). When desiring to achieve that, digital music performers should avoid using a schedule-based performance system. Typical schedule-based performance systems make use of the

DAW timeline, or the feature of switching ‘scenes’ of Ableton Live. They are designed to have the embedded macro structure of a performance set. An ideal fluid performance system should be freed from such an embedded macro structure. My performance system reflects this view by not having a schedule-based system. It has sequencers, but there are no scheduled events in the system. The user needs to make decisions and manipulate the behaviour of each sequencer spontaneously (video example 10).

Improvisational quality is closely related to the fluidity and the fixity of performance, when defining improvisation as ‘generating novel musical outcomes during the time frame of musical performance’ (Butler, 2014, p. 114). ‘Pacou suggests that certain elements—the ingredients—precede the performance itself. Through the process of [live] mixing, they enter into novel and special relationships with each other, resulting in a unique, larger entity’ (Butler, 2014, p. 125). This attitude helps when attempting to create a fluid performance with fixed materials. But Pacou warns that overly pre-planned sets would ruin liveness and ‘making decisions during the performance imbues it with an essential liveness’ (Butler, 2014, p. 129). Pacou’s preference for making decisions during the performance can be linked to Emmerson’s psychological presence of a performer (Emmerson, 2007, p. 2). It also resonates with live coding, where ‘the next section can be anything’ and live coders appreciate it as ‘A great intellectual challenge’ (Collins et al., 2002, p. 322). With my performance system, I designed it in such a way that the performer can control the degree of improvisation. While the performer can play back the original musical materials as they are, she/he can also deconstruct them and improvise with them freely. Please see video example 14.

2. Sequencer and pre-recorded materials in music performance

Performing with digital audio files is the act of using non-real-time-materials in real-time act. Comparing the computer and the piano, Kubota states that 'the most important thing in writing programmes is the act of abstracting, which is a non-real-time and non-bodily conceptual skill, and it is different from a real-time and bodily skill such as playing the piano' (Kubota, 2004). Henke, writes that 'During the creation of electronic music this non-realtime process allows for an almost infinite complexity and detail, since each part of the composition can be modified again and again' (Henke, 2007). In the acousmatic music context, Emmerson named such a phenomenon 'time dislocation' as part of his 'acousmatic dislocations' theory. In 1924, Ottorino Respighi premiered his orchestral composition *Pini de Roma*. In the piece, he used the sound of a nightingale recorded onto a phonograph. It can be regarded as one of the early examples of the 'dislocation of time' in live music performance (Andrew, 2007, p. 15).

In order to use the audio files produced in the DAW timeline in performance, we need some kind of sequencer to make the files audible. The traditional usage of a sequencer is that a performer presses a button, and the sequencer runs linearly and plays back pre-programmed musical events. Using such a linear and pre-programed system often makes performance fixed, and thus less fluid, as 'Pre-recorded parts provide a fixed background to performance' (Collins, 2013, Chapter 13 Live electronic music, Live and recorded music, para. 7). 'A large number of popular music concerts now depend on partial tape backing in order to get closer to the released recordings that the audience are familiar with, typically synchronized via a click track for the drummer (who is very familiar from recording studios with playing to a click!)' (Collins, 2013, Chapter 13 Live electronic music, Live and recorded

music, para. 7). The sequencer is also used where desired musical events are too complex to actualise in real-time without its help. The following quotes from Collins help in illustrating the issues concerning the use of the sequencer in live electronic music performance.

> In electronic music, live control can run on a continuum from a single press of a button to initiate playback, to in-the-moment fine control of all aspects of the music, at a human gestural rate. Because electronic music is so rich with potential complexities of system, its live performance is a negotiation between what is automated and what is left up to human real-time decisions (Collins, 2013, Chapter 13 Live electronic music, para. 2).

Henke, states that 'For our purpose of finding ways out of the laptop performance dilemma the tape concert situation is of much more interest, since it is closer to what we do with our laptops today' (Henke, 2007).

> At the very beginning of computer music, the only way to perform a concert was to play back.[28] The so-called tape concert was born, and the audience had a hard time accepting the fact that a concert means someone pressing a play button at the beginning and stop button at the end. Ironically, half a century later, this is what all of us have been experiencing numerous times when someone performs with a laptop. Trying to re-create a complex electronic composition live on stage from scratch is a quite absurd and, most of the time, simply impossible task.

[28] Later there were experiments in this field, where people explored more than an unaltered 'play back' in live performance, such as Steve Reich, Gavin Bryars referred in Collins' writing.
Collins, N. & D'Escrivan, J. 2007. *The Cambridge Companion to Electronic Music,* Cambridge, Cambridge University Press, pp. 43-45.

> The bottleneck is not that today's computers cannot produce all those layers of sound in real-time, but that one single performer is not able to control that process in a meaningful and expressive way. Even if someone owned all of the instruments of an orchestra and even if that person is capable of playing them all, it is obviously impossible for this person to perform a symphony alone (Henke, 2007)

Blake, consciously avoids using a sequencer in his electronic music performance. For him, the human performer who 'has to play along with clicks is the slave of a machine' (Nakayama, 2013, p. 12). He performs only with human instrumentalists instead.

> Thanks to them [Rob McAndrews and Ben Assiter] fresh aspects are brought to our live performance. I think I am very lucky that in most cases, the new ideas they come up with are right ones — as an example, Ben, the drummer, plays the beats I made for albums live, and I feel it sounds better than the CDs. Last night we played 'I am Sold' on stage, and Ben started to play the beat in the pattern which was two bars longer than the album version. I was waiting for my timing to join, but then I found myself just listening to his beats! (Nakayama, 2013, p. 12).

What is interesting here is his expression of 'I found myself just listening to his beats!'. Applying the logic whereby an autonomous sequencer enables a DJ or a laptop performer to have the attitude of 'listener orientation' (Butler, 2014, p. 106), Rob, the live drummer, becomes an autonomous sequencer who enables Blake to have the listener orientation. Of course, there is still a difference between them; Rob can think by himself and change his rhythmic pattern for example. But if we were to invent an AI sequencer which could think and make changes musically, there might

not be much difference between what such a sequencer does and what a live human drummer does.

Lewis can be treated as an opposing example to Blake in terms of her attitude towards the sequencer, since her live music is driven by a sequencer containing pre-recorded materials. As describing her performance, she states that 'I work a lot with reverb and EQing […]. I work a lot with reacting to and using the space where I'm performing, because the acoustics and the type of sound system can really change the character of the material' (Sounds Of A Tired City, 2015).[29] The music itself is pre-structured and played back from her laptop on stage. What the musicians who have this type of approach to live performance do is similar to what a live dub PA engineer does. Such a live-PA-engineer-style performance is also related to electroacoustic tape music performance, as 'Electroacoustic performance practice centers on sound diffusion, inspired by the realization that not all acoustic playback environments are the same and that tweaking to individual concert rooms is a pragmatic necessity' (Collins, 2013, Chapter 13 Live electronic music, Live and recorded music, para. 5). From Lewis's viewpoint, fluid entities are the acoustics of performance environments. She adjusts malleable (thus fluid to a certain extent) parameters related to her fixed recordings, to make her music pieces work effectively for each environment. With this approach, the structural fixity of recordings remains the same, so I only adopted

[29] In her DJ performance at DOMMUNE studio in Tokyo on the 22nd of September 2015, she was using a guitar delay pedal (Red Panda Particle) and a guitar reverb pedal (Red Panda Context) connected to a mixer, along with a laptop. The 'Overview' section of Red Panda's Facebook page says 'DSP-based guitar pedals from Detroit.' RED PANDA. no date. *Overview* [Online]. Facebook. Available: https://www.facebook.com/RedPandaLab/info/ [Accessed 17 November 2015].

the capacity for adjusting the sounds to performance environments (with filters[30], reverbs[31] and delays[32]) in my performance system from it (video example 15).

With the system, I make use of the advantages of both sequencer-based and non-sequencer based systems. I use sequencers so that the performer can use pre-produced complex materials, but at the same time she/he has full control over the sequencers. The performer can freely get out of (and also get back to) the linear structure of a traditional sequencer. Please see video example 16. The performer can manipulate any sequencer freely, and is able to sync all the sequencers if desired (this happens at 3:27 of the video example. All the sequencers are synced to the master sequencer that the guitar track is using. The viewer can hear that the chorus disappears and the water flow sound appears). The master-and-slave relation between a performer and a sequencer, mentioned by Blake, is inverted here. This approach of redefining the use of sequencers was partly influenced by Myriam Bleau's unique approach towards sequencers in her *Soft Revolver* audiovisual performance (Bleau, no date).

The visual engine of the system lets the audience differentiate the sonic events caused by the performer's actions from the sonic events driven by a sequencer. When the performer is neither doing anything nor moving, projected visuals do not exist (all black screen). When the performer is doing something to the sounds with her/his controllers, various visuals are generated. Not only the existence of the performer's involvement, but also the quality of her/his involvement (the amount and the speed of

[30] DJMFilter made by Xfer Records is used.
XFER FREEWARE. no date. *Xfer Freeware* [Online]. Available: https://xferrecords.com/freeware/ [Accessed March 24 2017].
[31] One reverb effect can be adjusted to an extreme setting (based on Max's example reverb patch called 'gen~.gigaverb' implemented by Juhana Sadeharju), the other reverb is relatively more modest (based on Max's built-in example reverb patch called 'reverb_example').
[32] One is a sync delay effect (based on Max's built-in BEAP module called 'Sync Delay'), and the other is an async feedback delay effect.

involvement, the type of controller, and the type of sonic result) are visualised. Theatrical actions do not generate visuals. With this performance setup, the audience can naturally feel how much the performer's live involvements are there and how much a sequencer is playing its role. Please see video example 6, 10, 12 and 13.

3. Legibility

A legible performance helps the audience recognise the instant changes made by the performer. The artist needs to determine the optimal balance between the legibility of the changes and the level of musical complexity she/he desires to achieve in performance. Higher legibility does not always make performance better. John Bowers argues that 'Clearly legible interactive works – once the audience solves the puzzle, or the performer is well enough rehearsed – phenomenologically cease being ["]about["] interactivity' and 'an over-concern for interactive gestural legibility and so forth can all hang together to make interactivity more a technical problem than an arena for aesthetic enquiry' (Bowers, 2002, p. 57). His insight helps in explaining the failure of my early experiment. I was visualising sounds using a one-to-one approach, and because the relation was too 'legible', my supervisor Matt Wright noted that he lost his interest in the visuals once he understood how it worked. Smalley's following notion resonates here:

> to create a semblance of interaction between the seen and the heard, results in a very predictable music and an interactive play appreciated more by composer and performer than by the listener (Smalley, 2007, p. 81).

In contrast, Kelli Cain sees that puzzle-like aspect in a positive manner. She ‘described how certain Monome performances might engage the audience in figuring out what is going on: “[When] someone has made their own program that doesn’t have a level of transparency, then there’s this new facet of the whole performance, that … you’re not just watching someone be amazing, but you’re also actually wondering what they’re doing”’ (Butler, 2014, p. 100). Do the audience have to understand the ‘what and how’ behind a performance? Multimedia artist Norimichi Hirakawa, says ‘whether an audience is understanding what they are seeing has no relation with the quality of their experience’ (Yamamoto, 2013). At most live coding concerts, live coders project the content of their laptop screen onto a large screen, to show their real-time coding to the audience. Collins supports such a practice as ‘Normal performance programs like Reason look dull if the screen is projected – but the arcane text coding systems have allure’ (Collins et al., 2002, p. 322). Adam Parkinson and Renick Bell, write that ‘The visible screen of the live coder at least assures the audience that the labour being undertaken is appropriate to the task in hand and the performers fee (if they were lucky enough to get one), and they are less likely to be checking their Facebook, filing their tax return, replying to emails or submitting conference papers’(Parkinson and Bell, 2016). Kubota argues that ‘By showing a live coder’s screen, what the performer sees and what the audience sees become the same, and the process of live coding can be made open.’ (Kubota, 2017, 第 2 章 素材から即興へ, ライブコーディングの可能性, コードを見せるということ). However, even though non-programmer audience members can assume the live coder is programming in real-time by seeing it, they usually cannot understand the relationship between the content of the screen and the sound; in other words, they see but don’t understand how each line of the code affects

the resulting sounds. A similar thing can occur in the context of experimental pop music performance. Without any knowledge, the audience are not very sure about which sounds are produced on stage in real-time and which are coming from a PA or a synchronising sequencer system (in most cases all of them come from the same set of speakers, and that makes the causal relationships even more mystifying).

By expanding Hirakawa's viewpoint, 'legibility' in this context can be seen to have two layers. The first one is 'seeing' what is affecting sounds, and the second is 'understanding' how it affects them. The perspective of whether the audience 'understand' what they 'see' in a Monome-based performance is not integrated into the design of the interface. With Monome, it is an individual performer's responsibility to make a decision about the 'understanding' layer of legibility. The 'seeing' layer can be pre-designed in a performance system. The 'understanding' layer is more about the structure of performance, rather than about the performance system. If a performer desires to make the audience 'understand', the beginning of her/his performance set can be designed for that purpose, by reducing the complexity and highlighting the causality concerned.

In my performance, the level of legibility of performance is designed to be balanced. In other words, it should not be too enigmatic, and should not be too obvious. If it is too mystical, what the audience see visually does not add value to their experience. When it is too easy to understand everything, the audience tend to lower their interest once they do. By contrast, a good balance between them adds value to the audience's experience. In video example 17, the actual values I manipulate are sometimes visible, other times not. In the video, I change the playback speed of a sequencer from 2.0 to -2.0 (negative values mean reverse playback), then back to 2.0 again. My performance system is not designed to always sound simple.

Occasionally the nature of the sounds can become complex. Instead of compromising my desired complexity, the system offers the audience visual clues for the legibility of the changes.

4. Simplicity and constraints

Having ‘more’ options during performance does not necessarily mean the performer can express ‘more’, and does not help the performer make changes to fluidify the performance. I sometimes see that a solo electronic musician brings all the possible controllers (knob controllers, fader controllers, a pad controller, a keyboard, a mixer, an electric guitar, a microphone for singing), and flits from one controller to another, in the attempt of ‘performing live’ wherever possible. This approach can be problematic, as she/he is too busy following her/his more-or-less pre-planned routines and there is not much space left for spontaneous creativity. Moreover, despite of all of her/his efforts, as long as she/he uses a sequencer for a basic track to which she/he can play solo with each controller, she/he is still ‘the slave of a machine’ (Nakayama, 2013, p. 12) from the viewpoint of Blake. I was captivated by this type of approach for a while too. To obtain fluidity in performance, the appropriate level of simplicity is helpful. This point is noted by Butler, with the keyword of ‘constraints’:

> Although the rhetoric of technology, suffused as it is with images of advancement, might lead one to expect that musicians would seek hardware with as many improvements and options as possible, the opposite is often the case: to facilitate spontaneous changes and directness of control, most performers favor simplicity of design. […]
>
> […] Henke consistently emphasized the importance of these limitations, which he described as “constraints” […] Cain, after pointing out the absence of velocity-sensitive buttons or multicolored LEDs [of the Monome interface], noted, “There is a certain

> amount of constraint that's also liberating." Crabtree concurred, saying that "by reducing that set of parameters, it kind of requires more flexible thinking" and "there's a point where having constraints is actually really helpful." (Butler, 2014, p. 97).[33]

In short, constraints 'facilitate direct control and the clear communication of liveness' (Butler, 2014, p. 124). Kyoka, an electronic music producer says, 'when preparing materials for live performance, I consciously try to make them the simplest loops. Simple loops have more dynamics, counter-intuitively. When preparing elaborate stuff beforehand, all you can do is using them just as they are' (Nishiyama, 2014).

The constraints in terms of 'The limitation or specification of certain parameters' (Butler, 2014, p. 124) play a role in '[enabling] improvisational fluency' (Butler, 2014, p. 124). Jeff Pressing argues that such constraints allow a 'performer to devote less "processing capacity" of selecting and creating materials' (Butler, 2014, p. 124), thus they 'free up more processing resources for perception, control, and interplayer interaction, increasing the chances of reaching a higher artistic level' (Butler, 2014, p. 124). This 'higher artistic level' can be related to the highly focused flow state which was discussed in the previous chapter. To put it the other way around, 'more choice […] creates noise, hampering our ability to focus' (Iyengar, 2010, p. 189). Constraints help a performer enter a flow state, thus her/his decision making process becomes more efficient.

