NARRATIVE TO ACTION IN THE CREATION AND PERFORMANCE OF MUSIC WITH DATA-DRIVEN INSTRUMENTS

by

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A DISSERTATION

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DISSERTATION ABSTRACT

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This Digital Portfolio Dissertation centers on a collection of seven digital videos of performances of original electroacoustic compositions that feature data-driven instruments. The dissertation also includes a copy of the original software and affiliated files used in performing the portfolio of music, and a text document that analyzes and describes the following for each of the seven compositions: (1) the design and implementation of each of the seven complete data-driven instruments; (2) the musical challenges and opportunities provided by data-driven instruments; (3) the performance techniques employed; (4) the compositional structure; (5) the sound synthesis techniques used, and (6) the data-mapping strategies used. The seven compositions demonstrate a variety of electroacoustic and performance techniques and employ a range of interface devices as front-ends to the data-driven instruments. The seven interfaces that I chose to use for my compositions include the Wacom Tablet, the Leap Motion device for hand and finger detection, the Blue Air infrared sensor device for distance measurements, the Nintendo Wii Remote wireless game controller, the Gametrak three-dimensional, position tracking system, the eMotion™ Wireless Sensor System, and a custom sensor-based interface that I designed and fabricated. The title of this dissertation derives from the extra-musical impulses that drove the creative

impulses of the seven original electroacoustic compositions for data-driven instruments. Of the seven compositions, six of the pieces have connections to literature. Despite the fact there is a literary sheen to these musical works, the primary impulses of these compositions arise from the notion of absolute music – music for music's sake, music that is focused on sound and the emotional and intellectual stimulus such sound can produce when humans experience it. Thus, I simultaneously work both sides of the musical street with my compositions containing both extra-musical and absolute musical substance.

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To the future of music

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Video of performance of *Über allen Gipfeln ist Ruh*

Video of performance of *Ophelia*

Video of performance of *Ling Yin*

Video of performance of *Flowing Sleeves*

Video of performance of *Peony Garden*

Video of performance of *Qin*

Custom software and affiliated file required to perform *Ich grolle nicht Remix*

Custom software and affiliated file required to perform *Über allen Gipfeln ist Ruh*

Custom software and affiliated file required to perform *Ophelia*

Custom software and affiliated file required to perform *Ling Yin*

Custom software and affiliated file required to perform *Flowing Sleeves*

Custom software and affiliated file required to perform *Peony Garden*

Custom software and affiliated file required to perform *Qin*

CHAPTER I

INTRODUCTION

Overview of Digital Portfolio Dissertation

For my Digital Portfolio Dissertation, I created a portfolio of seven digital videos of performances of original electroacoustic compositions for data-driven instruments. The compositions are all multichannel real-time interactive works that use seven different performance interfaces and employ Symbolic Sound's Kyma sound creation environment.[1] Information about the title, performance interface and synthesis engine employed in each composition is provided below:

1. *Ich grolle nicht Remix* for two Blue Air infrared MIDI controllers, custom software created with Cycling '74's Max,[2] and Symbolic Sound's Kyma,
2. *Über allen Gipfeln ist Ruh* for Leap Motion controller, custom software created with Cycling '74's Max, and Symbolic Sound's Kyma,
3. *Ophelia* for Wacom Intuos5 Touch Small Pen Tablet, custom software created with Cycling '74's Max, and Symbolic Sound's Kyma,
4. *Ling Yin* for Gametrak game controller, custom software created with Cycling '74's Max, and Symbolic Sound's Kyma,
5. *Flowing Sleeves* for eMotion™ Wireless Sensor System, custom software created with Cycling '74's Max, and Symbolic Sound's Kyma,

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[1] Kyma is a "domain-specific programming language" in that it is specifically dedicated and optimized to facilitate the synthesizing and modification of sound, the exploration and construction of sound, and to the performance and creation of musical compositions. All seven of the portfolio's compositions were created using Kyma 7. For additional information see Jeffrey Stolet, *Kyma and the SumOfSines Disco Club* (Morrisville: Lulu Press, 2012), 8.

[2] All software created in Max was done under the Max 7 environment.

6. *Peony Garden* for four suspended Nintendo Wii Remote game controllers, OSCulator, custom software created with Cycling '74's Max, and Symbolic Sound's Kyma,

7. *Qin* for two custom sensor-based interfaces, custom software created with Cycling '74's Max and Symbolic Sound's Kyma.

In addition to the copies of my original software and affiliated files used in performing the portfolio of music, this text document will analyze and describe the following for each of the seven compositions: 1) the musical challenges and opportunities provided by data-driven instruments, 2) the performance techniques employed, 3) the musical compositions, 4) the sound synthesis techniques used, 5) the data-mapping strategies used, and 6) the design and implementation of each of the data-driven instruments.

In addition to the technical features, I will also examine the extra-musical and narrative themes that arise within the seven compositions. Six of the compositions clearly have literary impulses. Of these, two are "reimagined" or "recomposed" versions of the pre-existing masterworks: *Ich grolle nicht Remix*, based on Robert Schumann's song "Ich grolle nicht," Op. 48, No. 7, and *Über allen Gipfeln ist Ruh*, which is an electronic music setting of Johann Wolfgang von Goethe's poem "Ein Gleiches."

While there are literary and extra-musical impulses to these compositions, the primary drive comes from the notion of absolute music: music for music's sake, music that is not explicitly about anything. As a composer, I willingly work both sides of the musical street. The portion of the dissertation title "Narrative to Action" refers to how the literary and the objective performative actions used to play the compositions of the portfolio co-exist and amplify one another.

Broad Influences and Inspirations that Shaped the Seven Portfolio Compositions

Music and literature have existed in collaborative form since ancient times, and this association has led to much philosophical speculation how these two art forms relate. Certainly, music and literature both are temporal in their nature and are dependent on the medium of time for their meaning. This is distinct from the visual arts and architecture which are ordinarily regarded as existing in space rather than time. These ideas about the temporality of music and literature exert and immense influence on the compositions of this portfolio dissertation.

In both Western and Asian literary histories poetry and music are regarded as practically and philosophically related. The *Book of Songs* (《诗经》),[3] the oldest existing collection of Chinese poetry comprised of 305 works dating from the 11th to 7th centuries B.C.E., precisely demonstrates this point. Many texts contained in the *Book of Songs* emphasize textual and sonic repetition fused to create a multi-modal experience thus linking the musical and literary aspects. We can observe a further linking if we appropriately note that these musical texts functioned socially and culturally to direct and influence ethical and moral behavior within Chinese society.

In the West, a similar phenomenon can be observed. Aristotle's *Poetics,* dating from approximately 335 B.C.E., attempts, for example, to express commonalities he finds between and among painting, drama, poetry, and music. Even prior to Aristotle, Plato, famously stated that, "Music is a moral law." Continuing he connected music to practically everything saying, "It gives soul to the universe, wings to the mind, flight to the imagination, a charm to sadness, gaiety and life to everything; It is the essence of

[3] *Book of Songs* is the oldest existing collection of Chinese poetry comprising 305 works dating from the 11th to 7th centuries BC.

order and lends to all that is good, just, and beautiful."[4] Not explicitly mentioned in this quotation is the fact that music was also closely linked to mathematics by a number of early Greek writers including Pythagoras and Euclid. For these reasons, work contained within this digital portfolio dissertation can be understood as a continuation of this long multi-cultural tradition where literature and music are connected. Additionally, because my dissertation is deeply involved with numbers and the algorithms that shape, control or influence musical consequences, my work also represents a continuation of this tradition that associates numbers and music that dates back millennia.

The work of this digital portfolio dissertation prominently features the interconnection between and among these three same foci, music, literature and numbers, that have been the centers of concerns of cultures around the world for more than two thousand years. First, and most obviously, all musical outcomes that result from my musical performances arise initially as digital representations of sound. Prior to the actual realization of the musical outcomes heard as the musical compositions, a great deal of shaping of the sound occurs through synthesis processes and real-time control of those processes with data packets and data streams that must be aesthetically shaped through arithmetic and mathematical algorithms. Secondly, the influences of literary concerns are overtly present in six of the seven compositions of the dissertation and is covertly influential in the other composition.

Two of the works, *Ich grolle nicht Remix* and *Über allen Gipfeln ist Ruh,* arise as musical transformations born in the 19th century art song tradition and bathed in literary concerns. The composition *Ophelia,* is sonically and psychologically based on the poem

[4] Plato, *The Collected Dialogues of Plato Including Letters*, ed. Edith Hamilton and Huntington Cairns (Princeton: Princeton University Press, 1961), Bollingen Series LXXI.

of the same name by Symbolist poet Arthur Rimbaud. In the case of *Ophelia,* the literal sound of a recitation of the poem becomes the fabric of the musical material. In *Ling Yin*, four Sutras, *Vajracchedikā Prajñāpāramitā Sūtra*, *Suvarṇaprabhāsa-uttamarāja-sūtra*, *Sad-dharma Puṇḍárīka Sūtra and Karunika-rāja Prajñāpāramitā sūtra*, that function as important roles at the Ling Yin Buddhist Temple in Hangzhou, China, serve as spiritual guidance for the composition directing its musical tone. The composition *Flowing Sleeves is* inspired by a poem by Wen Tingyun that describes the women's ritual of the preparation in dressing, the art of face makeup, and the spiritual routine before daily exposure to the public. *Peony Garden* derives from the traditional Chinese Kunqu Opera *The Peony Pavilion* by Tang Xianzu. In this case, the musical unfolding is inspired by an original narrative and how it unfolds in its original operatic form. In *Qin*, the final composition in the digital portfolio, musical substance is inspired by the special Chinese cultural symbol Qin (琴) that is associated with elegance, power, weaponry, eloquence, delicacy, and longing for communication.