When designing my performance system, I could technically increase the performable parameters and physical controllers to as many as I desired. However, I

[33] A similar philosophy can be found in Novation's Launchpad grid controller, released in 2009. However, the latest Launchpad Pro (released in July 2015) increased its complexity to gain the integration between the device and Ableton Live. Such enhanced integration was seen earlier in Ableton's own hardware called Push, released in March 2013. The key concept of Push is being able to produce or perform music without looking at or touching a laptop. Push 2 was released in November 2015, with an increased amount of available controls.

had to stop increasing them at a certain point, because a usable system needs a good balance between capabilities and limitations. The attitude to dealing with the limitations is similar to the attitude towards acoustic singer-songwriter performance where it is performed only with voice and an acoustic guitar. The way I need to practise with the pre-existent parameters of the system (which is virtually an instrument) to be able to perform at my desired quality level, is again to a certain extent similar to the way I need to practise vocals and the guitar to perform acoustic songs. As mentioned at the beginning of this section, I used to spread many controllers over a table for performance. With my current performance setup, I only have two minimal MIDI controllers to play with, agreeing that simplicity and considered constraints can be the source of a creative application of the system. Please see video example 11 for the setup. When performance is too fixed, the audience cannot perceive musical changes caused by the performer, thus Emmerson's liveness is reduced significantly. When performance is too fluid as everything happens in real-time, one of the medium specificities of digital music is devalued, which is that digital music can be freed from real-time (performance-time) in its creation. Performing in the extremely fluid way means that they discard the unique nature of digital music. As the fixed and the fluid exist on a continuum, considering the desired balance between them is important in designing digital music performance. In an attempt to find the best balance between them, I built my system to make use of pre-recorded fixed materials in a fluid way. To achieve fluid performance with fixed materials, the redefinition of the usage of the sequencer system is crucial. To relieve the fixity, multiple independent sequencers and the functionality of the flexible and drastic manipulation of every sequencer are integrated into my performance system. The capability of the manipulation should be drastic enough for the performer to be

able to deconstruct and reconstruct the structure of the pre-recorded music pieces. My performance system is not designed to always sound simple. Instead of compromising my desired complexity, the system offers the audience visual clues for the legibility of the changes. Simplifying the options at the hand of a performer also contributes to fluidity in the sense of that it helps the performer's decision making process be more efficient. When instant decision making is required, having too many options available can be an obstacle. The risk of failing to take actions when needed increases, and the quantity of the changes made by the performer would decreases. Again, the artist needs to find her/his own ratio where what she/he wants to do in performance matches her/his skill of instant decision making. When the ratio is correctly designed, the artist can enter the highly focused flow state, as one of the key conditions for the flow state is to match one's skills with appropriate challenges (Csikszentmihalyi, 1998, 2 The Content of Experience, para. 36). Considering this condition, when the artist wants to expand the options of her performance system, she/he should do that gradually along with improving her/his decision making skills in performance.

With this performance approach, the sense of time becomes multi-layered and warped dynamically. Each of the pre-recorded materials holds its fixed DAW timeline in it. The performer manipulates the fixed DAW timelines in real-time. They can be sped up, slowed down, reversed, looped or intact, independently to each other. During the performance, the audience experiences the increase and the decrease of the number of existing timelines, and the dynamic transformation of them, and the real-timeness of the performer's manipulation of the timelines is enhanced through the real-time visuals generated from the manipulation.

Chapter 6: Portfolio

My performance system consists of three parts. They are an audio engine, controller mapping engine and visual engine.

The reader can download the Max file, the TouchDesigner file, and the preference file for MIDI Fighter Twister from the link in Appendices.

In order to make the system function fully, the reader needs to open the Max file on a computer with Mac OS running Cycling 74' Max, and open the TouchDesigner file on a computer with Windows OS running Derivative TouchDesigner 099. The Mac computer and the Windows computer should be set up to communicate via OSC. In the author's setup, I use a router between the computers. The below is the diagram of the hardware setup.

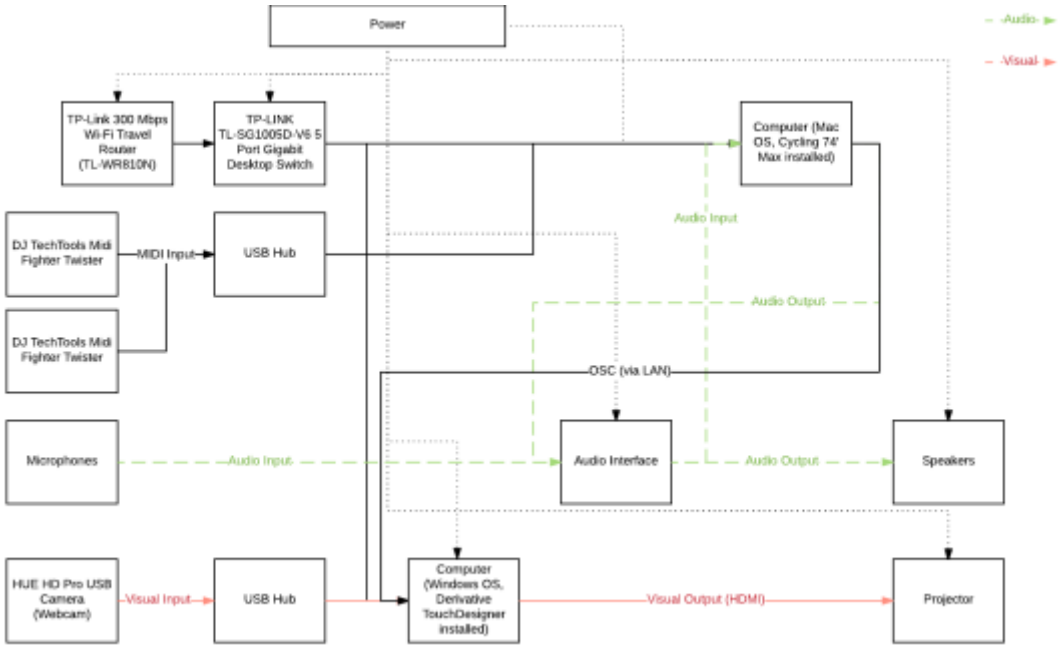

Figure 1

I assign static IP addresses to the computers by configuring the DHCP settings of the router (figure 1 and 2), so that I do not need to configure the IP address settings every time I open the performance system.

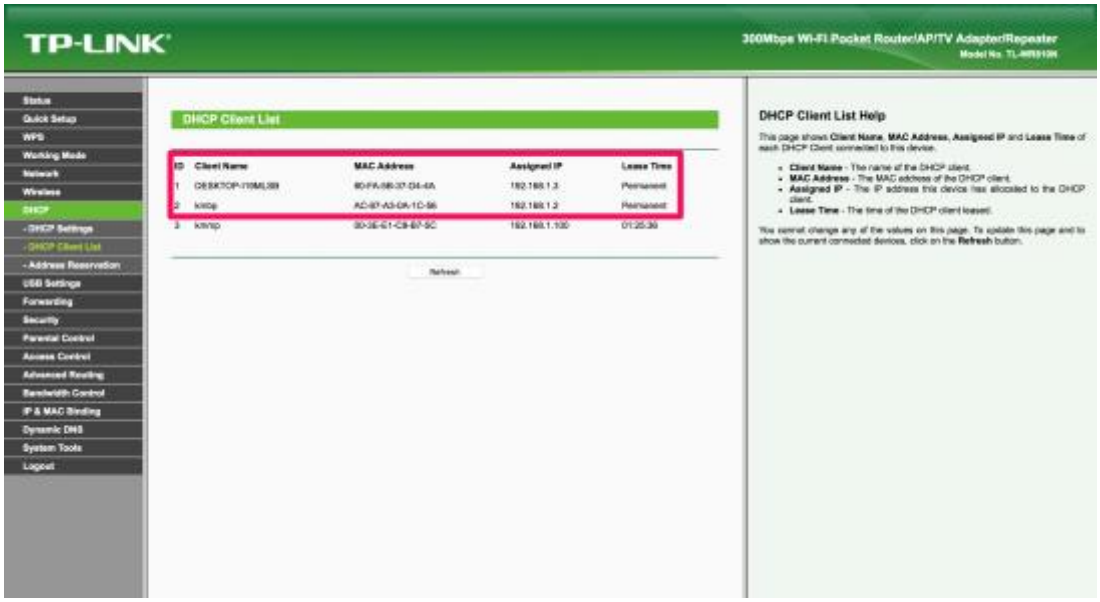

Figure 2

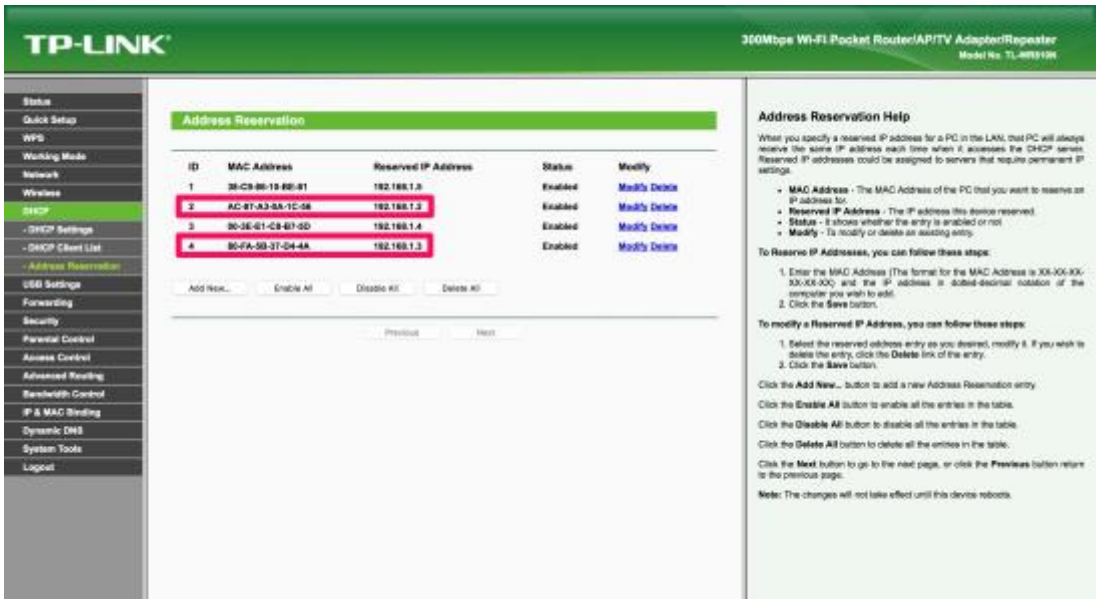

Figure 3

The latest program files for the system can be found on the author's website (https://kakinokimasato.com/).

1. Design of audio engine

The below is the overview of the audio engine programmed with Cycling 74' Max.

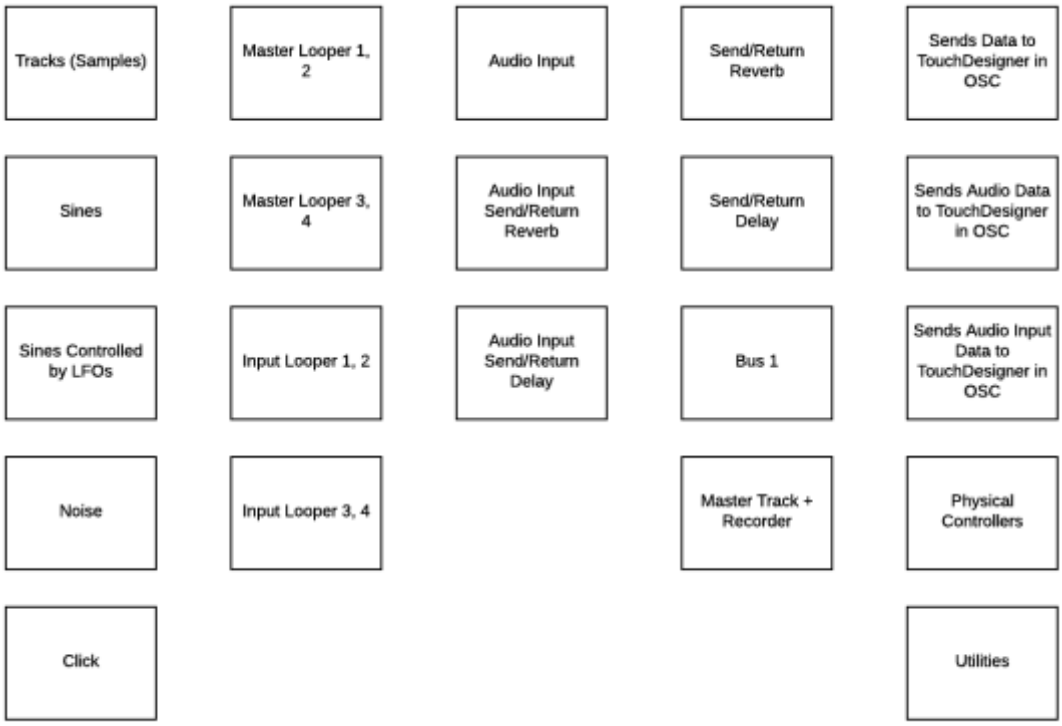

Figure 4

The 'Tracks (Samples)' module lets the user to perform with audio files. The below shows the internal structure of the module.

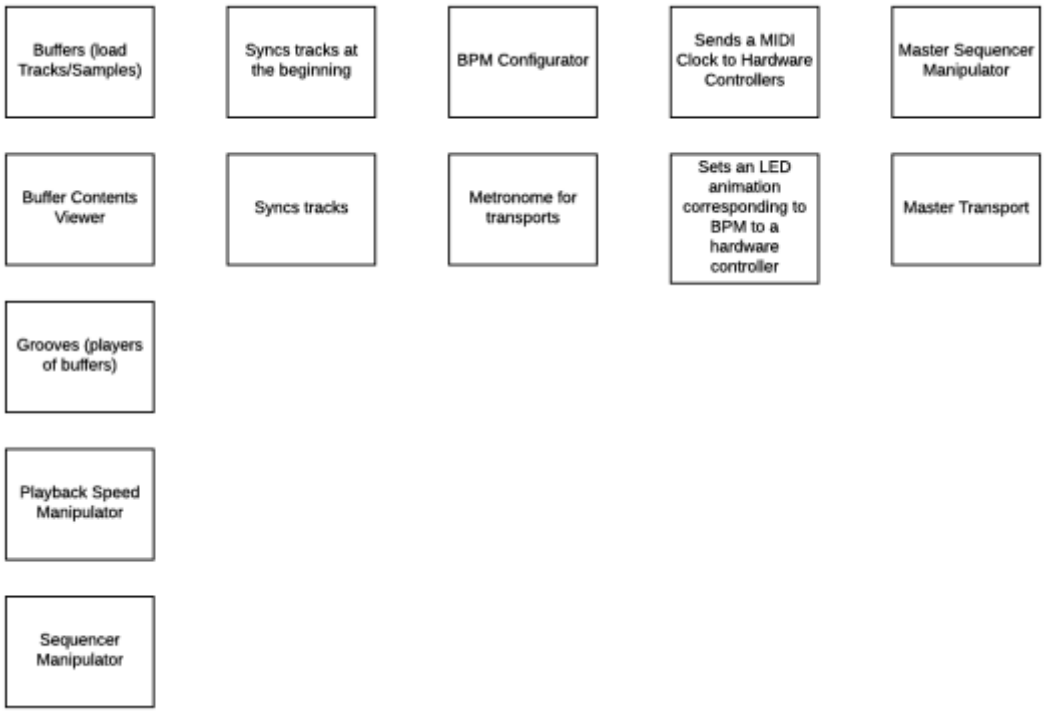

Figure 5

As with many electronic music producers, I compose and produce music at the same time. When such a process is done, I export an AIFF (or WAV)[34] file from DAW software, and the file is usually regarded as a primary 'musical piece' entity in the sense of digital music. The musical contents are fixed in one audio file. We can still do creative performances with such fixed audio files, and that is what digital DJs basically do.[35] But if we desire to alter or manipulate the contents inside their structures in performance, we need to go back to our original workspace (DAW software in my case), and separate and export several layers as different audio files. Each layer has a different function, such as rhythm, bass, harmony, chorus, melody and so on. Now I can have different levels of manipulation to each layer, and change

[34] AIFF and WAV are audio file formats.
[35] In 2015, Native Instruments, the German technology company that develops software and hardware for music production and DJing, 'announced Stems, a new multi-track audio format that allows DJs and live performers to incorporate individual parts of a track in their sets'. FACT. 2015. *Native Instruments' new open multi-track format lets DJs remix on the fly* [Online]. Fact. Available: http://www.factmag.com/2015/03/30/native-instruments-introduces-stems-format/ [Accessed 15 January 2017].

how they are combined. This is the one of the approaches to gain the fluidity of the performance with fixed materials, as we have seen in Chapter 5 along with Cage's Music for Piano series and 'The Ten Thousand Things'. However, if there are too many layers, we start to lose performability, thus the fluidity of performance is decreased, as we have seen in the 'Simplicity and constraints' section of Chapter 5. For that reason, I limit the number of layers up to six. When performing a music piece A, some parts from a music piece B can be used. As I mix the channels holding the materials from pre-produced music pieces, and the channels holding the other audio materials, it can be more or less regarded as live remixing. Or I can blend a heavily manipulated layer of a music piece A with a differently manipulated layer of the same music piece. With these approaches, even though each material is fixed, the whole sonic picture is not fixed. The user can swap the pre-recorded materials, change the sonic character of the materials, and manipulate the sequencers which play back the materials in various ways (which was discussed in the 'Sequencer and pre-recorded materials in music performance' section in Chapter 5). Please see video example 10.The below shows how the audio files used in the system are organised.

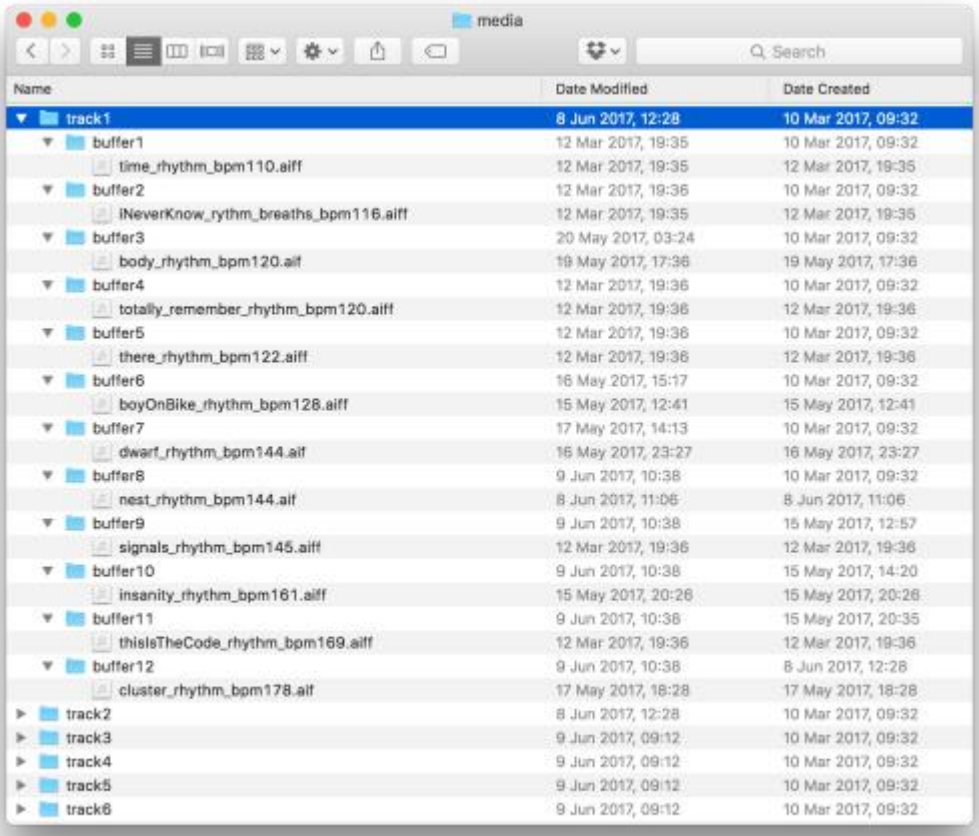

Figure 6

There are six track folders, and each track has 12 buffer folders. ‘tracks’ are categorised as different functional layers (e.g. ‘track1’ contains rhythm-related audio files and ‘track2’ contains bass-related audio files). ‘Buffers’ are categorised as different music pieces. ‘buffer1’ of ‘track1’ and ‘buffer1’ of ‘track2’ are exported from the same music piece. To use a different audio file in the performance system, the user simply replaces any existing audio file with the new audio file. The user does not need to adjust the programme. The below shows how the audio files are organised in the Max program.

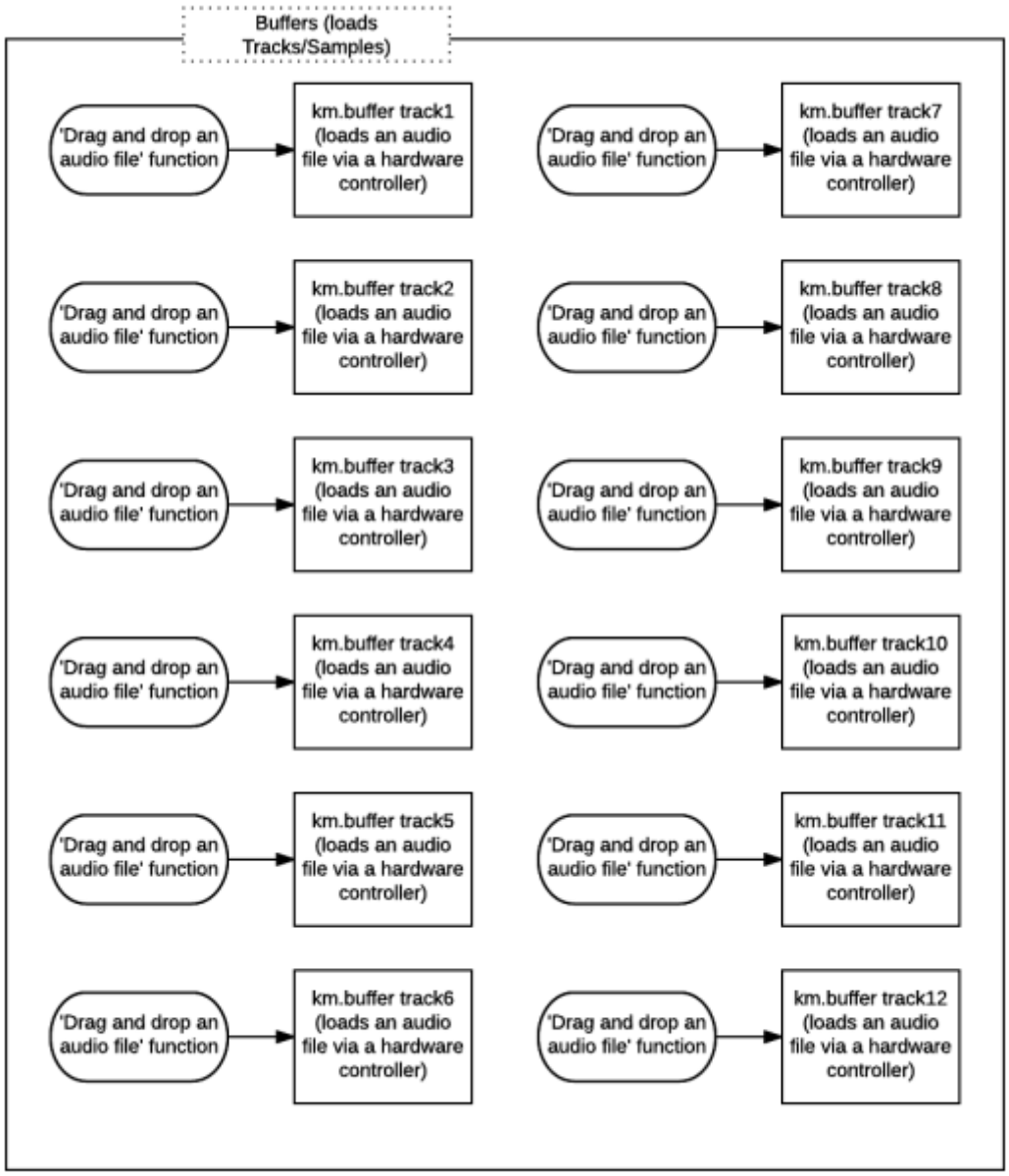

Figure 7

Each buffer loads a default audio file when the program is launched. The user can swap them with different audio files with hardware controllers, or drag and drop any audio file into the 'Drag and drop an audio file' function. The below is the internal structure of the 'km.buffer' modules, which enables the user to swap audio files with hardware controllers.

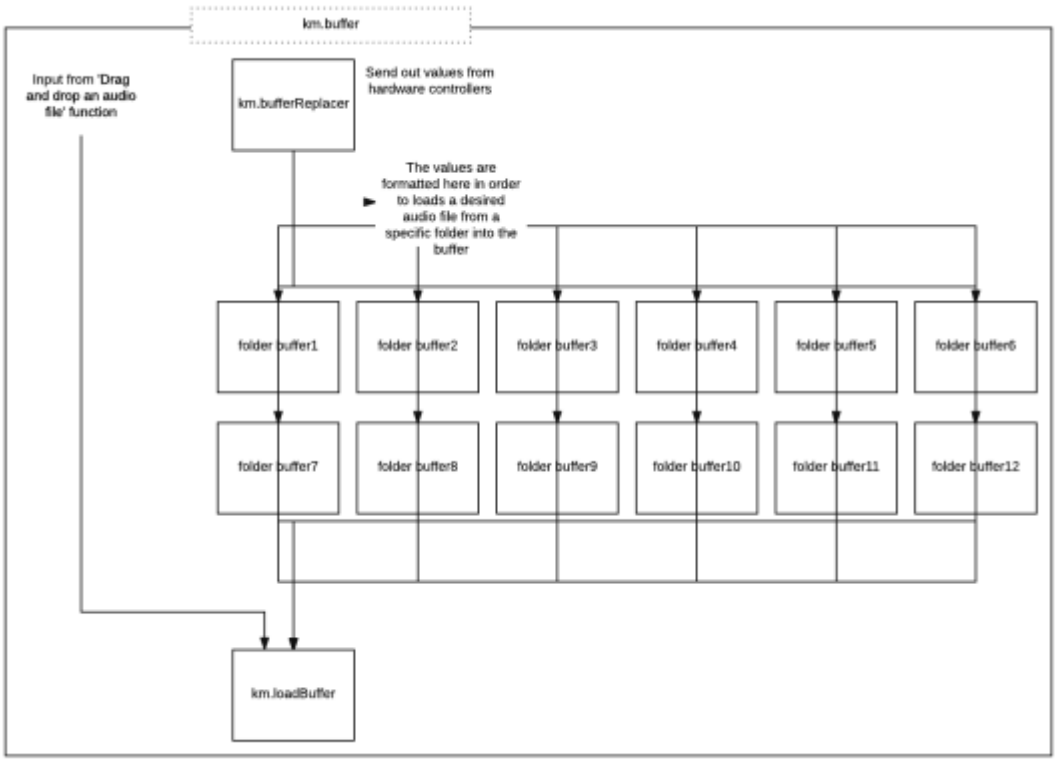

Figure 8

The below is the internal structures of the ‘Grooves (players of buffers)’ module.

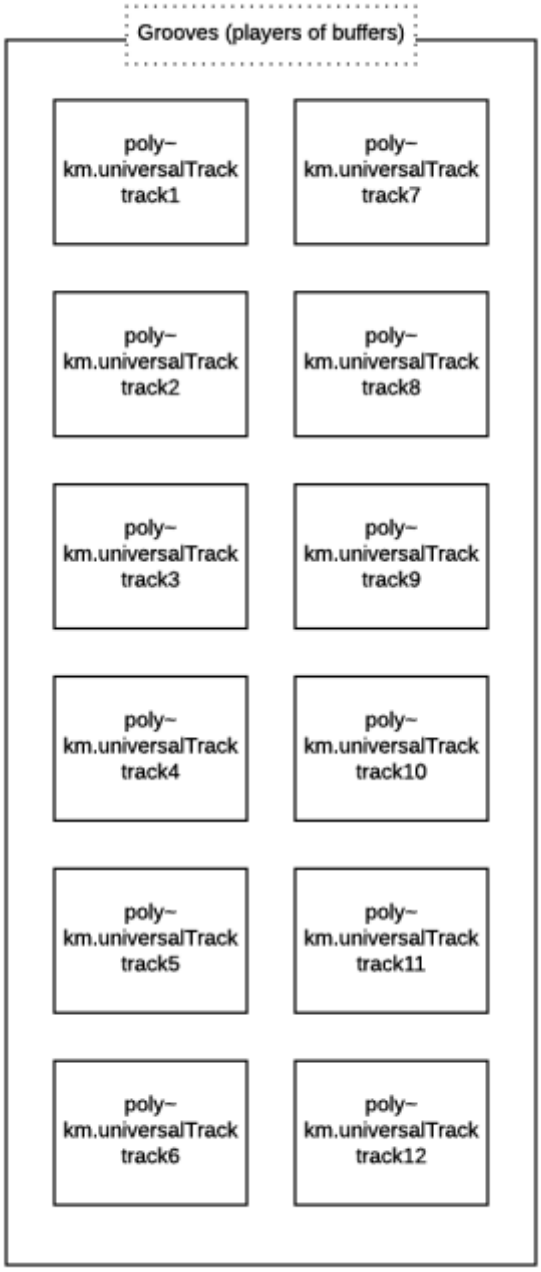
Grooves (players of buffers)
poly~
km.universalTrack
track1
poly~
km.universalTrack
track7
poly~
km.universalTrack
track2
poly~
km.universalTrack
track8
poly~
km.universalTrack
track3
poly~
km.universalTrack
track9
poly~
km.universalTrack
track4
poly~
km.universalTrack
track10
poly~
km.universalTrack
track5
poly~
km.universalTrack
track11
poly~
km.universalTrack
track6
poly~
km.universalTrack
track12

Figure 9

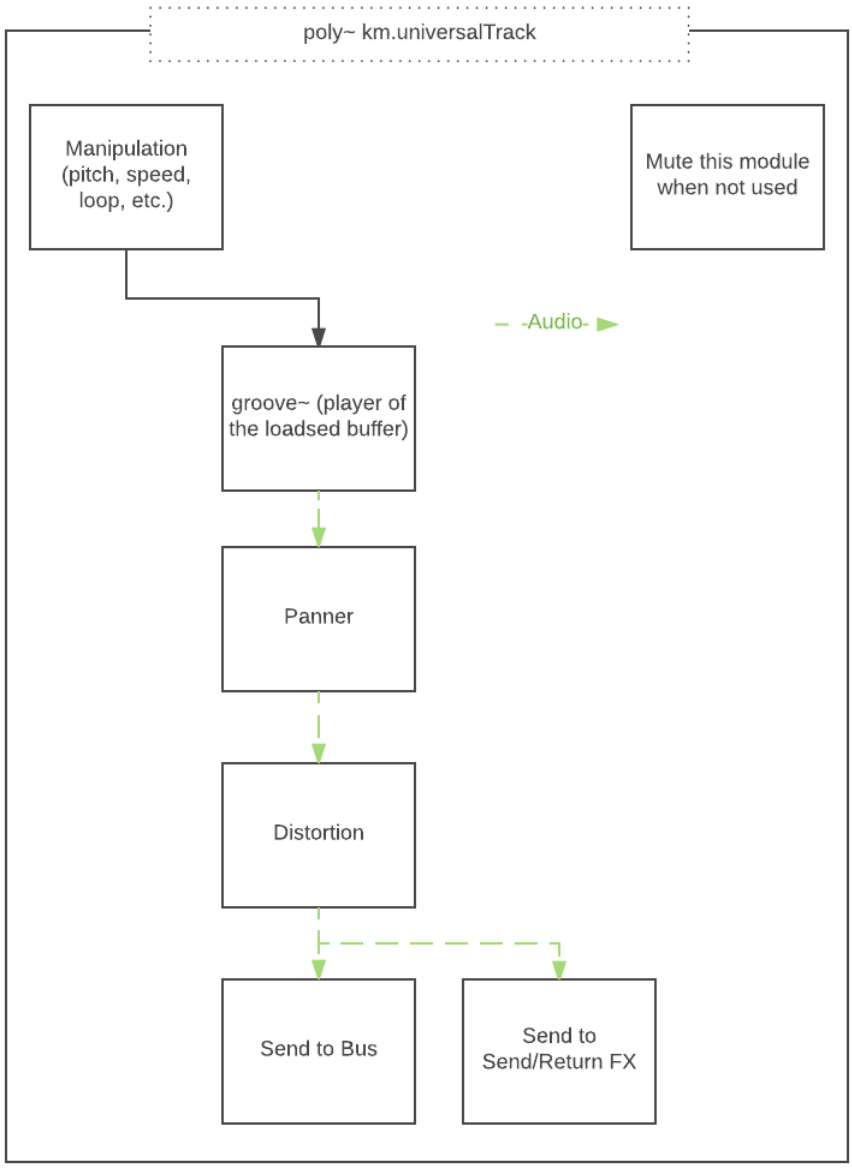

Figure 10

The below shows the internal structure of the ‘Sequencer Manipulator’ module.


Sequencer Manipulator
km.seqManipulator track1
km.seqManipulator track7
km.seqManipulator track2
km.seqManipulator track8
km.seqManipulator track3
km.seqManipulator track9
km.seqManipulator track4
km.seqManipulator track10
km.seqManipulator track5
km.seqManipulator track11
km.seqManipulator track6
km.seqManipulator track12

Figure 11

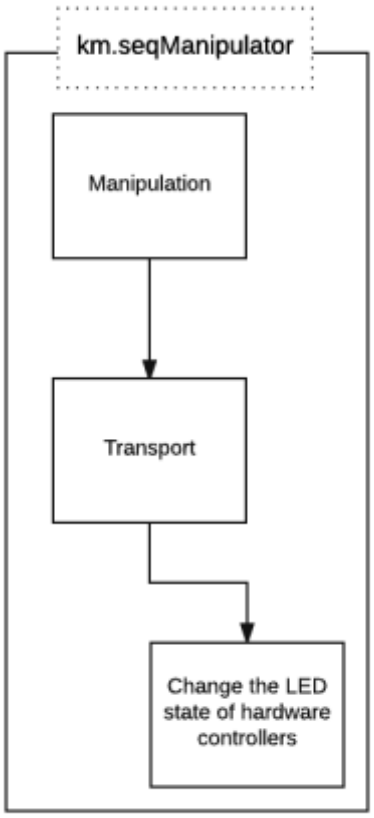

Figure 12

Each transport exists independently, but there is a master transport to which the user can make the all the other transports sync when needed. The combination of the 'Grooves (players of buffers)' module, the 'Playback Speed Manipulator' module and the 'Sequencer Manipulator' module allows the user to play back the audio files in a fluid way.