CHAPTER II

CONCEPTUAL BACKGROUND AND THEORETICAL FRAMEWORKS

There are many concepts involved in creating electroacoustic compositions that are to be performed in realtime with digital interfaces. To make the discussions about my compositions as understandable as possible, I will discuss those concepts important to the compositions contained in the dissertation portfolio. Among those critical concepts discussed below are 1) a conceptual model of a data-driven instrument, 2) the basic elements of a performance interface, 3) how this model is different from the action-excitement mechanism used to play traditional acoustic instruments, 4) data-mapping, 5) unique data signatures that digital interfaces report, 6) mutability, and 7) the data into algorithm paradigm. These and affiliated concepts will illuminate the analytic and descriptive comments that I will later offer for each of my portfolio compositions.

The Structure of a Data-driven Instrument

In relation to a musical instrument, the compound adjective *data-driven* means that data is causing, and/or controlling the sonic outcomes produced by a computer-centric instrument. This data serves to replace the function of energy exerted into the physical bodies of acoustic instruments. When the data streams originating from various sources are systemically connected through software that shapes the data and then routes it to designated musical parameters embedded in a mechanism that produces sound (perhaps some type of synthesis engine), a complete data-driven musical instrument is formed. Jeffrey Stolet describes the structure of a data-driven instrument as a three-part mechanism that includes:

1. a section where data is created or acquired through human operation of some interface device,
2. a software layer where each generated value input to it is mapped to an output value, or where each value input to it is analyzed, and, on the basis of that analysis, new replacement data is created, and then routed as control data to,
3. a sound synthesis section capable of receiving and responding to this modified data to control musical parameters in realtime.[5]

A basic illustration of a data-driven instrument is shown below in Figure 1.

Figure 1. Basic Model for Data-driven Instrument

Figure 2 shows examples that apply this conceptual framework of data flow into two data-driven instrument configurations. One using the "Blue Air" Infrared Sensor controller as a data-acquirement interface, sending data via MIDI protocol and received by software – Max, in this case, for data mapping, eventually routed to Kyma Sound-producing algorithms for sound design, composition and performance. The second example shows a "Game controller" sending data to Max for mapping and then on to Logic as a sound-producing environment.

[5] Jeffrey Stolet, "Twenty-three and a Half Things about Musical Interfaces," Kyma International Sound Symposium Keynote Address, Brussels, Belgium, September 14, 2013.

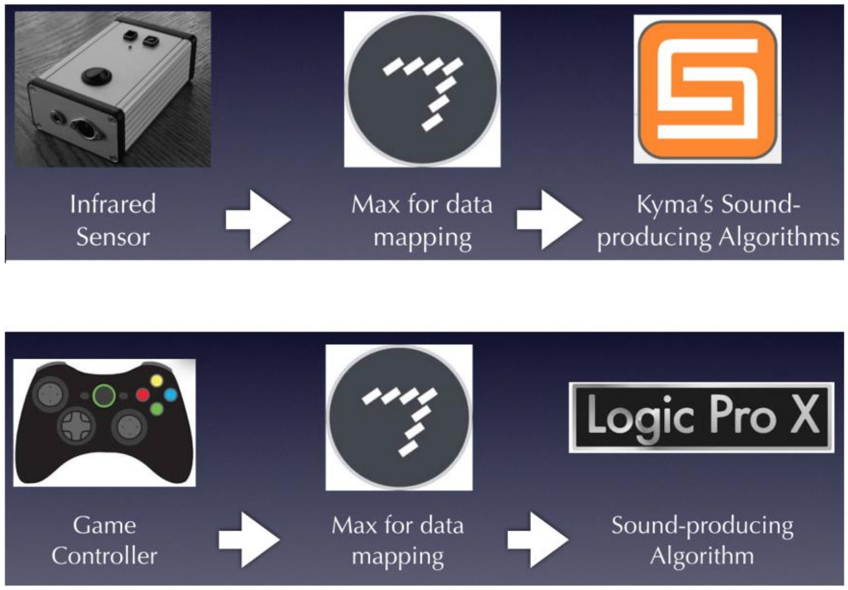

Figure 2. Two Literal Actualizations of Data-driven Instruments

Thus, the concept of transforming data packets and data streams from abstract numerical values to aesthetic actualizations is the essential task of real-time electroacoustic music and interactive musical performance.[6] Understanding this three-stage model where data is used as the controlling agent is, therefore, important in understanding compositional and performative outcomes.

While the central mission of all musical instruments is to make sound, there are at least three aspects that must be emphasized about the uniqueness of these new digital musical instruments:

1. these new musical instruments are driven by data rather than energy,
2. each source from which the data stream originates can possess a unique data signature that will produce unique aesthetic results, and
3. the instruments are mutable in realtime during the course of a composition or performance.

[6] Ibid.

These three attributes make data-driven instruments fundamentally different from their traditional acoustic forerunners.

The Function of Data

In his keynote address at the 2012 Kyma International Sound Symposium Jeffrey Stolet described how data functions in these new data-driven instruments. Stolet said, "Data has replaced energy's function in this new, data-dependent family of instruments. I use the term *data-driven instrument* to describe how these instruments are controlled, to differentiate them from traditional acoustic instruments predicated on an action-excitement mechanism. Specifically stated: whereas traditional instruments are driven by energy exerted into their physical systems, new instruments – data-driven instruments – replace energy's function with data streams. And the way we play these instruments is by generating data through performative actions involving interfaces."[7]

In the first stage of a data-driven instrument, data is generated by measuring and reporting, or by reporting current status of an interface device. For example, we might use an infrared sensor to measure the distance of the performer's hand from the sensor; we might use a Gametrak controller with it reporting the X/Y/Z coordinates of the ends of two thin retractable nylon cables in three-dimensional space; similarly, in 3-dimensional space, we might also use the Leap Motion controller to report the X/Y/Z coordinates of fingers and hands within the detectable hemispheric region of the Leap Motion. With all three of these examples, as well as with other interface devices, it is vital to note that data output from each interface device probably contains unique

[7] Ibid.

characteristics that have the potential to lead to unique musical results and opportunities. Stolet refers to this trait as a data stream's *personality*.[8]

The Data into Algorithm Paradigm

To produce sound using a synthesis environment, one simply needs to direct data to a sound-producing algorithm that resides in such an environment – and the first stage of this acquirement of performative data is achieved, according to Stolet,

> *By operating, with musical intention, an interface,* one of many possible data-generating devices that exist in our data-rich world. What makes this paradigm powerful, is that it is conceptually simple, yet infinite in its possibilities. This means that part of an interface's importance lies in its ability to respond to human operation.[9]

In playing a traditional musical instrument, there are three clear imperatives that also apply to the playing of data-driven instruments:

1. starting musical events,
2. stopping musical events, and
3. exerting ongoing control over musical events as they occur.[10]

Broadly speaking, with respect to data-driven instruments, interfaces provide button-like functionality to serve as control to start and stop events, and fader functionality to exert ongoing control over musical outcomes.

Mutability

One of the fascinating attributes of data-driven instruments is their ability to

[8] Ibid.

[9] Ibid.

[10] Ibid.

change the ways they function and sound during the course of a composition. This ability for an instrument to change during a composition is called *mutability*. While this attribute exists to a limited extent with some traditional acoustic instruments, say, for example, a muted trumpet, this trait is dramatically expanded within the context of data-driven instruments. In addition, unlike the fixed mapping strategies, such as with a piano, with its left to right arrangement of notes being from low to high, data-driven instruments provide the mechanism to alter such arrangements moment to moment and many times within a composition. Often this mutability occurs within the software layer of the data-driven instrument rather than within the fixed and inflexible hardware areas.

Technological Embodiment and the Performance Space

The technologies used in data-driven instrument interfaces do not exist in isolation, outside of a physical and conceptual context – the technology is always embedded or embodied in some manner including its position in physical space. Both the embodiment of the technology and the positioning of the interface in a performance space are important. For example, a 9 Degrees of Freedom[11] printed circuit board[12] can be held, thus leading to a particular type of human engagement, or it can be embodied in a ball that can be rolled across a table, leading to an entirely different type of engagement. In this example, the two types of embodiment are important because the two types of engagement lead to two different types of data streams, which leads to two different types of musical outcomes.

[11] "Degrees of Freedom" of "DOF" is a number of axis and sensors combined for balancing a plane, a helicopter or a robot. 9 DOF is mostly a 6DOF, combined with a magnetometer (compass) and a 6 DOF is mostly a 3-axis accelerometer combined with a 3-axis gyroscope; accessed March 22, 2018, https://playground.arduino.cc/Main/WhatIsDegreesOfFreedom6DOF9DOF10DOF11DOF.

[12] Printed circuit board (PCB) mechanically supports and electrically connects electronic components or electrical components; accessed March 22, 2018, https://en.wikipedia.org/wiki/Printed_circuit_board.

Even if the embodiment of the technology is the same from instance to instance, its context in the performance area is almost always vitally important. For example, a Gametrak 3-D positional controller can be placed on the floor, a table, or suspended from the ceiling – each yielding a vastly different performance space. Or a Nintendo Wii Remote controller can be held in one's hand, can be suspended in space, can be attached to a retractable cable, or, for that matter, attached to a wild animal. Each new positioning in the performance space causes new sorts of human engagements and musical controls. About these matters, Stolet stated in his address at the Kyma International Sound Symposium that:

> Interface devices that output data create, with the human performer, a performative space – and we want to understand the interface as it functions in this performative space.
>
> An interface exists not only as part of a data-driven instrument, but also as part of what I call the *performance space* – the space where a human performer engages the interface, and where its physical disposition may be radically transformed depending on how the performer chooses to engage it.
>
> Because interface devices originate from many sources, some uniquely invented for music, while many others appropriated, we can't be very certain how these devices will be engaged.[13]

Data Mapping

Data mapping in computing and data management is a process of creating

[13] Jeffrey Stolet, "Twenty-three and a Half Things about Musical Interfaces," Kyma International Sound Symposium Keynote Address, Brussels, Belgium, September 14, 2013.

data element correspondences between two distinct data models.[14] Data mapping is an essential part of a data-driven instrument and makes possible the connection of almost any interface to any sound-producing algorithm. Data mapping allows for one range of data to be transformed into another range to more appropriately control a given musical parameter; or perform traditional musical operations such as pitch transposition, inversion, or changing a minor scale into a major scale. Below are five common mapping operations that I employ in my portfolio compositions.