The multiple loopers which can capture a master track (where the output of all the layers are fed into) and the live audio input of the system at the user's desired timing, are integrated to the system.[36]

[36] For the loopers, I referenced and modified Christopher Jakobi's Super-Looper Basic Max patch.
Jakobi, C. 2016. *Super-Looper Basic* [Online]. Cycling '74. Available: https://cycling74.com/toolbox/super-looper-basic/ [Accessed March 26 2017].

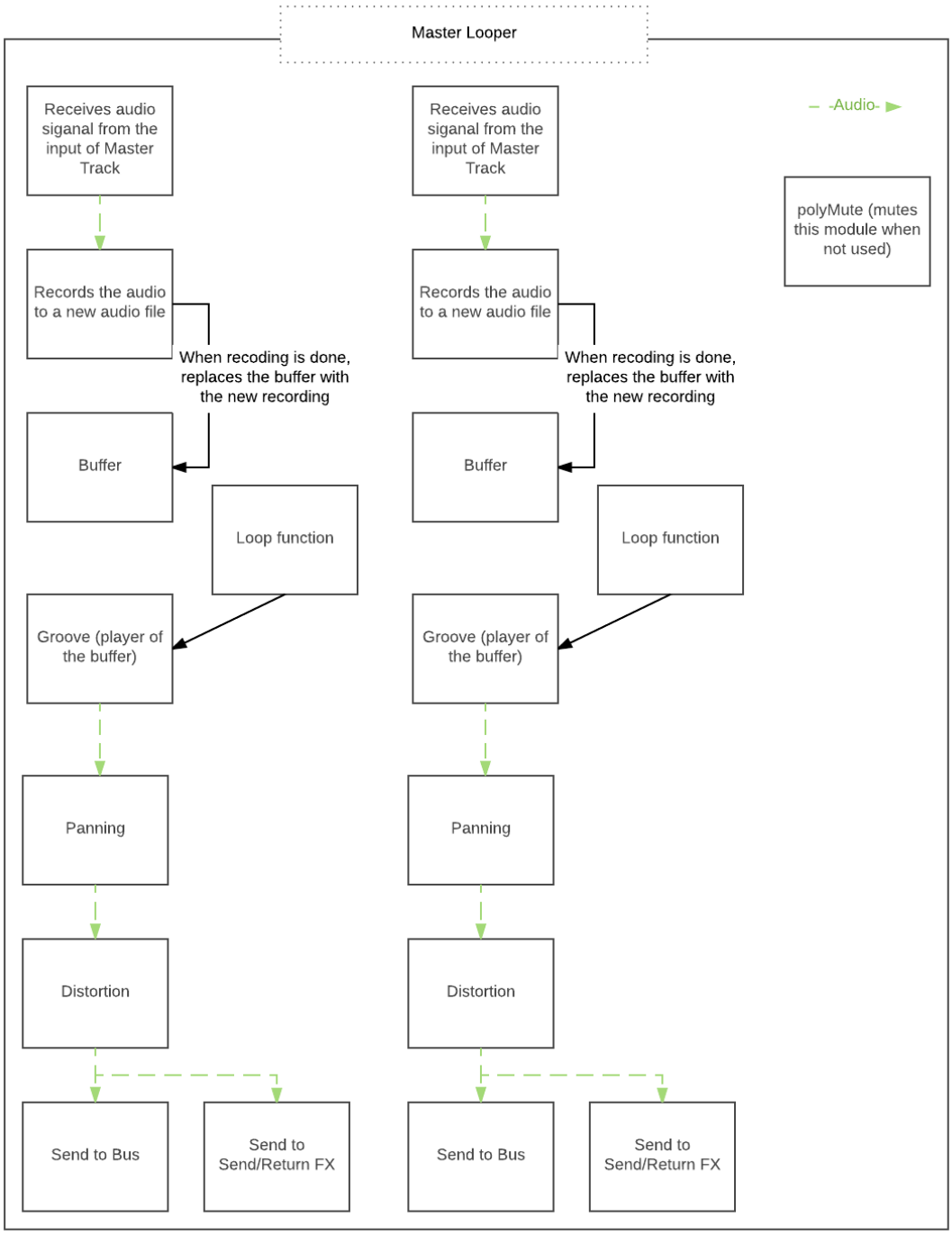
Master Looper
Receives audio siganal from the input of Master Track
Records the audio to a new audio file
When recoding is done, replaces the buffer with the new recording
Buffer
Loop function
Groove (player of the buffer)
Panning
Distortion
Send to Bus
Send to Send/Return FX
Receives audio siganal from the input of Master Track
Records the audio to a new audio file
When recoding is done, replaces the buffer with the new recording
Buffer
Loop function
Groove (player of the buffer)
Panning
Distortion
Send to Bus
Send to Send/Return FX
-Audio-
polyMute (mutes this module when not used)

Figure 13

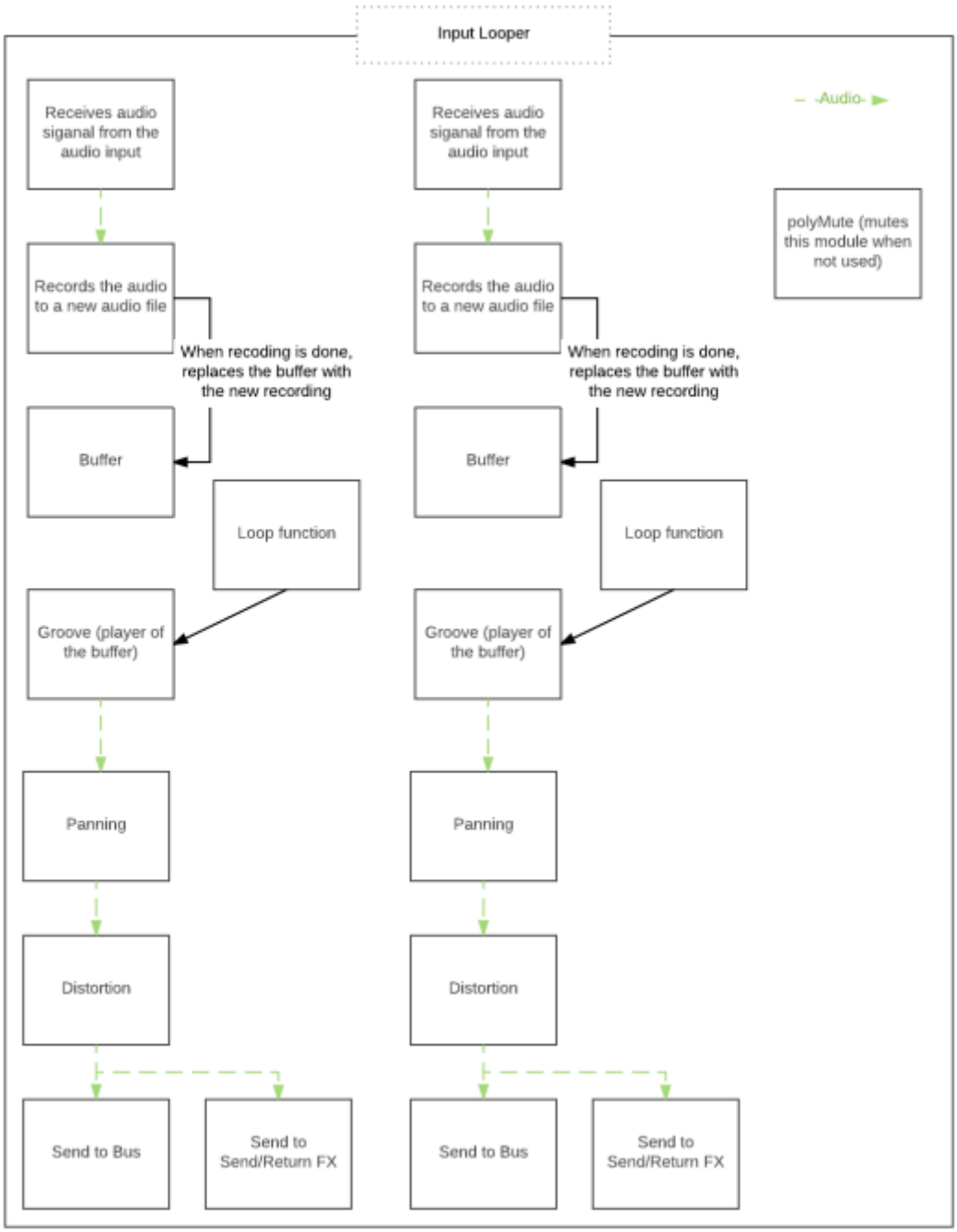

Figure 14

In addition to them, each track can be looped independently driven by the 'Sequencer Manipulator' module (figure 11 and 12). The looper functionality is one aspect of the real-time manipulation of the sequencer, which was introduced in Chapter 5. With all the loopers, because the starting point and the length of a looped section can be adjusted manually with a physical knob, the loopers enable the performer to introduce

and control '"microtiming," "expressive variation," and "microrhythm"—that tend to inform human performance' (Butler, 2014, p. 188). In other words, the introducing of microtiming enhances the bodiness of digital music performance, which we have seen in Chapter 3. With the performer's manual operation, unpredictability would be introduced too, as discussed in Chapter 4. While the starting point and the length of the looped section of the individual track looper are synced to the current tempo of the system, with the minimum unit of one bar and a 16th note respectively, those of the master track looper and the audio input looper can be manipulated freely, unaffected by the tempo. This combination provides the performer with further flexibility and performability, where for example she/he can spontaneously create polyrhythm by making use of different looped layers, or produce chaotic textures. With the loopers, playback speed, pitch, the amount of the looped sound sent to send/return effect tracks, low-pass filter, and high-pass filter can be adjusted too. All the loopers can behave either as a continuous looper (when the looped section reaches its end point, it immediately restarts), or a looper with a gap (when the looped section reaches its end point, it restarts after a gap. The user can control how long the gap is). Video example 18 shows the track looper in action. Video example 19 shows the gapped loop feature of the track looper. Video example 20 shows the input looper. Video example 21 shows the gapped loop feature of it. Video example 22 and 23 do the same for the master looper. In video example 22, the master looper captures the sounds coming to the master track at around 0:22. The input looper module provides the performer with the possibility of collaboration with external sound sources. What this module does is basically live sampling. Live sampling can introduce the elements of the 'here and now' uniqueness and contingency to performance (Kubota, 2017, 第 2 章　素材から即興へ, ライブコーディングの可能性, コンピュータとライブパフォーマンス).

The below is the internal structure of the ‘Audio Input’ module. It allows the user to perform with external audio sources. The use of vocals or instruments would be out of the focus of this thesis, but in terms of the manipulation of audio files, the user can live-sample the audio files from the speakers with a microphone for example. It would blend the resonance of the room with the original sound, and degraded sonic effect can be achieved too.

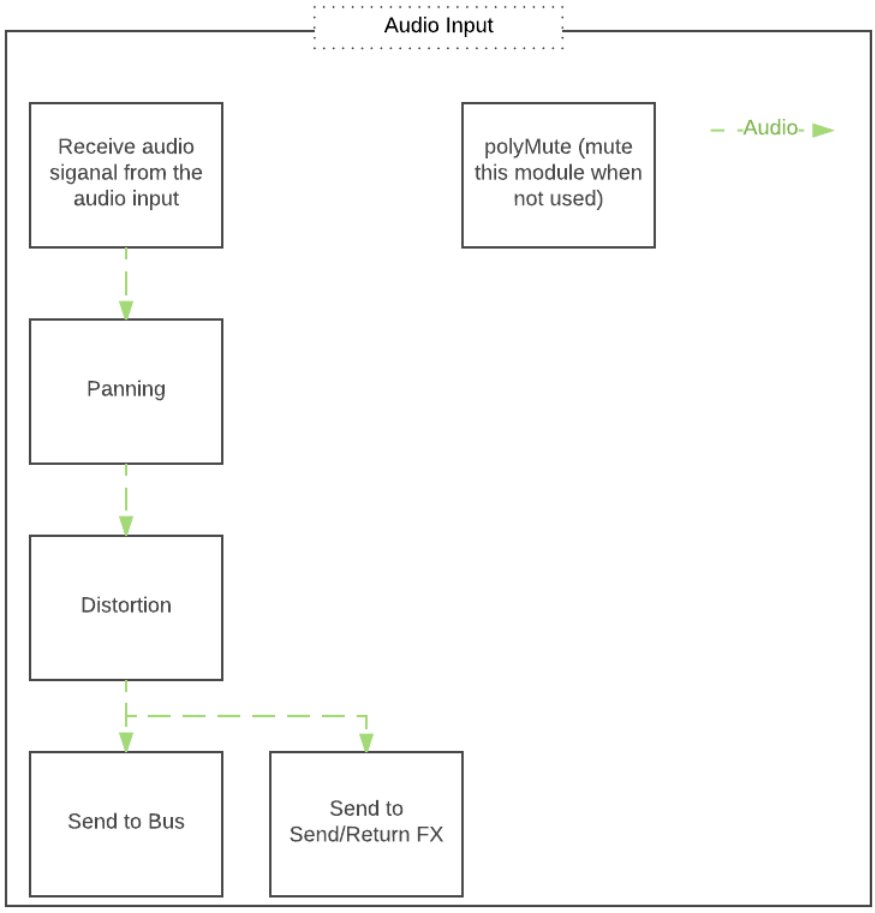

Figure 15

The below is the internal structures of the ‘Send/Return Reverb’ module and the ‘Send/Return Delay’ module.

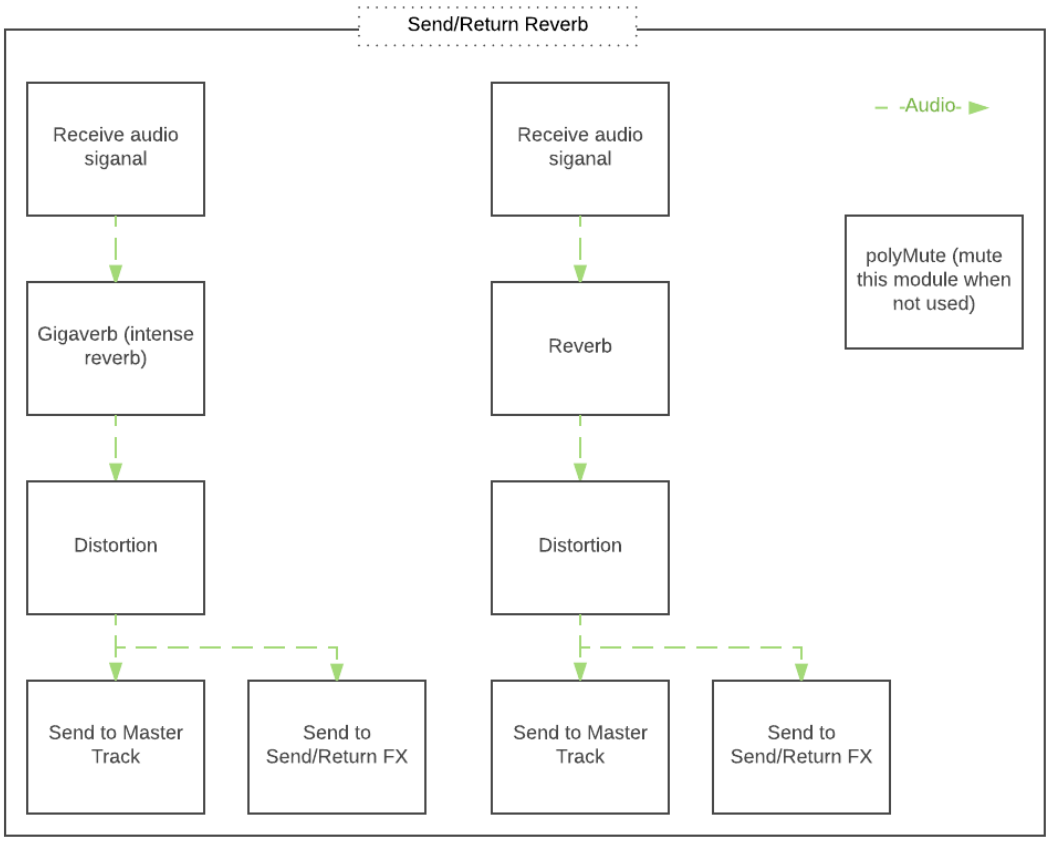
Send/Return Reverb
Receive audio siganal
Gigaverb (intense reverb)
Distortion
Send to Master Track
Send to Send/Return FX
Receive audio siganal
Reverb
Distortion
Send to Master Track
Send to Send/Return FX
-Audio-
polyMute (mute this module when not used)

Figure 16

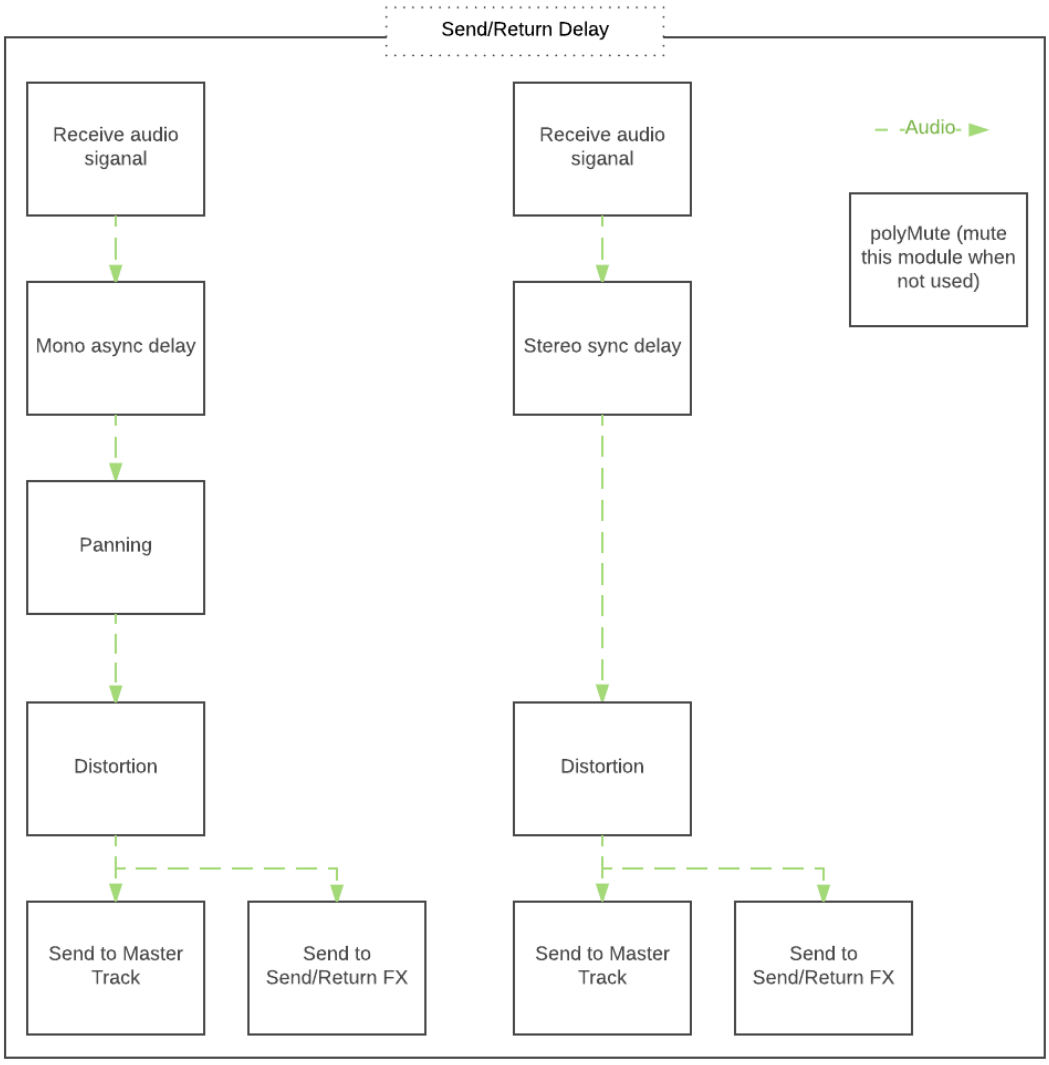

Figure 17

The ‘Audio Input Send/Return Reverb’ module and the ‘Audio Input Send/Return Delay’ module have the same structures, except the audio signal comes from the audio input, instead of the ‘Send to Send/Return FX’ modules.

The below is the internal structure of the ‘Bus 1’ module.

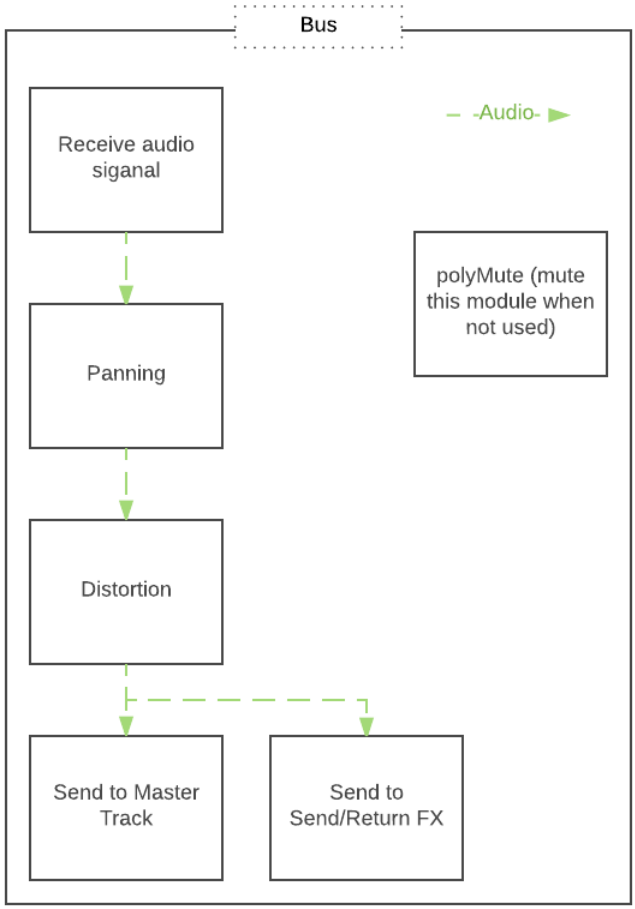

Figure 18

The below is the internal structure of the ‘Master Track + Recorder’ module.

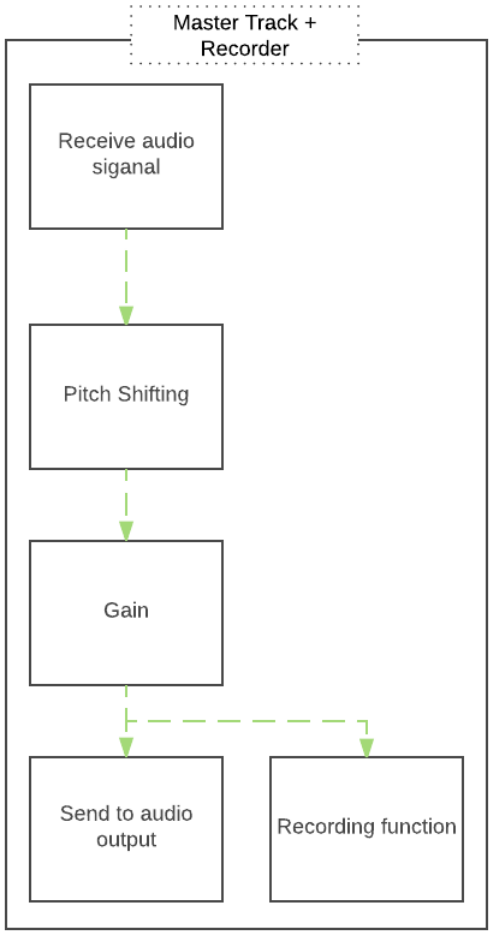

Figure 19

The ‘Sines’ module, the ‘Sines Controlled by LFOs’ module, the ‘Noise’ module and ‘Click’ module are oscillators. They work independently from the ‘Tracks (Samples)’ module, but share the same master transport which resides in the ‘Master Transport’ module.

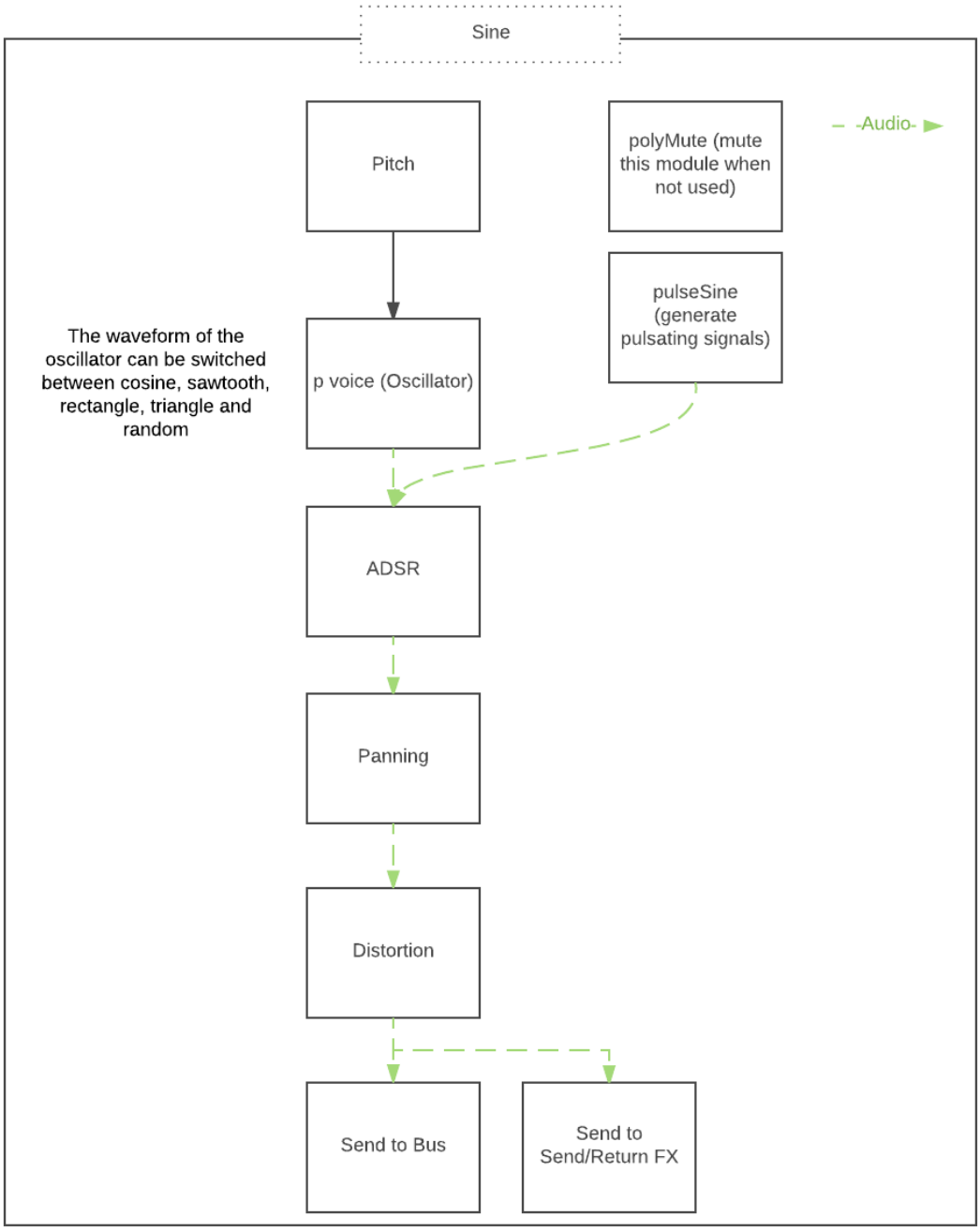
Sine
Pitch
polyMute (mute this module when not used)
-Audio-
pulseSine (generate pulsating signals)
The waveform of the oscillator can be switched between cosine, sawtooth, rectangle, triangle and random
p voice (Oscillator)
ADSR
Panning
Distortion
Send to Bus
Send to Send/Return FX

Figure 20

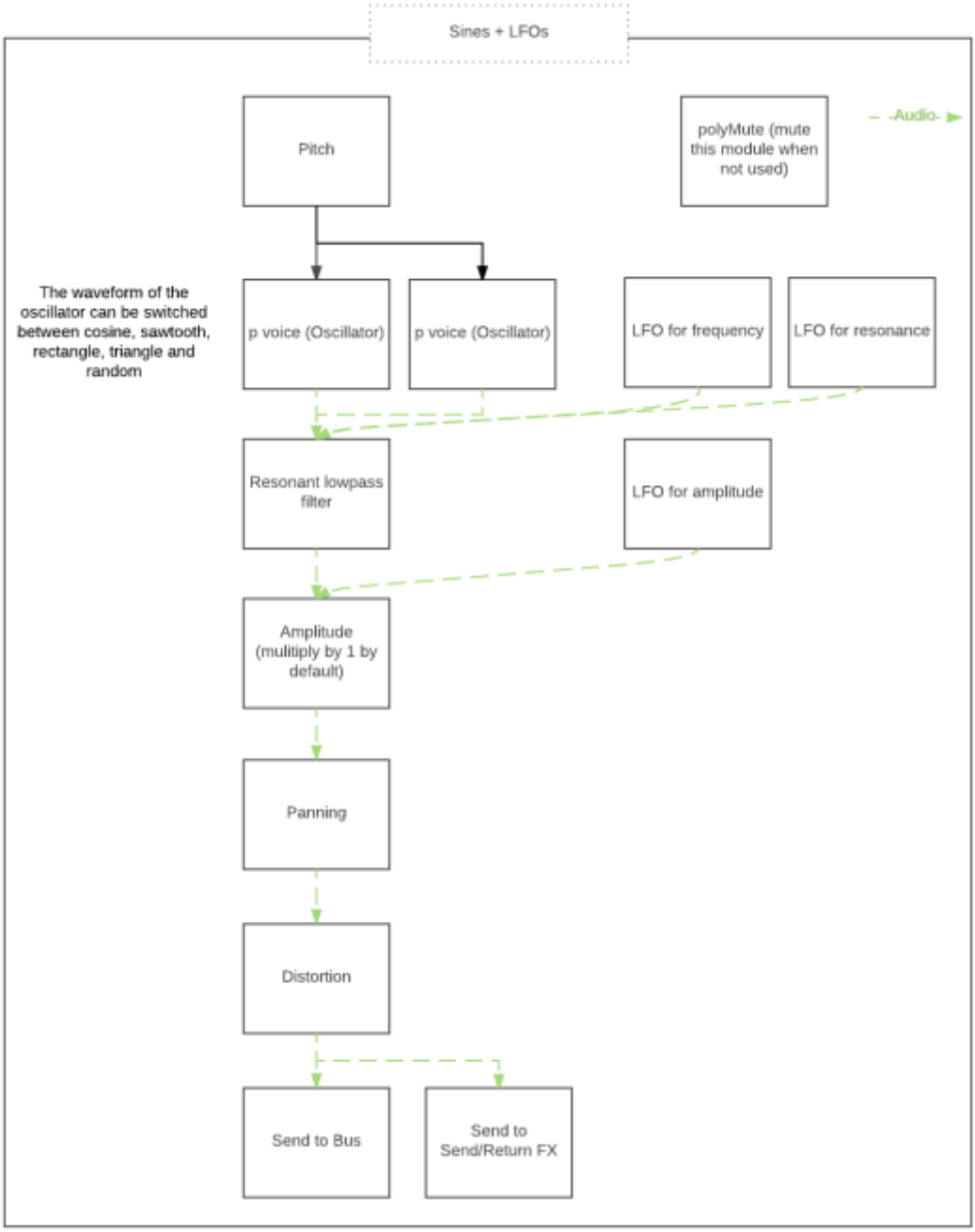
Sines + LFOs
Pitch
polyMute (mute this module when not used)
-Audio-
The waveform of the oscillator can be switched between cosine, sawtooth, rectangle, triangle and random
p voice (Oscillator)
p voice (Oscillator)
LFO for frequency
LFO for resonance
Resonant lowpass filter
LFO for amplitude
Amplitude (mulitiply by 1 by default)
Panning
Distortion
Send to Bus
Send to Send/Return FX

Figure 21

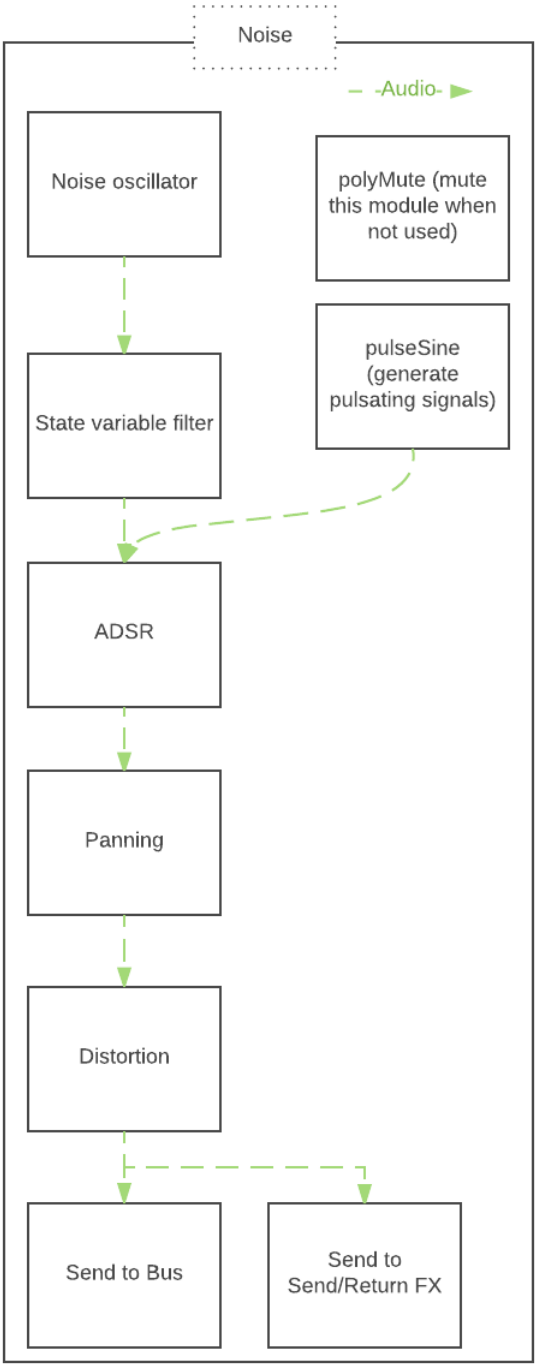
Noise
-Audio-
Noise oscillator
polyMute (mute this module when not used)
pulseSine (generate pulsating signals)
State variable filter
ADSR
Panning
Distortion
Send to Bus
Send to Send/Return FX