1. Data may be scaled so that the total range of values is expanded or contracted in order for the data to be useful in achieving a particular aesthetic result. A data stream may be expanded to be useful in frequency space or perhaps contracted to be used in pitch space. For example, in the Max environment such a data mapping might be executed with the "scale" object. In the example below, the "scale" object is used to map the 0-127 range that might come from a typical MIDI controller to a new range of 50-3000 so that the expanded range of the potential data can effectively control the frequency parameter of an oscillator.

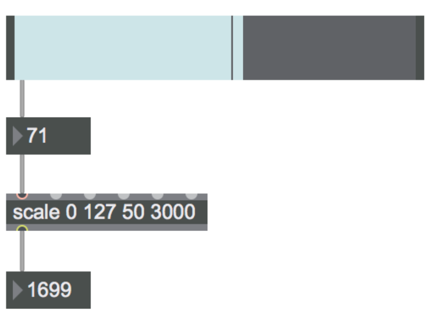

Figure 3. Scaling Data in Max

[14] Maurizio Lenzerini, "Data Integration: A Theoretical Perspective," *Proceedings of the Twenty-first ACM SIGACT-SIGMOD-SIGART Symposium on Principles of Database System*, 233-246, Madison, Wisconsin, USA, June 4, 2002.

In Kyma, MIDI data input to it is automatically mapped from MIDI's native 0-127 range to a 0-1 range for Kyma to use more easily. So, a data-mapping similar to the mapping shown in Figure 3 is executed with the following Capytalk expression within Kyma:

((!cc01* 2950) + 50)

2. Data may be offset so that the total range of values is changed from one range to another range equal in size. For example, data falling in a range of 0-10 could be offset (through addition) to occupy a range of 5-15 or 20-30. Simple offsetting is achieved in Max through the application of addition and subtraction objects and in Kyma Capytalk is used within a parameter field. Both environments are shown below in Figure 4.

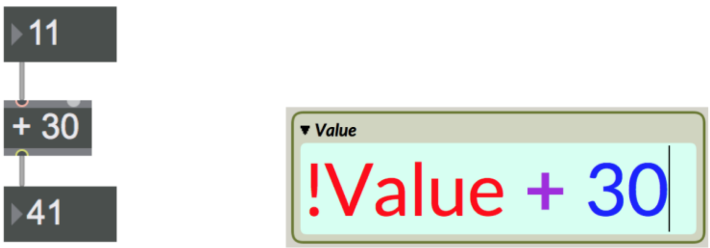

Figure 4. Max (left) and Kyma (right) Data Offset

3. Data may be smoothed so as to reduce the differences between contiguous values of data. Smoothing might be achieved through a simple averaging algorithm. Of course, the opposite of smoothing may also be done. Figures 5 and 6 show this type of smoothing operation in Max and Kyma, respectively.

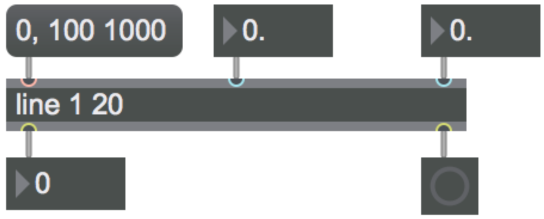

Figure 5. Smoothing Data in Max

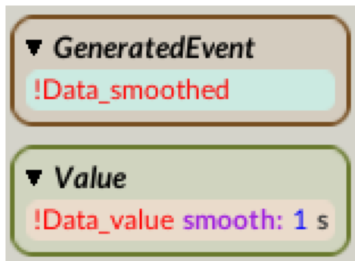

Figure 6. Smoothing Data in Kyma

4. Data may be filtered so that, say, a dense data stream containing values at a time interval of every 2 ms may be thinned so that the data stream only contains values every 10 ms. Several thinning objects exist in Max. Figure 7 shows one way to “thin” data using the “speedlim” object in Max.

Figure 7. Filtering Data in Max

Data Routing

By selecting a particular parametric destination for the data, one is defining what the data will control or influence, and what will be actualized. This process is sometimes called *mapping*, but I prefer the term *routing* to differentiate it from the operations where one data value is converted to a different data value. Data mapping and data routing sometimes happens simultaneously in the data into algorithm paradigm.

The Concept of Software as Score

In the Western musical tradition notated scores hold a central position. As a response to this history, the software for data-driven instruments may contain elements that contain score-like functionality. This functionality may take a variety of forms such as instructions being "published" in a timely manner on the computer screen for a performer so that he or she may receive directions about what to do. As a user of both the Kyma and Max environments I use their unique resources to provide myself "just in time" performative instructions to assist me in the rehearsal and execution of each composition. Examples of this approach of this *software as score* paradigm are seen in compositions *Ling Yin* and *Qin*.

CHAPTER III

PORTFOLIO COMPOSITIONS

ICH GROLLE NICHT REMIX

Overview

Ich grolle nicht Remix is a seven-minute real-time performance composition for two Blue Air infrared MIDI controllers, custom software created in Max, and Kyma. The *Ich grolle nicht Remix* represents my electro-acoustic recomposition of Robert Schumann's "Ich grolle nicht" from his song cycle *Dichterliebe, Op 48, No. 7.* To create my interactive electroacoustic recomposition I reflected upon Schumann's original musical setting inclusive of the text, the vocal lines, and the piano accompaniment and sought to create a new musical outcome that plays against the musical and cultural expectation generated by the original song. The sounds contained in this composition are predicated on a recording of a performance by Dietrich Fischer-Dieskau, baritone, and Alfred Brendel, piano.[15] The score of the song is attached in Appendix A. I augmented this sonic material by making individual audio recordings of both the voice and piano parts with Stephen Rodgers performing the vocal part, and me playing the piano part. Unlike traditional acoustic musical settings based on notes being the fundamental element, electronic music composition deals directly with sound as its primary component. The compositional techniques associated with the sonic transformations used in *Ich grolle nicht Remix* includes sampling techniques, granular synthesis, and analysis and resynthesis.

[15] Dietrich Fischer-Dieskau and Alfred Brendel, Schumann: Dichterliebe; Liederkreis, Philips 416 352-1, 1985, compact disc.

I also considered the original song and the poem's emotional tone before re-imagining the interactive electronic music composition. In "Ich grolle nicht," Schumann expresses intense inner conflict as an emotional response after the poetic persona has been rejected by his beloved. The original song is bursting with text painting, sometimes appearing as the excessive repetition of a single text phrase (most notably the text "Ich grolle nicht"), or appearing at other moments as a six-beat suspension on the word "längst" (m. 17 of the original song). Both the belaboring repetition and the musical sustainment of individual syllables make the sarcastic tone more acute and amplify the text's semantic meaning. In my composition, I augmented this sarcastic and ironic tone to their micro-sonic level through synthesis techniques and performative actions shaped by Blue Air controllers. Audio snippets of sounds are shortened and expanded to durations that cannot be achieved or imagined using traditional acoustic instruments or human voice.

Because the sight of an individual operating infrared sensors and computer technology is visually so different from a vocalist and pianist performing, the sensitivity of time and place is dramatically altered in my version. Because Schumann's original music setting is so familiar to our ears, the musical transformations I produce are all the more striking.

Design and Implementation of the Data-driven Instrument used in *Ich grolle nicht Remix*

The essential data-driven instrument for *Ich grolle nicht Remix* consists of two custom-made Blue Air MIDI controllers, custom software created in Max, and the Kyma sound synthesis environment. Also used to move data from between these components was a multi-port MIDI interface and the helper application KymaConnect. The complete data-driven instrument for *Ich grolle nicht Remix* is shown in Figure 8.

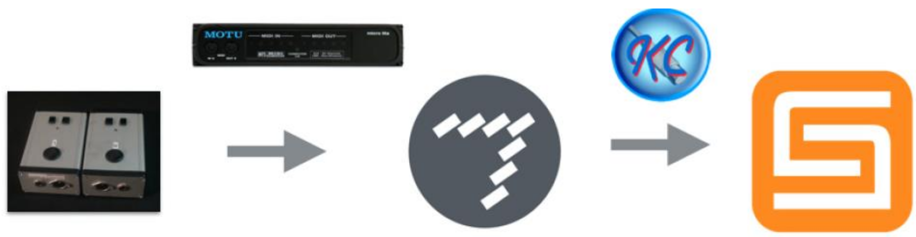

Figure 8. Basic data flow diagram for *Ich grolle nicht Remix*

The interface components of the data-driven instrument used to perform this work are two Blue Air infrared-based MIDI controllers that output MIDI continuous controller values. These devices, created under the direction of Jeffrey Stolet in 2005, output continuous controller values between 0-127 every 5 milliseconds.[16] The fact that the Blue Air operates over a semi-linear continuum of values allows it to serve well in its function as a fader.

Each Blue Air MIDI controller has a single MIDI OUT port that exists as a standard five-pin DIN connector and is powered individually by a 9v 300 mA DC power supply[17] These connection points are shown in Figure 9. The data output from these two controllers was then sent to a MIDI interface that forwards the data to the Max programming environment. Max was used because it conveniently and simply receives MIDI data and also easily generates “note-on” and “continuous control” messages that were useful to me in controlling and initiating the musical events that I desired.

[16] Jeffrey Stolet and Andrew Lane. *Blue Air Manual and Doc*. Eugene, University of Oregon, 2004.

[17] Ibid.

Figure 9. Side view of Blue Air controller

MIDI Continuous control messages are generated within Max after receiving similar messages from the two Blue Air controllers. Figure 10 shows how MIDI continuous controller data is received in the Max programming environment.