Figure 22

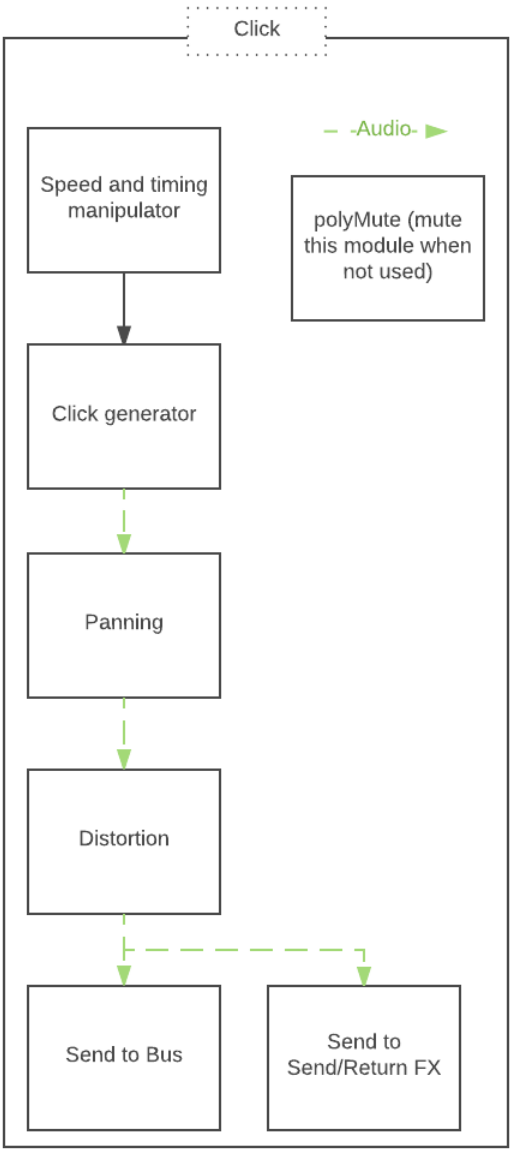

Figure 23

These oscillator-based modules and the audio-input-related modules are not our focus in this research. They are available as additional options for further versatility, but we have to note that more options do not necessarily benefit better performance as we have seen in Chapter 5.

The audio engine was built within Max, a graphical programming language. The user needs to build her/his own program for their purpose,[37] unlike generic applications such as Ableton Live. Writing our own program for expression means manipulating the material, which was chosen by us, by ourselves (Kubota, 2017, 第 3 章　コードから知覚へ, コンピュータアートの今日的展開, 素材としてのプログラミング言語). Kubota states as follows:

> Excavating the true potential and possibility that the computer holds by direct manipulation of the material as programming, and finding our own expression there, is the still most valid approach to making best use of the computer and the software as art media (Kubota, 2017, 第 3 章　コードから知覚へ, コンピュータアートの今日的展開, 素材としてのプログラミング言語).

The audio engine program consists of different modules, outlined in the next section. Kubota encourages such modular program in order to balance between improvisation and algorithm.

> You should not attempt to write the whole. By generating, eliminating or changing modules on which only the part is written, or by making them to autonomously transform or communicate, the whole emerges temporally from there (Kubota, 2017, Interlude A, 即興のパラドックス).

[37] The user can reference and make use of the programs made by others, found in help files, example files, and online communities if applicable.

With the way the audio engine is structured, I am freed from the restrictions of a human body when producing music. In other words, I do not have to think about performability. When it comes to the performance stage, I gain full physical control over sounds with my hands, as we discussed in Chapter 3.

2. Design of control mapping engine

The primary aim behind the control mapping engine is about the performer being able to 'change the real sounding nature of the music' with their 'actions'. With such 'changes', the performance becomes more 'fluid', and less 'fixed', where Butler defines 'the fixed' as 'musical outcomes that are specified fully ahead of time', and 'the fluid' as 'those determined entirely within the time frame of performance' (Butler, 2014, p. 8).

The designing of the approach should not be about increasing performable options or parameters just for the sake of 'more options'. The appropriate level of simplicity should be kept in mind. This was discussed further in Chapter 5.

The sonic changes caused by controlling actions should not be too vague to the audience. This is because if the change is not sonically clear, the audience cannot relate the performer's actions to the sounds. As a result, to the audience, non-theatrical actions (which actually affect the sounds) become theatrical actions (which do not affect the sounds). Again, when A *does not appear* to cause event B, *then* it *has not done*. The balance between being able to generate 'obvious' sonic changes via the controllers (for the causality between actions and sonic results discussed in Chapter 3), and retaining delicate and nuanced controllability (for our ideal hardware device discussed in Chapter 4) should be designed carefully.

Carefully selected parameters of the audio engine are mapped to physical MIDI controllers, thus the performer can express her/his instant decisions sonically, through her/his physical actions. The mapping was designed in such a way that the performer can add, subtract and manipulate sounds (effects, melodies, harmonies, beats, textures, noises, timbre, etc.), change music structure (jumping between playback locations, speeding up, slowing down, rewinding, instant looping, etc.), and change the mixing of channels. (video example 10 and 11). To paraphrase the design in terms of Emmerson's definition of 'live' set out in the Introduction, the performer, as *a human performer, takes decisions and makes actions during a performance which change the real sounding nature of the music through electronically mediated interfaces under* her/his *immediate control*.

The controllers used for the system are two Midi Fighter Twisters (DJ TechTools, no date). Each Midi Fighter Twister has 16 pushable knobs and six side buttons. There are four banks for the pushable knobs so in effect there are 64 pushable knobs. Two of the side buttons are used for switching between the scenes. Each pushable knob has 11 white LEDs (with an optional red/blue LED in the middle for a centre detent), and one RGB segment (DJ TechTools, 2015). I programmed how those control modules work within Max. Basically, the rotation of the knobs is used to change continuous values. The switch state of the knobs is used to change on/off states or which parameter is affected by the rotation of the same knob. By calculating the elapsed time between successive pushes, a double-push is also used for on/off states. The side buttons (except the two side buttons which are pre-configured to change banks) are used as shift buttons for the rotation of the knobs, which change the destination of the rotational effect. The context behind this mapping design was discussed in Chapter 4. Please see video example 11.

3. Design of visual engine

When the performer of digital music interacts with their sound by physically controlling something (knobs, faders, pads, buttons, etc.), the physical speed of their controlling actions, and the amount of controlling, and even whether they are controlling anything or not, are much less clear to the audience, compared to 'visible music', 'a music produced by singers and instrumentalists' (Smalley, 2007, p. 79), as we have seen in Chapter 1. The performer can alter their sound physically by using a hardware controller, but the audience are not given sufficient information to know whether that audio alteration was actually the result of the performer's physical action, or sequenced to happen at that time point. As long as the audience don't perceive it, it does not exist to the audience, regardless of how many immediate 'here and now' actions are occurring in the 'local' field (Emmerson insists that 'The *fact* that our local protagonist may trigger events, or processes, in the field is not our concern, only what *appears* to be true to the listener' (Emmerson, 2007, p. 92). This was discussed in Chapter 3. Emmerson describes laptop performance as:

> The concert listening conditions often included much non-musical information as to how the work was generated (programme notes, presence at a Computer Music Conference, and so on). If that could be 'bracketed out' then there was often little left to judge the effect of the performers on the sounding result (Emmerson, 2007, p. 92).

If the audience do not feel that a performer 'changes the real sounding nature of the music' (regardless of whether she/he actually changes it or not), this could mean the audience do not experience that performance as 'live' (in terms of Emmerson's

working definition of ‘live’). In an attempt to restore the ‘liveness’ to such a situation, all the elements referred to above (‘whether controlling or not controlling, the physical speed of controlling, the amount of controlling’) can be visualised to let the audience perceive them. The below is the overview of the visual engine of my performance system (the right edge of figure 24 continues to the left edge of figure 25). What the ‘Trace’ module does is ‘generating a set of faces around areas exceeding a certain brightness threshold’ (Derivative, 2014a). The ‘Wireframe’ module ‘renders the edges of polygons and curves as lines’ (Derivative, 2014b).

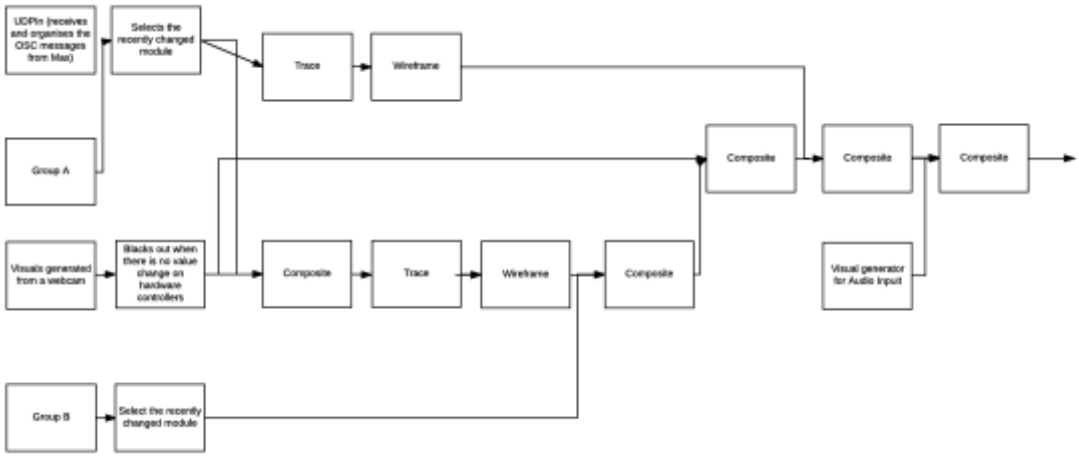

Figure 24

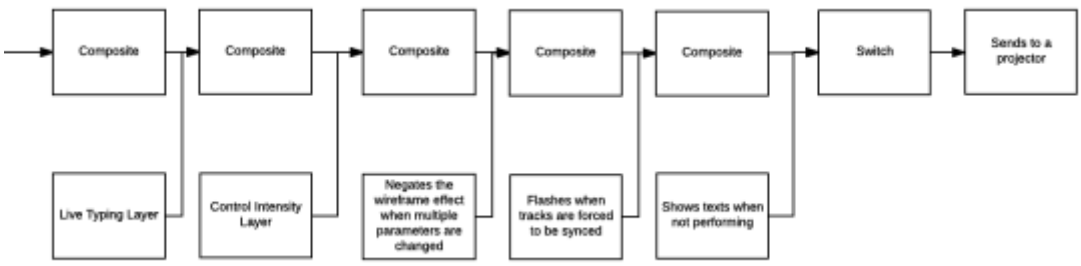

Figure 25

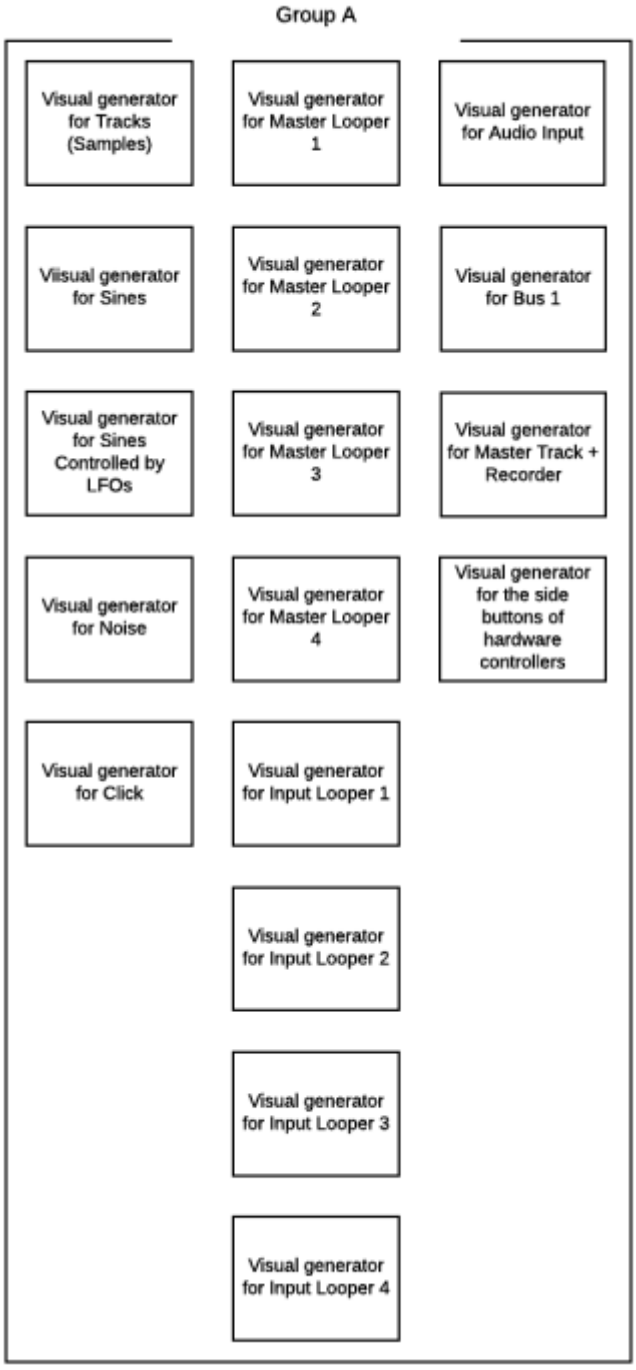
Group A
Visual generator for Tracks (Samples)
Visual generator for Master Looper 1
Visual generator for Audio Input
Viisual generator for Sines
Visual generator for Master Looper 2
Visual generator for Bus 1
Visual generator for Sines Controlled by LFOs
Visual generator for Master Looper 3
Visual generator for Master Track + Recorder
Visual generator for Noise
Visual generator for Master Looper 4
Visual generator for the side buttons of hardware controllers
Visual generator for Click
Visual generator for Input Looper 1
Visual generator for Input Looper 2
Visual generator for Input Looper 3
Visual generator for Input Looper 4

Figure 26

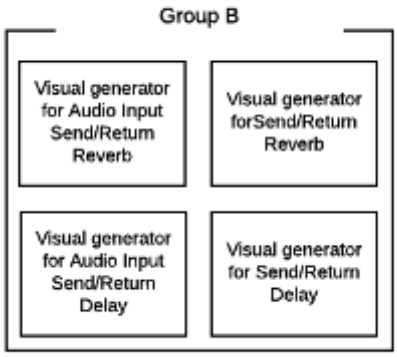

Figure 27

In my performance system, the continuous video images of the performer's hands are inputted from a webcam as a visual source. I extract the differences between each frame from the webcam, in order to project the performer's movements only. This gives me visuals when the performer moves in front of the webcam, and a black screen when there is no movement. I shall call this stage the 'Difference stage'. The visual effect added at a later stage which emphasises the performer's movements, unwantedly turns that black screen to a somewhat coloured one. To solve this problem, I put an analyser which gives me information about the level of activity going on in the image at the Difference stage in numerical values. I use those values to control the brightness of the image fed into the exaggeration effect. The screen goes back to black again, when there are no movements captured by the webcam. In order to avoid any random visuals being shown when the performer does not take any action, I programmed the entire webcam-based module to be activated only when there is a value change in MIDI controllers. The point is that when the performer does not make any changes to the sounds, the visuals will not be seen at all (i.e. darkness), and the audience see visuals only when the performer interacts with the hardware

controllers physically. The below is the structure of the ‘Visuals generated from a webcam’ module.

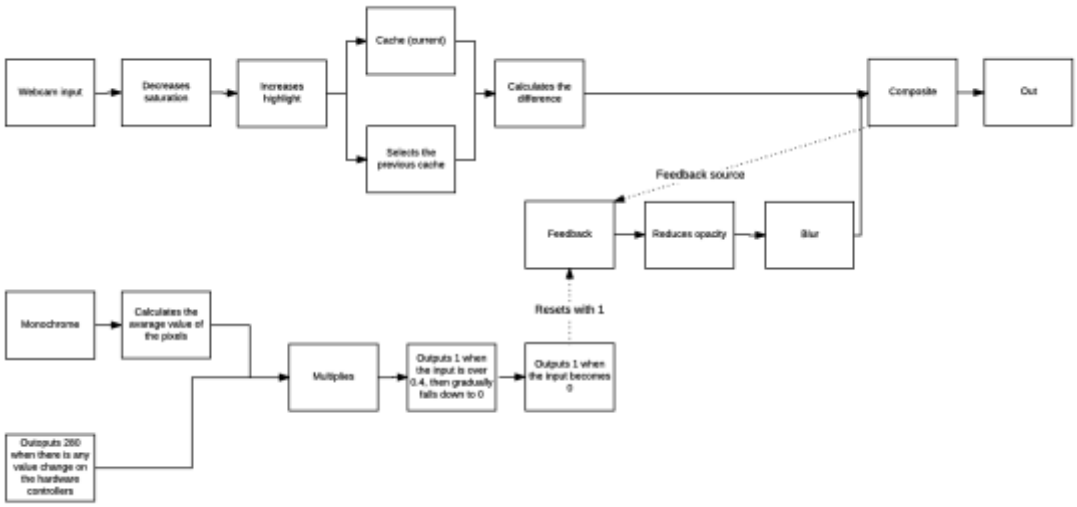

Figure 28

Please see video example 6 for the resulting visuals generated through this process. One of the medium specificities of the computer is algorithm (Kubota, 2017, 第 2 章 素材から即興へ,ライブコーディングの可能性, コンピュータは楽器にはなれない). Kubota writes that ‘the essence of the expression generated by algorithms is in the point of that “it does not involve a hand”. In artistic expressions and manufacturing, a hand has been regarded as the symbol which represents the dignity, ugliness, greatness and ineptness of a human being. Algorithms eliminate the symbolic “hand”’ (Kubota, 2017, Interlude A, 手の消滅). In this sense, what I do with this module is to salvage what is lost in digital expression, for the sake of the liveness of human performance.

Not only the visual data input, but also the numerical parameter values of the controllers changed by the performer’s physical involvement with them, generates

another layer of visuals. The ‘Visual generator’ modules in figure 26 and 27 were built around this rule. The raw digits are used for the visuals related with sound generators (such as sine tone generators, noise generators, an LFO-affected sine tone generator and a click generator) and utility controls (such as overall volume etc., video example 24). With the sound generators, the digits are morphed with certain shapes, helping the audience sense which sound generator the performer is affecting (video example 25). The transformation and morphing between the raw digits and the images of insects (which have been cropped out from the background with Photoshop) are integrated for the ‘Tracks (Samples)’ module of the audio engine. The transformation and morphing of the images imply the transformation of the pre-recorded materials (video example 8). The contexts and aesthetic reasons behind this approach was discussed further in Chapter 2.

The units of the controllers (each knob and button) are categorised into several groups depending on the type of effect (whether it adds a new sound, applies filters, adds reverbs, changes music structure, etc.) and the type of physical character (the rotation of a knob, the push of a knob, or the push of a side-button in the current setup, video example 12), so there are two interrelating categorisations of control groups. Each group generates a different visual, and the speed, number, and degree of controlling actions taken, will be shown visually. With this approach, the audience will have a clearer sense of what and how the performer changes sounds during performance.

The amount of the controllers’ parameter changes in a certain time frame is visualised, in an attempt to show the performer’s physical (thus probably also emotional) intensity of his actions. In addition, when the performer changes the value of more than two knobs at the same time, Control value visualisation layer modules

are coloured. The context behind this was discussed in Chapter 2 with the keyword 'the emotional intensity', and Chapter 3 with the keyword 'effort'. Please see video example 4 and 5.

The resultant visuals are relatively abstract and non-narrative, as discussed in Chapter 2. Also, unnecessary visuals are designed to be filtered out where possible. If dynamically-changing complex visuals are always shown regardless of the performer's movement or actions, the audience cannot discern between the visual changes triggered by a performer and those triggered by a sequencer. Using the real-time captured images of the performer's body has a by-product of giving some organic feeling to computer-generated visuals because a human 'body is, crucially, an unpredictable entity'(Peters et al., 2012, p. 1). The preference for the organic can be regarded that I treat my visuals as the extension of my physical 'organic' body like a cyborg or a transformed human, or as another physical entities with which I collaborate like Kraftwerk. These notions were introduced in Chapter 2.

I have included the feature of typing and showing letters in real-time in the performance system. Some live coding performances at Algorave and Holly Herndon's performance influenced this idea.[38] How I am going to use that type-and-show feature is still under consideration. It can be used to actualise a 'real' interactivity between a performer and audience. Also it has potential to be an interesting counter-approach to the popular 'checking email' discussions raised frequently among laptop-based music performances, as I can 'write an open letter or email' to audience from behind my laptop. The design of the relationship between real-time typing and sounds is possibly another key for this approach. The typing function can be useful to notify the audience of the beginning of the performance. A

[38] One of the supporting members for Herndon, Mat Dryhurst, who was mainly controlling the visuals on the screen, occasionally typed words in real-time, many of which attempted to communicate with the audience.

vague start to a performance, where the audience cannot be sure if it has begun or not, can cause some problems, as described in Chapter 1 with my personal experience at Autechre's performance. Please see video example 26 for this module in action.

The visual engine was built within TouchDesigner. It consists of different layers. The layers are blended and processed in such a way that the whole visual scene stands as one aesthetic entity, while the viewer can still distinguish the different layers. Please see video example 10.

4. Development of the performance system

For the audio engine of my performance system, as a starting point, I built a combination of a multi-track DJ-based approach (e.g. Four Tet)[39] and a live PA engineering approach (e.g. Lewis, or a live PA engineer in dub music), taking into consideration that I use the recordings of my music pieces as core audio performance materials. For the visual engine, in the early stage of my PhD, I explored how audio elements should be visualised. At that time the audio engine was built with Ableton Live and the visual engine was built with Cycling '74 Max. The use of Leap Motion (a sensor device which can fetch the data of the position and the movement of hands and fingers) was also experimented. The work-in-progress system was tested at a performance in Tokyo on the 29th of March 2015. I found that performing with Ableton Live's built-in clips is technically not much different from the push-play approach. The performance of pushing the right clip at the right timing, and being locked to a single master sequencer are too fixed. This realisation encouraged me to build my own sequencer system with Max. Leap Motion also started to reveal itself problematic, as I explained in Chapter 2. An APC40 mkII, which is designed to work

[39] Four Tet explains about his performance setup here.
Red Bull MusicRED BULL MUSIC ACADEMY. 2013. *Studio Science: Four Tet On His Live Set* [Online]. YouTube. Available: https://www.youtube.com/watch?v=9KIvnLBF7vU [Accessed 20 November 2015].

primarily with Ableton Live, was used as a main controller, but as I shifted from Ableton Live to Cycling ’74 Max for the audio engine, I started to look for a more general-purpose programmable controller, and ended up with a MIDI Fighter Twister, which was explained in Chapter 4. With the theories I found around that time, which were discussed in Chapter 1 and 2, I stopped visualising audio elements directly. For the visual engine, I started to focus on visualising a performer’s physical actions as a complementary role to sounds, and Cycling '74 Max was replaced with TouchDesigner because of its optimisation for visual-oriented tasks.

Conclusion

Digital music performance is a contradictory art form. The significance of 'Digital music' is in its non-real-timeness and non-bodiness. The producer of digital music can work on multiple time scales in the same DAW timeline to construct a piece. The sounds they produce are not constrained by our physical body, unlike visible music. In contrast, the liveness of 'performance' is in its real-timeness and bodiness. The 'here and now' quality and the physical presence of a performer renders a performance live. In order not to compromise the medium specificities of digital music, we should be freed from real-timeness and bodiness during its production stage. The audio engine of my performance system turns such fixed digital music pieces into fluid, without losing the complexity 'fixed' in the recordings, by redefining the way we use the sequencer. The real-time and dynamic manipulation of multiple independent sequencers introduces multi-layered and interrelated time scales into the performance. The audience can experience the continuously transforming and warping family of independent but related time entities during the performance.

In an ideal performance, the audience should be able to sense a performer's physical actions 'which change the real sounding nature of the music' (Emmerson, 2007, p. 90) strongly enough to believe the causality between the actions and related sounds during the performance. With my practice, visuals are exerted to tackle the issue. Direct audio-to-visual visualisation or a synaesthetic audiovisuals approach were avoided in order to not interfere with 'the trans-modal perceptual nature imbedded in aural perception' (Smalley, 2007, pp. 81-82). The use of the carefully filtered out visuals generated from the performer's musical actions, is the third audiovisual approach in digital music performance, which could be regarded both

acousmatic and audiovisual, or neither of them. It does not provide the audience with signifying signposts which could restrict their aural imagination, while enriching the audience's experience through the visually enhanced physical presence of the performer.

In Chapter 1, we looked into the reasoning of using visuals in digital music performance. The views from acousmatic practitioners and audiovisual practitioners were referenced, in order to find a reasonable audiovisual approach for digital music performance. Visual music and VJ culture played roles in providing the historical contexts. We established the ideal conditions of the audiovisual approach. Firstly, the audience should be able to sense a performer's physical actions 'which change the real sounding nature of the music' (Emmerson, 2007, p. 90) strongly enough to believe the causality between the actions and related sounds. Secondly, the audience's multisensory audio experience should not be distracted by eye-pleasing but unnecessary visual elements.

In Chapter 2, the key visual aspects in digital music performance were explored. The first of these is a performer's physical body and her/his actions as visual information, considering Emmerson's definition of 'live' ('The presence of a human performer: who takes decisions and/or makes actions during a performance which change the real sounding nature of the music') (Emmerson, 2007, p. 90). The second key visual aspect is the parameters of mediatised visuals. Several specific parameters were covered in detail in the chapter, occasionally referring to Chion's audiovisual theories. The third aspect that the artist should be concerned with is the nature of the media used for mediatised visuals. We also considered how my mediatised visuals can be related to digital materialism. The findings from Chapters 1 and 2 determined the design of the visual engine of my performance system.

Chapter 3 examined how a physical body plays a role in digital music performance and production respectively. In particular, the perceivable causality between physical actions and sonic results was my focus, and the issues of disproportion and effortlessness were covered by comparing digital music performance to traditional instrumental music. In contrast to the way I used the visual data of a performer's physical body in my system for the issues of Chapters 1 and 2, here I used the numerical data of a performer's physical involvements with hardware controllers to solve the problems concerned. The topics in this chapter also affected the design of my audio engine.

In Chapter 4, how the use of hardware devices, and their mapping design, affects digital music performance, and the characteristics of an ideal hardware device were discussed. The idea of flow was referenced in several aspects. The findings in this chapter are reflected in the choice of the hardware devices, the audio engine, and the control mapping engine of the performance system.

Chapter 5 explored the fixity and the fluidity of digital music performance. The concepts were defined in terms of digital music performance, with Butler's theories, the comparison to Cage's indeterminacy and relevant examples. The issues around the use of a sequencer were visited, and a redefinition of it was suggested for enhanced fluidity. In addition to that, the topics of legibility, simplicity and constraints were discussed in order to find further approaches to increasing the fluidity of a performance which uses fixed materials. This chapter determined the design of the audio engine of the performance system.

With the performance system, digital music pieces can be 'performed' with maximised liveness. The performer can fluidify any fixed recording to any desired extent manually with her/his hands. The presence of the performer's spontaneous

physical actions is delivered to the audience without deteriorating their auditory imagination unnecessarily. These two core aspects of the design are the considered attempts to respond to the Emmerson's working definition of 'live', from the field of digital music performance.

> The presence of a human performer: who takes decisions and/or makes actions during a performance which change the real sounding nature of the music (Emmerson, 2007, p. 90).

In closing, I would suggest that digital musicians need to be freed from the norms of previous music performance standards, in order to exploit technology (the computer) and create the most effective performance. Attempts to imitate the performance formats of how popular musicians (such as rock bands or vinyl DJs) reproduce the production process of their music on stage could be considered regressive. Instead, perhaps, digital musicians should keep asking the question of what the nature of digital music performance is. The performance approach of presenting organic entities of time living in the performer's hands, and of communicating to the audience's sensory organs in an acousmatic and audio-visual way is what I have found most significant so far in my exploration of this area. There surely is a great deal more to be discovered on this journey, as long as people are still performing music created with the computer.

References

Addictive TV. 2013. *Orchestra of Samples ["Hangman"] - Addictive TV live @ Watermans Arts Centre, London* [Online]. Vimeo. Available: https://vimeo.com/79791431 [Accessed 12 October 2015].

Alexander, A. & Collins, N. 2007. 7 Live audiovisuals. In: Collins, N. & D'Escriván, J. (eds.) *The Cambridge Companion to Electronic Music.* Cambridge: Cambridge University Press.

Andrew, H. 2007. The origin of electronic music. In: Collins, N. & D'Escriván, J. (eds.) *The Cambridge Companion to Electronic Music.* Cambridge: Cambridge University Press.

Auslander, P. 2008. *Liveness: Performance in a Mediatized Culture,* Abingdon, Routledge.

Auslander, P. 2012. Digital Liveness: A Historico-Philosophical Perspective. *PAJ: A Journal of Performance and Art,* 34**,** 3-11.

Bailey, D. 1993. *Improvisation: Its Nature and Practice in Music*, Philadelphia, Da Capo Press.

Barrett, N. 2007. 13 Trends in electroacoustic music. In: Collins, N. & D'Escriván, J. (eds.) *The Cambridge Companion to Electronic Music.* Cambridge: Cambridge University Press.

Benjamin, W. 2008. *The Work of Art in the Age of Its Technological Reproducibility, and Other Writings on Media,* Cambridge, Mass., Belknap Press.

Bleau, M. no date. *Soft Revolvers (2014)* [Online]. myriambleau.com. Available: http://www.myriambleau.com/soft_revolvers.html [Accessed 11 October 2015].

Bowers, J. 2002. *Improvising Machines Ethnographically Informed Design For Improvised Electro-Acoustic Music.* University of East Anglia, Norwich, UK.

Brandom, R. 2016. *Google's art machine just wrote its first song* [Online]. The Verge. Available: http://www.theverge.com/2016/6/1/11829678/google-magenta-melody-art-generative-artificial-intelligence [Accessed 6 December 2016].

Butler, M. J. 2014. *Playing with Something That Runs: Technology, Improvisation, and Composition in DJ and Laptop Performance,* New York, Oxford University Press.

Cascone, K. 2002. *Laptop Music: Counterfeiting Aura in the Age of Reproduction* [Online]. Academia.edu. Available: http://www.academia.edu/4865510/Laptop_Music_Counterfeiting_Aura_in_the_Age_of_Reproduction [Accessed 4 January 2017].

Cascone, K. 2003. Grain, Sequence, System: Three Levels of Reception in the Performance of Laptop Music. *Contemporary Music Review,* 22**,** 101-104.

Cascone, K. 2004. The Aesthetics of Failure: "Post-Digital" Tendencies in Contemporary Computer Music. In: Cox, C. & Warner, D. (eds.) *Audio Culture: Readings in Modern Music.* New York: Continuum.

Chion, M. 1994. *Audio-Vision: Sound on Screen,* New York, Columbia University Press.

Chion, M. 2012. The Three Listening Modes. In: Sterne, J. (ed.) *The Sound Studies Reader.* Abingdon: Routledge.

Collins, N. 2013. *Electronic music,* Cambridge, Cambrige University Press.

Collins, N. & D'Escriván, J. 2007. *The Cambridge Companion to Electronic Music,* Cambridge, Cambridge University Press.

Collins, N., McLean, A., Rohrhuber, J. & Ward, A. 2002. Live coding in laptop performance. *Organised Sound,* 8**,** 321-329.

Conte, J. 2008. *VideoSong 1 - Push - Jack Conte* [Online]. YouTube. Available: https://www.youtube.com/watch?v=FUVgPjnEMzw [Accessed 12 October 2016].

Cox, C. & Warner, D. 2004. *Audio Culture: Readings in Modern Music,* New York, Continuum.

Crevits, B. 2006. the roots of vjing. In: Faulkner, M. & Fuse, D. (eds.) *VJ: Audio-Visual Art and VJ Culture.* London: Laurence King.

Csikszentmihalyi, M. 1998. *Finding Flow: The Psychology of Engagement With Everyday Life (MasterMinds)*, New York, Basic Books.

Cytowic, R. E. 2002. *Synesthesia: A Union of the Senses*, Cambridge, Mass., A Bradford Book.

D'Escriván, J. 2006. To sing the body electric: Instruments and effort in the performance of electronic music. *Contemporary Music Review*, 25**,** 183-191.

Derivative. 2011. *Alva Noto - unitxt/univrs (Derivative Version)* [Online]. Vimeo. Available: https://vimeo.com/21317325 [Accessed 12 October 2016].

Derivative. 2014a. *Trace SOP* [Online]. Derivative. Available: http://www.derivative.ca/wiki099/index.php?title=Trace_SOP [Accessed 12 August 2017].

Derivative. 2014b. *Wireframe MAT* [Online]. Derivative. Available: http://www.derivative.ca/wiki099/index.php?title=Wireframe_MAT [Accessed 12 August 2017].

DJ Techschools. 2015. *Midi Fighter Twister - User Guide 2015* [Online]. DJ TechTools. Available: https://drive.google.com/file/d/0B-QvIds_FsH3Z0ZLT041VnZfOTA/view?usp=sharing&usp=embed_facebook [Accessed 16 January 2017].

DJ Techschools. no date. *Midi Fighter Twister* [Online]. DJ TechTools. Available: https://store.djtechtools.com/products/midi-fighter-twister [Accessed 16 January 2017].

Eck, D. 2016. *Welcome to Magenta!* [Online]. Magenta. Available: https://magenta.tensorflow.org/welcome-to-magenta [Accessed 6 December 2016].