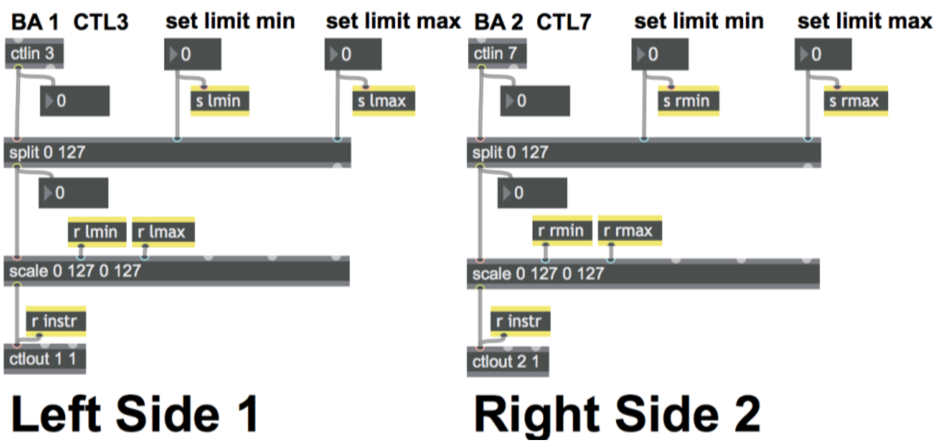

Figure 10. Point of Data Reception in Max

There are two technical details that need attention when setting up Blue Air controllers. First, the controller number and MIDI channel number can be specified through hardware reconfiguration (Figure 11).[18] In my composition, the two controllers' MIDI channels are set to be on channel 1 and given the controller numbers are 3 and 7,

[18] Ibid.

respectively. Second, because Blue Air controllers use near-infrared beam technology, the lighting condition in different performance settings can influence the data stream that is ultimately output. Awareness of this sensitivity is important when using many infra-red technologies.

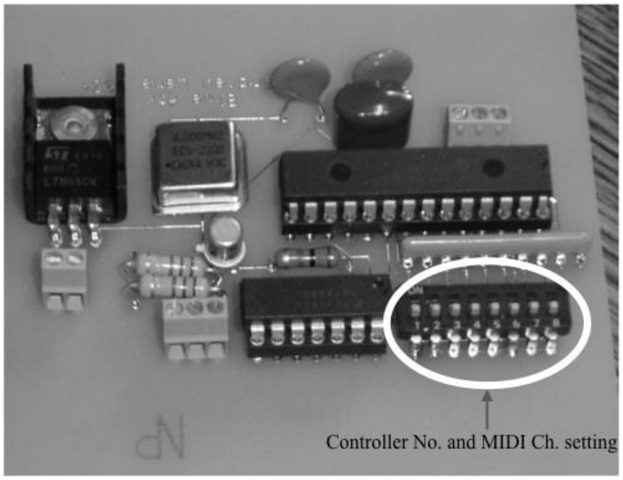

Figure 11. Physical configuration of MIDI channel and controller number

To send data from Max to Kyma I use the middleware application KymaConnect[19] that passes data to Kyma via an Ethernet connection from the computer to the Pacarana. Kyma contains the sample playback, granular processing, subtractive synthesis, and resynthesis algorithms that are dominant in the composition.

Musical Challenges and Opportunities

The musical challenges and opportunities in my *Ich grolle nicht Remix* are driven by the conceptual understanding of the original poem by Heinrich Heine, the musical setting by Robert Schumann, my re-imagination of the sonic world, and the control of this reconstruction of this new sonic world in realtime using Blue Air MIDI controllers. I also depend on an imagined link between the original Schumann setting and my

[19] KymaConnect is an OS X user agent program for the Mac that reduces the cost and setup complexity while offering expanded capability and customization of MIDI device connections to/from a Paca, Pacarana, or Capybara; accessed February 3, 2018, http://www.delora.com/products/kymaconnect/.

interactive recomposition that I arrived at through analysis of the notated score and traditional vocal and piano performances.

The first four repeated piano chords of the original score present an important motive for my entire composition. In the original composition, the piano prelude is a brief, but bold statement. In my composition, repeated articulation of the C major triad continues, but is fragmented and rather decomposed using granular processing. I augmented both the repetition and fragmentation to the extreme using granular synthesis, and control the pitch and duration of each granular particle using one of the Blue Air controllers.

Figure 12. Opening measure of original Schumann song

In my recomposition the first two measures of the vocal part containing the text "Ich grolle nicht" is heavily granulated, decomposed to its smallest sound quanta, and rearranged to its new form. One can think of the granulation of the text "Ich grolle nicht" as a form of decomposition and as a metaphor that represents the stripping away of the falseness of the protagonist's claim "I'll not complain." Through the alternation of the two hands moving upward and downward within the infrared sensors sight line, I dramatically change multiple musical parameters including texture, timbre, loudness, pitch, and spatial location.

Performance Techniques Employed using the Blue Air Controllers

I use two Blue Air infrared MIDI controllers to provide independent streams of data control. The Blue Air controllers create data streams by measuring the distance between my hands and the controllers. Thus, the primary performance techniques of the composition involve me moving my hands in the active performance and measurement areas of the Blue Airs. The Blue Air devices then output MIDI data that correspond to the reported distance. Figure 13 shows the two beams of infrared sensors emitted from Blue Air controllers.

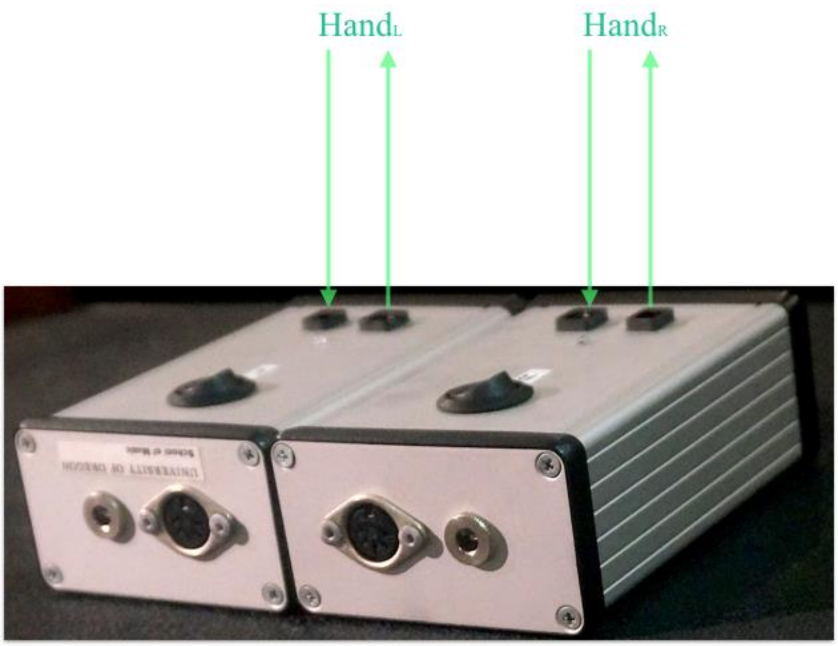

Figure 13. Two Blue Air controllers

One interaction I have with the Blue Air interfaces is the "press" and "release" performance motions, which, for me, metaphorically represent the sarcastic tone and anger as if expressed through the teeth. I use this control data to shape the modification processes applied to the performance recordings of the original Schumann song. This "press" and "release" performance motion controls numbers of voices, pitches, durations, tempo, amount of deviations from original pitch center and cutoff frequencies of filter modifications in different sections of the composition. This particular performance action is observable at the times 2:35, 3:55 and 5:17 of the affiliated video, and requires a notable level of accuracy in terms of timing and spatial location of my hands.

The originally effortless interactions with the Blue Air interfaces "press" and "release" are transformed into stressed motions that are difficult to master adding another layer of tension to the original narrative.

Compositional Structure

0:35-1:22 The first section starts with my hands placed within the detectable range of the Blue Air controllers. This action triggers a C major triad from which a heavily granulated version of the same piano chord emerges. At around 0:52, a vocal sound starts to appear, initially as sparse particles that ultimately form a continuous sustained vocal texture with the "I" of "Ich" gradually intensifying and reaching a climax near the end of this section. Simultaneously, I increase the distance between my hands and the Blue Air controllers. When I raise my hands high enough I output data values that breach a threshold and an octave C in the piano is triggered that leads to the next section.

1:22-5:06 The second section of the composition reimagines the original Schumann's setting of music in a phrase by phrase sequence. This section begins with the presentation of a slightly filtered recording of the original Fischer-Dieskau and Brendel performance, pausing at the end of each phrase on the same pitch as in the original score, but in a state of substantial sonic modification achieved through granulation. Each time a sound reappears within my remix the timbres and pitches are altered resulting in small amounts of purposefully indeterminate detuning and discord.

Because of the nature of the infrared technology used in the Blue Air sensors, it is not possible to hold or sustain a numerical value unchanged. This natural instability in the Blue Air's data personality imprints itself on all matters of control within the composition.

5:06-7:26 The last section of the composition begins with 32 slightly detuned, amplitude modulated voices stating the text "Ich grolle nicht." It is as if there is a discordant chorus of a thousand voices in the head of the song's central figure. The voices repeat and repeat almost as if he is trying to convince himself, through this repetition, that he will not complain. This repetition ultimately collapses leaving only sparse fragments of this primary text metaphorically depicting the falseness in the claim "I'll not complain."

Sonic Materials and Data Mapping Strategies

As previously stated, the sounds contained in this composition arise from a recording of an actual performance of *Ich grolle nicht* and is augmented by independent recordings of both the vocal and piano parts. The sonic transformations used in *Ich grolle nicht Remix* includes sampling techniques with slight and extreme detunings, granular synthesis, analysis and resynthesis, and Kyma's TAU[20] algorithm. Within the composition one can also hear the fragmentation of audio that might be considered a metaphoric manifestation of the mental state of the devastated lover.

When the first piano chord is triggered, a set of complex pitched, unpitched, short, and sustained textures are created. Figure 14 shows the signal flow for the initial sound of this composition.

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[20] Kyma's TAU algorithm is a proprietary analysis and resynthesis procedure where temporally coordinated amplitude, frequency, format, and bandwidth parameters can be exploited to produce stunning and unusual sonic results.

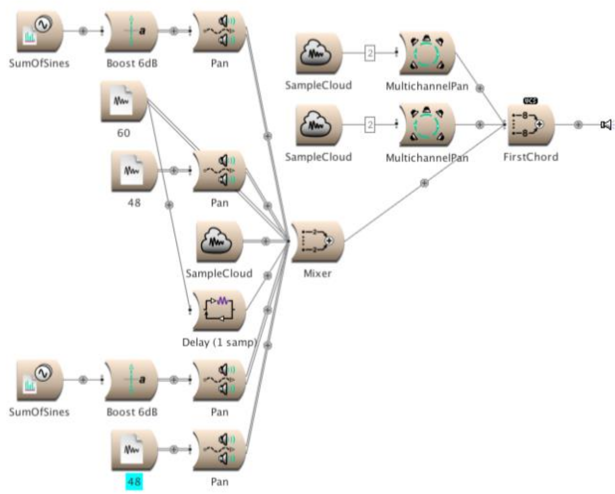

Figure 14. Kyma algorithm of opening sound of composition

The tonic piano chord in the piece occupies a special position. At different points throughout the composition we can hear the initial harmony being granulated and presented at different transpositional levels.

During the course of the composition multiple sonic transformations of the original material are presented simultaneously. The simultaneous presentation of this material creates dense and complex sonic textures that create the sonic signature of the work. The compositional strategy, in some sense, is based in sound design where sonic transformations are juxtaposed with versions of the Schumann song that is close to the original. This type of side-by-side presentation of the "original" and the "transformed" allows the listener to hear more easily how extreme the transformations are. The fact that Schumann's "Ich grolle nicht" is so well known and that I, at moments, so completely sonically distort and destroy the original, adds a further level of cultural meaningfulness.

As the piece progresses one can hear how the transformations of the original song are intensified little by little. The presentations of the relatively unaltered portions of the original Schumann begin at 1:23, 2:17, and 3:37, respectively. These sections are juxtaposed with sonic transformations of various types that begin at 1:52, 2:27, and 4:07.

As the composition reaches its emotional climax a chorus of voices chanting “Ich grolle nicht” is crossfaded into the texture and ultimately becomes the dominant sonic feature. The chanting voices are detuned and temporally misaligned from one another using the TAU algorithm to achieve an effect of psychological crisis. This algorithm is shown in Figure 15.

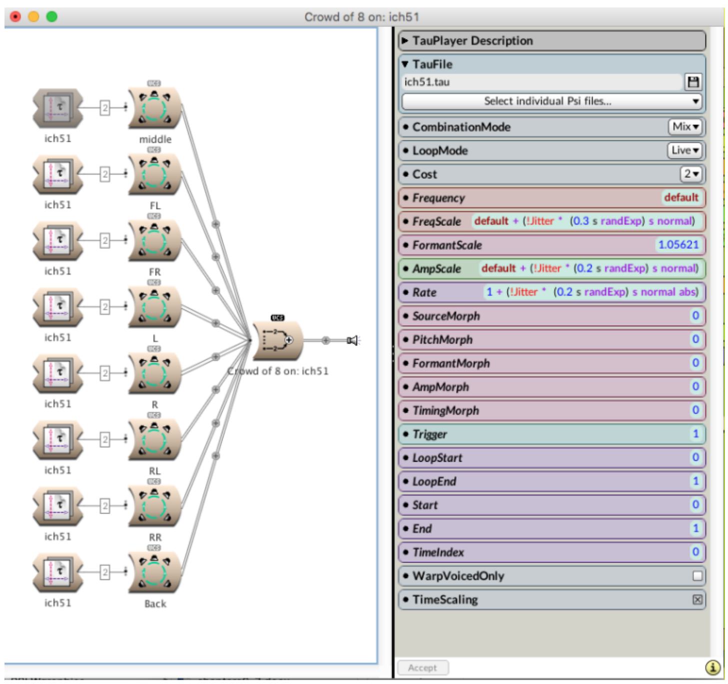

Figure 15. Eight “TAU” Sound objects’ algorithms spatially distributed

The composition ends with only the sparsest of sonic fragments created with granular processing.

Data mapping in the remix is dominated by several methodologies. I explicitly employ a technique where events are triggered when data I create exceeds a specified value. The piece begins precisely this way where I use a Capytalk expression in Kyma to trigger the initial chord once both of my hands create controller values greater than 0.1. The Capytalk expression I use in this context is:

(!cc01 gt: 0.1) * (!cc02 gt: 0.1)

The Blue Air controller provides a single dimensional, semi-linear data stream that functions approximately like a fader on a mixer. In this composition, the data streams output from the Blue Air are often mapped to multiple music parameters. This mapping supports the sonic complexity previously described and provides "parametric support" that is essential in virtually any musical expression.[21] Data mapping that exploits parametric support is overtly used throughout the composition.

Because of the fader-like functionality of the Blue Air I can use it to effectively control the balance of sonic layers in the overall mix. The mapping of data to overall volume can be heard clearly during the opening moments of the composition.

Another mapping technique I use is to convert MIDI continuous controller values into a stream of note-on messages. Note-on messages were created within Max by converting continuous controller values into note-on messages using "speedlim" objects, which reduce the frequency that data values are passed through the system, and by routing those thinned data streams to the "makenote" and "noteout" objects, respectively. Depending on where my hands are positioned within the performance field, different "speedlim" values can be specified resulting in different rates that piano chords are sounded. A basic version showing how I remap continuous controller values to note-on values is shown below in Figure 16.

[21] Parametric support refers to changing multiple parameters at the same time to enhance a musical expression. For example, the frequency may ascend while the musical volume gets louder.

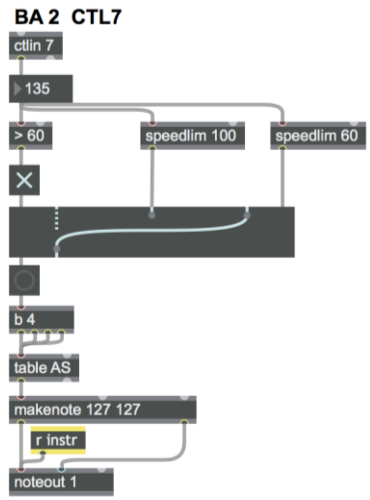

Figure 16. Data type remapped from continuous controller data to note-on data

<u>ÜBER ALLEN GIPFELN IST RUH</u>

Overview

Über allen Gipfeln ist Ruh is an eight-minute, real-time performance composition for Leap Motion controller, custom software created in Max, and Kyma. The sounds contained in the composition are predicated on a recording of Stephen Rodgers reciting the text of Johann Wolfgang von Goethe's poem "Ein Gleiches." This composition was inspired by both Fanny Hensel's and Robert Schumann's musical settings of "Ein Gleiches." I am of the belief that "line length, metre, enjambment, assonance, alliteration, and caesuras are so thoroughly absorbed by the music that they cease to be very relevant to an understanding of the song."[22] When a recording of a recited poem becomes the primary sound materials for music composition a, "poem ceased to be a poem."[23] This position is contrary to that expressed by Professor Rodgers in the article cited above.

[22] Stephen Rodgers, "Song and the Music of Poetry," *Music Analysis* 36, no. 3 (October 2017): 316.

[23] Ibid.

As I considered the text that formed the basis for this composition, my study led to the conclusion that a central component of the narrative related to a sense of longing that is never satisfied. This lack of emotional resolution also apparent in the Hensel and Schumann songs is reflected at the ends of both of their compositions. In my composition, I willingly and purposely allow these literary and musical shadows to cast their influences over my piece as I work to have the emotional motive of "restful unrest" infiltrate the musical fabric.

Design and Implementation of the Data-driven Instrument used in *Über allen Gipfeln ist Ruh*

The complete data-driven instrument for *Über allen Gipfeln ist Ruh* consists of the Leap Motion, custom software created in Max, and Kyma. The structure of this instrument is shown in Figure 17.

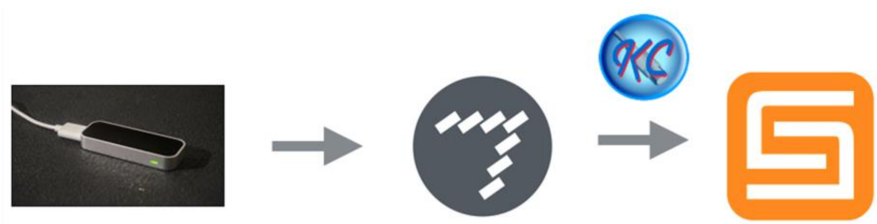

Figure 17. Basic data flow diagram for *Über allen Gipfeln ist Ruh*

The Leap Motion is a small hardware sensor device that outputs data based on the position of hands and fingers in a relatively small active sensing area. The Leap Motion primarily consists of two cameras and three infrared LEDs. Using these optical sensors the Leap Motion is able to recognize and report the location of hand and finger positions in 3-D space within the active sensing area. According to information provided by the company, the performance space created by the Leap Motion is approximately hemispheric in shape and extends two feet above and to either side of the device. This shape is shown in Figure 18.[24]

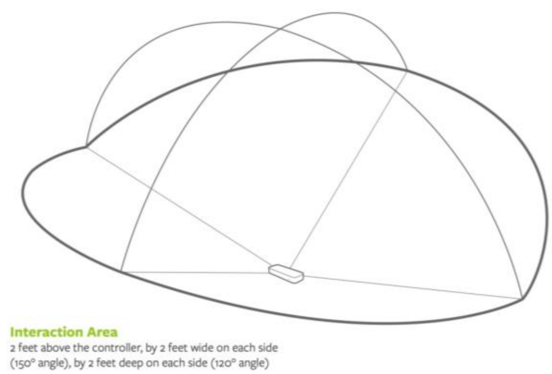

Figure 18. Hemispheric performance area of Leap Motion

Typically, the Leap Motion is connected to the computer through a USB port on a computer. Once at the host computer the Leap Motion's raw data is filtered through its Image API for adjustment and fine tuning. According to Alex Colgan, once the Leap Motion controller's data is acquired by the computer, the Leap Motion software preforms any necessary data adjustment before making the data available to other software components. For example, the Leap Motion software processes the grayscale stereo image to compensate for background objects and ambient environmental lighting. At the end of the Leap Motion pipeline, data, expressed as a series of frames bundled snapshots of data packets, is available for other applications to incorporate.