Emmerson, S. 2007. *Living Electronic Music*, Aldershot, Ashgate.

Eshun, K. 2004. Operating System for the Redesign of Sonic Reality. In: Cox, C. & Warner, D. (eds.) *Audio Culture: Readings in Modern Music.* New York: Continuum.

Fact. 2015. *Native Instruments' new open multi-track format lets DJs remix on the fly* [Online]. Fact. Available: http://www.factmag.com/2015/03/30/native-instruments-introduces-stems-format/ [Accessed 15 January 2017].

Factmagazine. 2015. *Inside Tim Exile's Flow Machine* [Online]. YouTube. Available: https://www.youtube.com/watch?v=s2Rp4xbmtRk [Accessed 18 November 2015].

Fontanari, I. P. D. P. 2013. DJs as Cultural Mediators: The Mixing Work of São Paulo's Peripheral DJs. In: Attias, B., Gavanas, A. & Rietveld, H. C. (eds.) *DJ culture in the mix : power, technology, and social change in electronic dance music.* New York: Bloomsbury Academic.

Fukami, E. 2015. *スクエアプッシャー・来日ライヴ前インタビュー「実験的な音楽にはファンのサポートがすごく重要」 [Pre-Concert interview in Japan with Squarepusher: "Fans' support is crucial for experimental music"] [Japanese]* [Online]. Gadget Tsushin. Available: http://getnews.jp/archives/948787 [Accessed 12 October 2015].

Greenberg, C. 1940. *Towards a Newer Laocoön* [Online]. Salt Lake City: West High School. Available: http://west.slcschools.org/academics/visual-arts/documents/laocoon.pdf [Accessed 8 December 2016].

Greenberg, C. 1960. *Modernist Painting* [Online]. The University of Chicago. Available: https://voices.uchicago.edu/wittgenstein/files/2007/10/Greenbergmodpaint.pdf [Accessed 21 November 2016].

Hadfield, J. 2014. *黒川良一: 感覚のオーバーロード [Ryoichi Kurokawa, Sensory Overload] [Japanese]* [Online]. Resident Advisor. Available: https://jp.residentadvisor.net/features/2295 [Accessed 12 October 2016].

Heidegger, M. 1977. *Question Concerning Technology and Other Essays,* New York, HarperPerennial.

Henke, R. 2007. *Live Performance in the Age of Supercomputing* [Online]. Available: http://www.monolake.de/interviews/supercomputing.html [Accessed 10 October 2015].

Henke, R. 2009. *Live Performance in the Age of Supercomputing II* [Online]. Available: http://www.monolake.de/interviews/hitchhiker.html [Accessed 11 October 2015].

Herbert, M. 2017. *The Music* [Online]. Unbound. Available: https://unbound.com/books/matthewherbert [Accessed 18 March 2017].

Hutchings, N. 2015. *Super Fury Animal: Squarepusher Interviewed* [Online]. The Quietus. Available: http://thequietus.com/articles/17497-squarepusher-interview [Accessed 12 October 2015].

Ikeda, R. no date-a. *datamatics* [Online]. ryojiikeda.com. Available: http://www.ryojiikeda.com/project/datamatics/ [Accessed 9 November 2016].

Ikeda, R. no date-b. *V ≠ L* [Online]. ryojiikeda.com. Available: http://www.ryojiikeda.com/project/VL/ [Accessed March 20 2017].

Ishii, A. 2005. *AUTECHRE インタビュー/LOUD131 号 [Autechre Interview / LOUD Vol.131] [Japanese]* [Online]. iLOUD. Available: http://www.iloud.jp/techno/autechre/interview/autechre_loud131.php [Accessed 18 August 2017].

Iyengar, S. 2010. *The Art Of Choosing: The Decisions We Make Everyday of our Lives, What They Say About Us and How We Can Improve Them*, London, Hachette Digital.

Jakobi, C. 2016. *Super-Looper Basic* [Online]. Cycling '74. Available: https://cycling74.com/toolbox/super-looper-basic/ [Accessed March 26 2017].

Jordà, S. 2007. 5 Interactivity and live computer music. In: Collins, N. & D'Escriván, J. (eds.) *The Cambridge Companion to Electronic Music.* Cambridge: Cambridge University Press.

Kakinoki, M. February 22 2017a. *RE: Author's personal recollection of Matthew Herbert's casual talk at Canterbury Christ Church University. The details of the talk session can be found here.* https://blogs.canterbury.ac.uk/mpa/matthew-herbert-on-broadstairs-campus/.

Kakinoki, M. January 4 2017b. *RE: Author's personal discussion with Yuko Izumi.*

Kandinsky, W. 1914. *The Art of Spiritual Harmony*, Boston, Houghton Mifflin Harcourt.

Kent, M. 2014. *Designing Experience: Klara Lewis Interviewed* [Online]. The Quietus. Available: http://thequietus.com/articles/16541-klara-lewis-msuic-interview [Accessed 7 October 2015].

Kirn, P. 2012. *Deadmau5, Honest About His Own Press-Play Sets, Misses Out On "Scene"* [Online]. Berlin: Create Digital Media. [Accessed March 21 2017].

Klose, T. 2017. *MIDIbox OSC Server/Client* [Online]. uCApps. Available: http://www.ucapps.de/midibox_osc.html [Accessed 27 August 2017].

Kubota, A. 2004. 第 3 回 音階とリズム：音楽を疑え！ [Vol.3 Scale and Rhythm: Doubt Music!] [Japanese]. *21st Century Museum of Contemporary Art, Knazawa, annual report 2002*. Ishikawa: 21st Century Museum of Contemporary Art, Kanazawa.

Kubota, A. 2007. *Post-Techno[Logy] Music [Japanese]*, Toyama, Omura Shoten.

Kubota, A. 2017. *遙かなる他者のためのデザイン―久保田晃弘の思索と実装 [Design for Distant Others - Study and Implementation of Akihiro Kubota] [Japanese]*, Tokyo, BNN.

Kurokawa, R. 2010. *rheo: 5 horizons* [Online]. Ars Electronica. Available: http://archive.aec.at/prix/ - 18314 [Accessed 12 October 2016].

Maclay, C. & Tone, Y. 2004. Record, CD, Analog, Digital. In: Cox, C. & Warner, D. (eds.) *Audio culture : readings in modern music*. New York: Continuum.

Manning, J. 2014. *Klara Lewis: Mood and Perception* [Online]. Juno Plus. Available: http://www.junodownload.com/plus/2014/12/15/klara-lewis-mood-and-perception/ [Accessed Web Page 2015].

Mettler, M. 2015. *SQUAREPUSHER DOESN'T JUST MAKE ELECTRONICA, HE MAKES THE SOFTWARE TO MAKE IT* [Online]. Digital Trends. Available: http://www.digitaltrends.com/music/squarepusher-interview-the-software-behind-damogen-furies/ [Accessed 6 November 2015].

Miessen, M. 2010. *The Nightmare of Participation (Crossbench Praxis as a Mode of Criticality)*, Berlin, Sternberg Press.

Moore, F. R. 1988. The Dysfunctions of MIDI. *Computer Music Journal*, 12**,** 19-28.

Nakayama, M. 2013. ジェイムス・ブレイク　生演奏とエレクトロニクスのめくるめく融合　今最もエッジィなライブを徹底取材! [James Blake, The Sparkling Fusion of Live Performance and Electronics, the Exhaustive Coverage of the Edgiest Performance Today!] [Japanese]. *Sound & Recording Magazine.* Tokyo: Rittor Music.

Nakinishi, H. 2015. *10000 字インタビューが実現！奇才スクエアプッシャーかく語りき 後編 [10,000-character Interview Realised! Also Sprach Elegant Squarepusher Part 2] [Japanese]* [Online]. FLOOR. Available: http://floormag.net/150512squarepushuer/ [Accessed 12 October 2015].

Naumann, S. 2009. Seeing Sound: The Short Films of Mary Ellen Bute. In: Lund, C. & Lund, H. (eds.) *Audio.Visual On Visual Music and Related Media*. Stuttgart: Arnoldsche Art Publishers.

Nicolai, C. 2007. Artists' Statements I. In: Collins, N. & D'Escriván, J. (eds.) *The Cambridge Companion to Electronic Music*. Cambridge: Cambridge University Press.

Nishiyama, N. 2014. *【インタビュー】Kyoka「私はビートやベースが、イコール“曲”だと思っているフシがある」 [【Interview】*

Kyoka 'I Find Myself Regarding Beats and Bass as "Musical Pieces" '] [Japanese] [Online]. Qetic. Available: http://www.qetic.jp/interview/kyoka/111203/ [Accessed 11 October 2015].

Parkinson, A. & Bell, R. 2016. *Deadmau5, Derek Bailey, and the Laptop Instrument – Improvisation, Composition, and Liveness in Live Coding* [Online]. London: Goldsmiths, University of London. Available: http://research.gold.ac.uk/12838/ [Accessed March 20 2017].

Peters, D., Eckel, G. & Dorschel, A. 2012. *Bodily Expression in Electronic Music: Perspectives on Reclaiming Performativity,* Abingdon, Routledge.

Poschardt, U. 1998. *DJ-culture,* London, Quartet.

Pritchett, J. 1993. *The music of John Cage,* Cambridge, Cambridge University Press.

Pytlik, M. 2011. *James Blake* [Online]. Pitchfork. Available: http://pitchfork.com/features/interview/7941-james-blake/ [Accessed 12 October 2016].

Red Bull Music Aacademy. 2013. *Studio Science: Four Tet On His Live Set* [Online]. YouTube. Available: https://www.youtube.com/watch?v=9KIvnLBF7vU [Accessed 20 November 2015].

Red Panda. no date. *Overview* [Online]. Facebook. Available: https://www.facebook.com/RedPandaLab/info/ [Accessed 17 November 2015].

Rietveld, H. C. 2013a. Introduction. In: Attias, B., Gavanas, A. & Rietveld, H. C. (eds.) *DJ culture in the mix : power, technology, and social change in electronic dance music.* New York: Bloomsbury Academic.

Rietveld, H. C. 2013b. Journey to the Light? Immersion, Spectacle and Mediation. In: Attias, B., Gavanas, A. & Rietveld, H. C. (eds.) *DJ culture in the mix : power, technology, and social change in electronic dance music.* New York: Bloomsbury Academic.

Roads, C. 2001. *Microsound*, Cambridge, Mass., MIT Press.

Rolling Stone. 2012. *On the Cover: The Rise of Deadmau5* [Online]. Rolling Stone. Available: http://www.rollingstone.com/music/news/on-the-cover-the-rise-of-deadmau5-20120620 [Accessed 12 October 2016].

Ryoji Ikeda Studio. 2012. *Ryoji Ikeda :: superposition [updated 28 JAN 2014]* [Online]. Vimeo. Available: https://vimeo.com/49873167 [Accessed Web Page 2016].

Ryoji Ikeda Studio. 2013. *Ryoji Ikeda :: datamatics [prototype-ver.2.0], 2006-08* [Online]. Vimeo. Available: https://vimeo.com/62242278 [Accessed Web Page 2016].

Schloss, W. A. 2003. Using Contemporary Technology in Live Performance: The Dilemma of the Performer. *Journal of New Music Research,* 32**,** 239-242.

Shah, S. 2016. *Facebook's first Live Video ad campaign encourages you to stream everyday life* [Online]. Yahoo. Available: https://www.yahoo.com/tech/facebook-first-live-video-ad-050322097.html [Accessed March 26 2017].

Shaughnessy, A. 2006. Last night a vj zapped my retinas THE RISE AND RISE OF VJING. In: Faulkner, M. & Fuse, D. (eds.) *VJ: Audio-Visual Art and VJ Culture.* London: Laurence King.

Smalley, D. 1996. The listening imagination: Listening in the electroacoustic era. *Contemporary Music Review,* 13**,** 77-107.

Smalley, D. 2007. The acousmatic. In: Collins, N. & D'Escriván, J. (eds.) *The Cambridge Companion to Electronic Music.* Cambridge: Cambridge University Press.

Ssounds of a Tired City. 2015. *Klara Lewis: I cannot improvise my tracks, because then the concert would have to last several months* [Online]. Sounds Of A Tired City. Available: http://soundsofatiredcity.com/klara-lewis-interview/ [Accessed 7 September 2017].

Spice, A. 2016. *Vinyl sales outstripped digital downloads for the first time last week* [Online]. The Vinyl Factory. Available:

http://thevinylfactory.com/news/vinyl-sales-exceed-digital-downloads-uk/ [Accessed 7 December 2016].

Spinrad, P. 2005. *The VJ Book: Inspirations and Practical Advice for Live Visuals Performance*, Los Angeles, Feral House.

Stockhausen, K. 2007. Artists' Statements II. In: Collins, N. & D'Escriván, J. (eds.) *The Cambridge Companion to Electronic Music.* Cambridge: Cambridge University Press.

Strick, J. 2005. Visual Music. In: Brougher, K., Strick, J., Wiseman, A. & Zilczer, J. (eds.) *Visual Music: Synaesthesia in Art and Music Since 1900.* New York: Thames & Hudson.

Tokyo Art Beat. 2009. *池田亮司 + / - [the infinite between 0 and 1]　キュレーターインタビュー [Ryoji Ikeda + / - [the infinite between 0 and 1] Curator Interview] [Japanese]* [Online]. YouTube. Available: https://www.youtube.com/watch?v=FJ--b3VHBpg [Accessed 12 October 2016].

Tsukada, A. 2014. *“自然を再構築する”オーディオビジュアル・アーティスト、黒川良一が目指すもの｜インタビュー in ベルリン [‘Reconstructing Nature’ Audio Visual Artist, Ryoichi Kurokawa's Aims | Interview in Berlin] [Japanese]* [Online]. CBCNET. Available: http://www.cbc-net.com/topic/2014/01/ryoichi-kurokawa_interview/ [Accessed 11 October 2015].

Turner, T. 2003. The Resonance of the Cubicle: Laptop Performance in Post-digital Musics. *Contemporary Music Review,* 22**,** 81-92.

Ueno, K. 2012. *＜SónarSound Tokyo 2012＞直前スペシャル！ イベントの一大テーマ「メディア・アート」とは？ テクノロジーの最先端で活躍する黒川良一と川村信司（PARTY）にインタビュー！ さらに出演アーティストからもコメント続々到着！[*

<SónarSound Tokyo 2012> Last Minute Special! 'Media Art' is the Big Theme of the Event, but What Is It? Interview with Ryoichi Kurokawa and Shinji Kawamura (PARTY) Who Are Active at the Cutting Edge of Technology! Comments from the Artists Arrived One After Another!] [Japanese] [Online]. Qetic. Available: http://www.qetic.jp/sonartokyo2012/archives/449 [Accessed The link has expired].

Völker, N. 2009. The Evolution of the Court Jester. In: Lund, C. & Lund, H. (eds.) *Audio.Visual On Visual Music and Related Media.* Stuttgart: Arnoldsche Art Publishers.

Voss, J. 2013. *The first abstract artist? (And it's not Kandinsky)* [Online]. Tate. Available: http://www.tate.org.uk/context-comment/articles/first-abstract-artist-and-its-not-kandinsky [Accessed 2 November 2016].

Whitmer, T. C. 1934. *The art of improvisation: A handbook of principles and methods for organists, pianists, teachers and all who desire to develop*

extempore playing, based upon melodic approach, New York, M. Witmark & Sons, Dept. of Standard and Educational Publications.

Xfer Freeware. no date. *Xfer Freeware* [Online]. Available: https://xferrecords.com/freeware/ [Accessed March 24 2017].

Yamamoto, K. 2013. *「fuZe Vol.2」開催記念スペシャル対談。久保田晃弘と平川紀道が語る、プログラミングで広がる新しい表現の探求。[fuze Vol.2 Commemorative Special Talk. Exploring New Expressions with Programming by Akihiro Kubota and Norimichi Hirakawa.] [Japanese]* [Online]. white-screen.jp. Available: http://web.archive.org/web/20160401223611/http://white-screen.jp/?p=31886 [Accessed 7 March 2017].

Yu, J. 2013. Electronic Dance Music and Technological Change: Lessons from Actor-Network Theory. In: Attias, B., Gavanas, A. & Rietveld, H. C. (eds.) *DJ culture in the mix : power, technology, and social change in electronic dance music.* New York: Bloomsbury Academic.

Zilczer, J. 2005. Music for the Eyes: Abstract Painting and Light Art. In: Brougher, K. S., Jeremy & Wiseman, A. Z., Judith (eds.) *Visual music : synaesthesia in art and music since 1900.* New York: Thames & Hudson.

Appendices

1. Video examples

All of the video examples can be accessed here: https://goo.gl/sjkiKV

The videos 27 to 32 are from the performance at ArtReview in London on the 18th of May, 2017. The video 33 is from the performance at The Old Truman Brewery in London on the 15th of June, 2017. The video 34 is from the performance at IKLECTIK in London on the 23rd of September 2017.

They can be accessed through the attached data DVDs too.

2. Max patch, TouchDesigner project file and configuration file for MIDI Fighter Twister

The Max patch, TouchDesigner project file, and the configuration file for MDI Fighter Twister can be accessed here.

https://drive.google.com/drive/folders/0BzTdjn0T9zssX0Zrc1FueFBDX1U?usp=sharing

They can be accessed through the attached data DVDs too.