I use Max as the initial point where the Leap Motion's data appears. To assist in the execution of this service I use the "aka.leapmotion" developed by Masayuki Akamatsu.[25] Figure 19 shows the "aka.leapmotion" interface within the Max

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[24] Alex Colgan, "How does the Leap Motion Controller Works," Leap Motion; accessed January 19, 2018, http://blog.leapmotion.com/hardware-to-software-how-does-the-leap-motion-controller-work/.

[25] Masayuki Akamatsu is a musician, multimedia artist and programmer who has created a number of external Max objects that are widely used. "aka.leapmotion" Max external object package was downloaded from https://github.com/akamatsu/aka.leapmotion; accessed March 23, 2018.

environment. This Max external object acquires data originating in the Leap Motion and parses it into individual streams for convenient use.

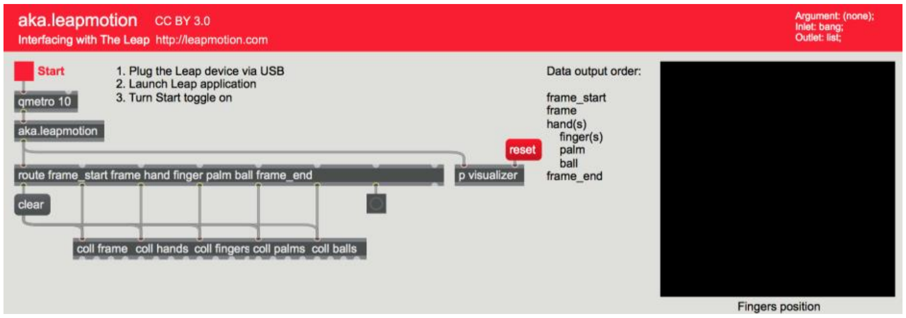

Figure 19. Top portion of help patch of Max object "aka.leapmotion"

Because of the nature of near infrared sensing, the sensors that the Leap Motion controller use shape the response characteristics and the data output from the device. For example, incandescent (tungsten) and halogens lights, as well as daylight will often be detected by the Leap Motion and distort its expected performance. In the context of a musical performance, the ideal space should contain no daylight and few light sources that emit light or even surfaces that might reflect light. For example, a dark concert hall with LED lighting is better than an environment containing day light or a room with tungsten lighting.

Before the data is sent to Kyma for sound production, additional mapping is executed. These mapping methods will be discussed in the section *Sonic Materials and Data Mapping Strategies* below. As a final destination, control data is sent to the Kyma environment where its sound-producing algorithms respond to its reception.

Musical Challenges and Opportunities

In *Über allen Gipfeln ist Ruh* one of the musical challenges relates to how the audio representation of the poem, a 19th-century text represented in a 21st-century medium, technically and aesthetically connects to a musical expression fundamentally controlled through a fully 21st-century mechanism, a data-driven instrumental system. The musical materials I used in this composition derive from a recording of Goethe's poem "Ein Gleiches," and the result of this creative process is an interactive electronic music composition based on the sound elements of that recording. However, there are fundamental differences between my interactive electroacoustic music setting and a traditional musical setting of a poem. First, instead of composing with notes (as Schubert or Schumann would have done), my version of *Über allen Gipfeln ist Ruh* directly works with sounds. Composing with sounds involves, among many things, understanding the extra-musical importance embedded in each sound beyond the objective qualities such as pitch, timbre, etc. Second, instead of employing a 19th-century style of voice with accompaniment as the primary expressive modality, my approach in this composition takes audio representations of the poem as sound materials to be manipulated and transformed. My compositional approach also seeks to disentangle the complex sonic structure of a sound whose fundamental structure always contains elements of frequency, timbre, duration, volume, and spatial location, and shapes a musical expression predicated on the performance of a data-driven instrumental system. Thus, my musical challenges and opportunities come from the same source: the tension that arises from the musical collision between 19th-century sentiments and emotions with the 21st-century objective coolness of a data-driven instrumental system.

Performance Techniques Employed using the Leap Motion Controller

In my performance of *Über allen Gipfeln ist Ruh* I use performance techniques that involve movements of my hands in 3-D space within the active hemispheric area of the Leap Motion. How the X, Y and Z spatial dimensions align themselves with the Leap Motion are shown in Figure 20.

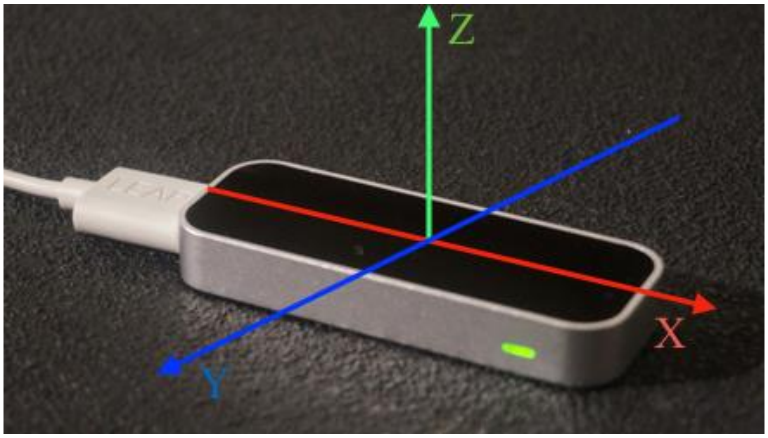

Figure 20. Three spatial axes of Leap Motion

Often the entering of my hands into the Leap Motion's performance area initiates individual or multiple musical events. The composition begins in this way as the opening sound is triggered by my hand breaching the external skin of the Leap's dome. When two hands enter into the active performance area multiple sounds are triggered and controlled. When both hands continuously move inside of the performance area left and right hands are differentiated from one another and independent continuous data streams are produced. The 3-D distance between the two hands are calculated, and when my two hands are far enough apart from each other, musical events are triggered. Sometimes, one hand is continuously moving within the functional sphere of the Leap Motion, while the other hand moves in and out. Because palm data acquired from the "aka.leapmotion" object is calculated from other data, change of the hand shape indirectly alters palm data. I use palm data to control both *TimeIndex* position and spectral modification processes. Changing the shape of my hand, therefore, becomes an important performance technique within the composition.

Compositional Structure

To create timbral unity, much of the musical material is derived from Stephen Rodger's recording of Goethe's poem. The original Goethe poem "Ein Gleiches" and its English translation are provided below.

Ein Gleiches
Über allen Gipfeln
Ist Ruh,
In allen Wipfeln
Spürest du
Kaum einen Hauch;
Die Vögelein schweigen im Walde.
Warte nur, balde
Ruhest du auch.

The English translation of the poem is

Another One
Above all summits
It is calm.
In all the tree-tops
You feel
Scarcely a breath;
The birds in the forest are silent,
just wait, soon
you will rest as well.[26]

The composition can be divided into four sections of unequal duration.

0:35-1:15 The first section is introductory and leads to the second section. In essence the section is one long crescendo that emerges from silence and culminates at its very end. Punctuating this crescendo are seven arpeggiated harmonies triggered by the entry of my hand into the performance area. The precise pitches of these harmonies, articulated with a metallic sound, are indeterminate and different with each performance. These pitches are selected via algorithm inside of Kyma.

[26] Henry Wadsworth Longfellow, *The Poets and Poems of Europe*, in *Wanderer's night-song*, no.2, first published 1871.

1:15-3:29 The second section concentrates on the word “ruhest.” I divide the word “ruhest” into its vowel and consonance to reshape the phonetic experience hearing this word. “Ruhe” is dramatically sustained, elongated, and “st” sonically interrupts other sonic components when my left hand enters the performance hemisphere.

3:29- 6:24 The third section explores temporal reorganization and fragmentation of the principal source audio recording. The section begins with a recapitulatory allusion to the opening of the piece, but is immediately followed by a granular fragmentation of the text. Using my hand shape, I am able to execute what I would describe “atomic level rubato” by extending and drawing out the “al” of the word “balde,” while hurrying through other portions of the word. Through these types of temporal distortions I am able to make reference to the 19th century performance practice of rubato within the technical and cultural framework of the 21st century.

6:24-8:15 This sonically symphonic final section functions as a coda and it is where the sonic material is recalled using Kyma’s TAU algorithm to playback the text “Ruhest du auch.” In my performance, I emphasize the textual moments “Ruh” and “au.” The subtle articulation of unpitched creaking string sounds together with harmonically shaped vowels creates a peaceful, yet quietly unrestful ending.

Sonic Materials and Data Mapping Strategies

The primary musical material of the composition arises from recordings of the spoken recitation of the original Goethe’s text, percussion instruments, and cello creaking string sounds originally performed by Ramsey Sadaka. To shape the original sonic material, I used a range of synthesis techniques including audio file playback, analysis and resynthesis, granular processing, and Kyma’s TAU algorithm. There are, of course a number of ways to create unity in a musical composition, but because the initial sonic materials were narrow, I was able to reasonably expand the number of synthesis processes that I used. At the beginning of the composition we can hear audio file playback; later sections feature sounds based on scrubbing through a *TimeIndex* parameter of Kyma algorithms that use resynthesis techniques. Often multiple versions of the same sound that have slight parametric variation are combined. With Kyma, the *FreqScale* parameter is set to be rounded, resulting in specific pitches being produced. To create rich and complex sonic results I often resorted to doubling the use of certain Kyma Sound objects. Such an example is shown in Figure 21 where four TAU players are combined.

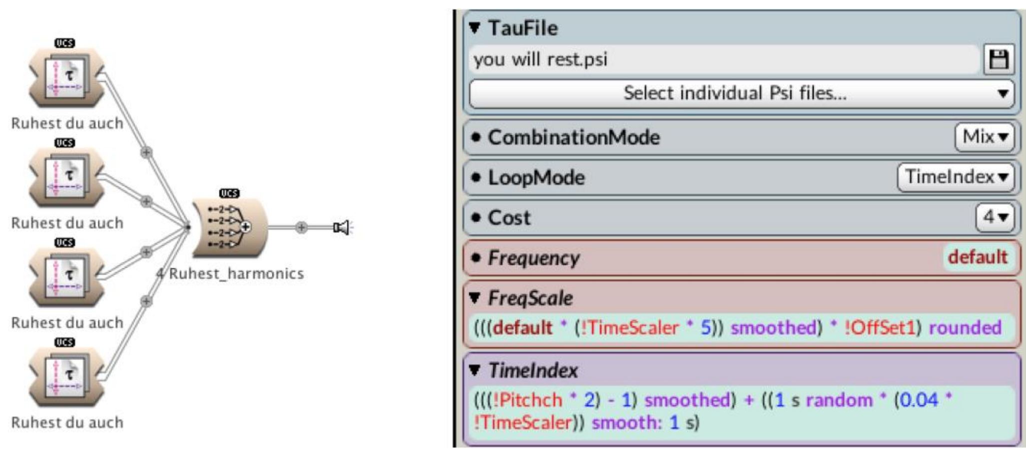

Figure 21. Multiple copies of the “TAU” algorithm with slight parametric variations

Data mapping is applied in both Max and Kyma. Initially data is subtly massaged in Max to bring the data into convenient ranges for Kyma to use. I also execute a calculation procedure with the simple routine shown in Figure 22. This simple algorithm calculates the distance[27] between my hands and is used to trigger sounds once a particular distance threshold has been breached.

[27] The distance between two points in three-dimensional space is the square root of the sum of the squares of the differences between corresponding coordinates.

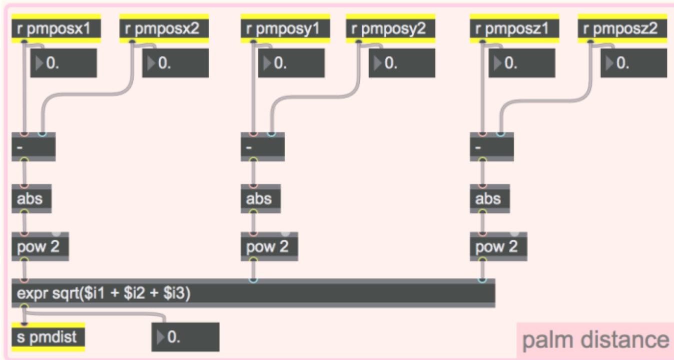

Figure 22. Two hands distance calculation

In Kyma the data mapping is more extensive and relates to desired musical outcomes. I use basic scaling and offsetting techniques to process almost all the data received by Kyma. At some points in the composition, two hands are both continuously controlling data inside of the interaction area and sometime confusion arises about "which hand is which." The consistency in indexing hands is important because sometimes the left hand is the agent of control and sometimes the right hand functions in that capacity. I used the following algorithm shown in Figure 23 to re-index the hands based on value of axis X. When palm data X is greater than 0, *palm id 1*, when less than 0, *palm id 2*.

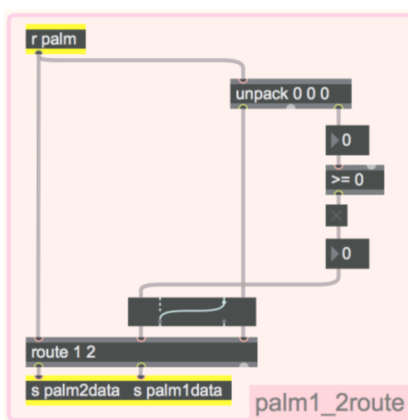

Figure 23. Re-indexing two hands in Max

OPHELIA

Overview

Ophelia is a real-time interactive electronic music composition for Wacom Intuos5 Touch Small Pen Tablet, custom software created in Max, and Kyma. The sonic texture of the composition is based on recordings of Marie-Caroline Pons's voice reciting the poem *Ophelia* by Arthur Rimbaud.[28] Rimbaud's personification of nature and Ophelia's inner emotional world especially moved me. To provide a concentrated focus to my music I decided to use one line of Rimbaud's poem (Ses grands voiles bercés mollement par les eaux) as the primary, but not exclusive, sound source. For me, the single line of text reflected the essence and soul of the poem – an essentialness that I wished to have embedded in my musical formulation. To present this basic material within the framework of the composition I relied extensively on Kyma's TAU algorithm. Using the TAU algorithm I was able to expressively shape pitch and rhythmic material as well as effectively employ musical dynamics, spectral inflections, and spatial placement. In my musical manifestation of the poem, I chose to use the Wacom Tablet as a "cinematic stage" for my metaphoric and theatrical working out of the inner drama contained in the poem, and the "Wacom Pen"[29] and the "human finger" as the primary characters in this drama.

Design and Implementation of the Data-driven Instrument used in *Ophelia*

The complete data-driven instrument for *Ophelia* consists of the Wacom Intuos5 Touch Small Pen Tablet, custom software created in Max, and Kyma. The complete structure of this instrument is shown in Figure 24.

[28] The entire text of the poem and its translation is provided in Appendix B of this document.

[29] In this chapter, "Wacom Tablet" is shortened to *tablet*, "Wacom Pen" is shortened to *pen*.

Figure 24. Basic data flow diagram for *Ophelia*

The “Wacom Intuos5 Touch Small Pen Tablet” (shown in Figure 25)[30] provides the performance interface I used for this instrument.

Figure 25. Wacom Intuos5 Touch Small Pen Tablet

Each Wacom Tablet is sold with a compatible digital *pen*. Some *pens* feature buttons on the shaft or an eraser at the other end. The tablet is connected to the primary computer via USB or Bluetooth. This pen and tablet set was originally designed to be used by professional illustrators. Because the Wacom pen and tablet set was intended for professional use it possesses powerful capabilities that the best artists can use. An interesting aspect of performing music using a digital illustrators tablet is that there exist a number of similarities to Chinese calligraphic practice, where every stoke happens in an irreversible time – as is true in a real-time performance of a musical composition.

The Wacom Intuos models provide 1024 levels of pressure sensitivity and 2540 lines per inch (1000 lines/cm) resolution.[31] The model I use has an active surface area

[30] Image downloaded from http://intuos.wacom.com

that is 6.2” by 3.9” (15.75 by 9.84 cm) and has six control buttons. The tablets are paired with a battery-free pen powered by the same electromagnetic resonance that is generated when the pen is positioned physically near the tablet. The version of the tablet I use provides similar control functions via touch. Kyma can understand such messages transforming the tablet into a true multi-touch performance surface, however, in the case of this composition, I sent the Wacom data through the Max environment first and then on to Kyma.

As I mentioned above, using the tablet and pen as the interface controller for a musical composition shares much with Chinese calligraphic writing. Chinese calligraphy is a form of aesthetically pleasing writing whose meaningfulness extends beyond the objective meaning or meanings of each Chinese character (*hànzì*). Chinese calligraphy is the art of beautiful writing. Chinese calligraphic practice reflects life experience through energy in motion that can be traced on silk or on paper. Although the result of the calligraphy can be considered visual art, the process of creating Chinese calligraphy share many similarities with live musical performance. This type of expression has been widely practiced in China for millennia and has been held in high esteem in Chinese culture.

I found that the ritual and performance of Chinese calligraphy and the procedures used when employing tablet and pen as a control interface for music have many commonalities and a few differences. In Chinese calligraphy, a brush is the traditional writing instrument. The body of the brush is commonly made from bamboo or other materials such as wood, while the head of the brush is typically made from animal hair.

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[31] “Intuos: Creative Pen Tablet,” Wacom; accessed January, 14, 2018, https://www.wacom.com/en-gb/products/pen-tablets/wacom-intuos

In Chinese calligraphy, paper and a desk pad are bundled together. Paper (*xuanzhi*)[32] is made from rice, paper mulberry, or silk, among other materials. The desk pad is usually made with felt and provides a soft, comfortable surface on which to shape the nuances required of Chinese calligraphy. When writing, *xuanzhi* is placed on top of the desk pad. Some pads are printed with grids of different sizes and shapes to provide a guide for individual strokes and to structure conceptually the design before writing with the brush. The *xuanzhi* is replaced after it has been written on. Desk pads are used for longer periods of time. In writing, the calligrapher's control of brush pressure, inclination angle, and spatial direction (inclusive of the brushes speed, acceleration and deceleration) produce different thicknesses of text, different edges (round or rough) for the text of the strokes, and that which we consider the "spirit" of the calligraphy. Calligraphy brushes are widely considered an extension of the calligrapher's arm. The calligrapher's masterful control of the brush is a crucial contributor to the final calligraphic outcome.

The Wacom tablet, on the other hand, provides a firm, hard, high-resolution surface on which to draw with the pen. Its surface is made for repeated use and can be written on thousands of times facilitating both musical experimentation and extensive practice. The pen offers opportunities and challenges similar to those offered by the brush in its calligraphic context. To control the data streams that are output from the tablet, the position of the pen in the X and Y spatial dimensions, the pressure applied by the pen to the tablet, and the angle the pen is tilted, all must be artfully and musically controlled. In the case of these data streams, how these data streams unfold over time is additionally

[32] Xuanzhi, Xuan paper, is a kind of paper originating in ancient China used for writing and painting. Xuan paper is renowned for being soft and fine textured, suitable for conveying the artistic expression of both Chinese calligraphy and painting. Wikipedia, accessed March 20, 2018, https://en.wikipedia.org/wiki/Xuan_paper.

consequential. Parallel controls are also possible through touching fingers directly to the tablet. Both the pen and brush come to rest when not in use. In my performance of *Ophelia* I use both the pen end and my index finger to articulate six, data-streams based on spatial positions in three-dimensions: *penX*, *penY*, *penZ*, *finger*, *fingerY*, and *fingerW*, respectively. Figure 26 shows the external Max object "s2m.wacomtouch"[33] and how OSC messages[34] are sent from Max to Kyma.

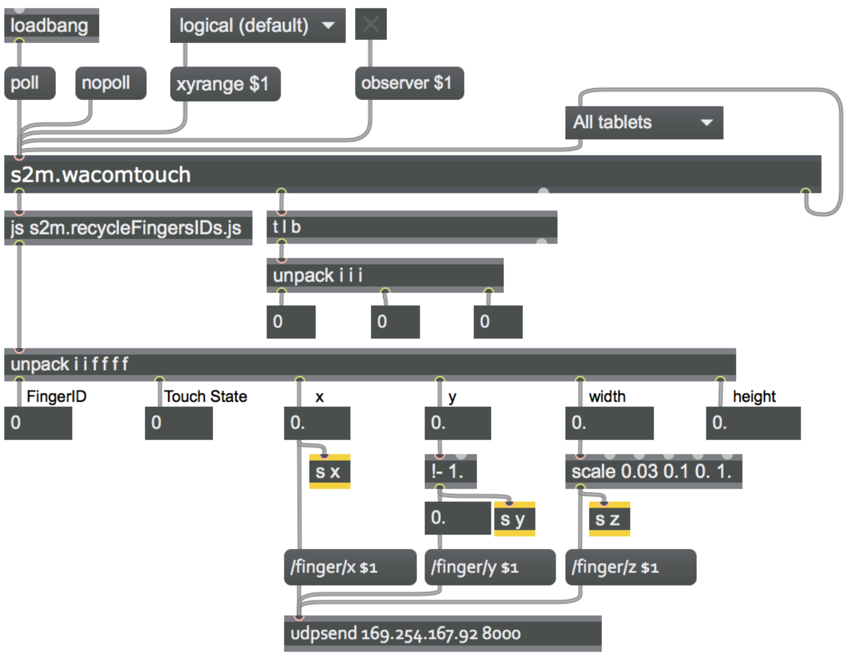

Figure 26. Max external object "s2m.wacomtouch"

I use colored adhesive dots placed on the surface of the *tablet* as mnemonic devices that function similarly to the desk pads underneath *xuanzhi* (see Figure 27).

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[33] The "s2m.wacomtouch" Max external object was created by Charles Gondre.

[34] *Ophelia* was composed in winter 2015, before the Symbolic Sound's Kyma developed algorithms that allow direct data connections between the Wacom Intuos5 Touch Pen Tablet and Kyma for the transmission of touch data.

Figure 27. Colored adhesive dots on tablet

As part of the value system of Chinese calligraphic writing, it is considered good form not to amend existing strokes.[35] Imperfection is regarded as the imprintation of an author's unique and individual personality. Figure 28 shows one of the masterpieces in Chinese calligraphic history *Lan Ting Ji Xu*[36] by Wang Xizhi.[37] I circled some of the crossed-out characters and written over characters in this imitation of the original work.[38] Despite the crossed-out characters, the "spirit" of this piece remains an all-time favorite in Chinese calligraphy.

Figure 28. Examples of crossed-out characters in imitation of Lan Ting Ji Xu

[35] Tang, Damin. *A Brief History of Chinese Calligraphy* (Nanjing: Nanjing Normal University Press), 2012.

[36] *LanTingJi Xu* is a piece of Chinese calligraphy work generally considered to be written by the well-known calligrapher Wang Xizhi from the East Jin Dynasty.

[37] Wang, Xizhi, a Chinese writer and official who lived during the Jin Dynasty (265 - 420), is best known for his mastery of Chinese calligraphy.

[38] Originally by Wang, Xizhi, imitation by Feng, Chengsu, Tang dynasty, ink on paper. Palace Museum in Beijing.

While it may have been possible for Wang Xizhi to backtrack, and revise such errors, he chose, as part of this value system, not to do so. When using the tablet in a musical context, however, we find ourselves in a similar situation. We cannot backtrack because music unfolds over time and there is no possibility of returning to the past to alter history. Instead a performer finds themselves analyzing a performance moment to moment and performatively compensating for, but not correcting, errors that may have been made.

Following the parsing and simple mapping procedures within Max the control data is sent to the Kyma environment where its sound-producing algorithms respond to its reception.

Musical Challenges and Opportunities

When performing *Ophelia* an expressive opportunity that the tablet provides becomes especially apparent when paired with Kyma. Within Kyma scrubbing through defined segments of audio files, which can be realized in multiple fashions including granular synthesis, the many versions of analysis and resynthesis, and Kyma's "TAU" algorithm. In the Kyma environment each moment an audio segment is given a temporal index value between -1 and 1. The value of -1 points to the beginning of the audio segment, a value of 1 point the end of the audio segment, and a value of 0 specifies the middle position. Intermediate values between -1, 0, and 1 point to relative time positions in the -1 to 1 continuum. In Figure 29, the recorded voice reciting "Ses grands voiles bercés mollement par les eaux" is shown as a waveform and its *Timeindex* is shown below the waveform in Figure 29.

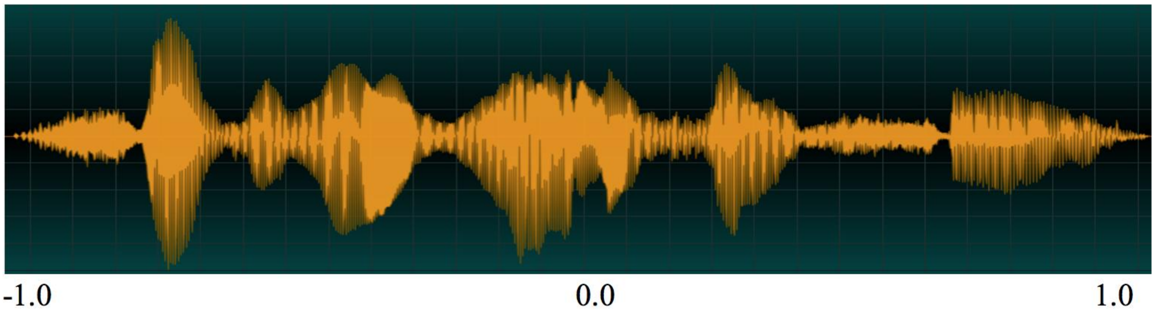

Figure 29. Waveform and TimeIndex

Because the tablet provides such high-resolution output, most particularly across the X- and Y-axes, one can scrub an audio segment with great specificity and exquisite detail and nuance. This particular scrubbing technique allows the progression of time through a chosen audio segment to be dramatically and beautifully extended revealing the sonic details that would have been missed had progression through the audio been at a normal rate. In *Ophelia*, this particular scrubbing technique is used throughout, but is, perhaps, most notable in the middle section starting at 4:01 into the video performance associated with this dissertation. In this section, data generated from the position of the pen in the X-axis is mapped to control the position that will be accessed in the audio segment, while the position of the pen in the Y-axis is mapped to control moment to moment pitch. Because the audio segment I chose to scrub through derives from the spoken text of the poem, rich sonic possibilities exist that progress from one sonic state to another. In this section, one can easily note the musical journeys that progress from very high to very low pitch. There are, for example, micro-sonic-journeys that move from constants to vowels which in vocal sound means progressing from noise-centric moments to moments where a central pitch is more clearly articulated. Metaphorically, such sonic progressions are progressions from moments of chaos and dissonance to moments of stability and consonance. Locating the specific point of the Kyma *TimeIndex* parameter by moving the pen to that point on the tablet constitutes the primary technical challenge of performing *Ophelia*. To be able to perform such actions reliably took much time and practice to perfect.

Performance Techniques Employed using the Wacom Tablet

As I performed *Ophelia*, I conceptualized the performance area of the tablet as being like a cinematic stage, with two “active characters” – the pen in my right hand and my index finger on my left hand. The actions required to perform the composition then are representational of the multiple dramas embedded in the text with pen and index finger articulating two different writing styles. While, the two types of writing are not the same, they can, however, reflect on one another. Just like in the poem, Ophelia and nature are two different narratives, but narratives that relate to one another, reflecting upon and contrasting with the other. In my composition, the two sonic worlds share similar harmonic content, similar sound synthesis methods, however they are comprised of different sonic materials, thus providing different potentials for musical expression.

In the opening section of the composition, I used the pen as both a dramatic character, nature, and also the controlling agent for my sound. My choice of sections of the text that translate into the phrases “the groans of the tree,” “the sighs of the nights,” and “the voice of the mad seas,” while intuitively arrived at, now appear to be conscious and strategic decisions given that each phrase makes a clear reference to sound (groans, sighs, and voice). In this section I use data streams generated from the pen position in the X- and Y-axes, and the touch of the pen to the tablet to control all sound. I used the index finger to symbolize another character, Ophelia, in water. On the tablet a drama plays out just as in the text of the poem. In the poem Ophelia “floats like a great lily, floats very slowly." Reflective of these lines we can see the performative trace of the index finger, once placed on the tablet, hardly moves. This is in stark contrast to the pen that dramatically symbolizes nature by swirling around the full dimensions of the tablet.

Compositional Structure

At the beginning of my compositional work I made an audio recording of Marie-Caroline Pons reciting the poem *Ophelia*. From this recording I selected line ten of the original poem, "Ses grands voiles bercés mollement par les eaux," as the primary sonic sound. This textual fragment reflects the strong sense of the inner emotional turmoil through the depiction of water that casts Ophelia's long veil up and down. This segment of text musically aligns itself with the idea of creating unsettled peaks within extremely static moments in time, thus creating both seemingly peaceful moments juxtaposed with dramatic inner turbulence and tension that can never be resolved "for more than a thousand years."[39] This unfolding of tension over the course of the performance drives the structure and journey of the composition.

The work divides itself into three sections with the last being both the longest and the section containing the musical climax of the piece.

0:36-4:01 In this opening section the two characters in the poetic tale are performatively represented by my index finger and the pen. I also employ a sort of text painting to personify some of the elements central to the original poem such as wind, water, the voice of trees, and the spirit of nature. Ultimately the musical forces come together, and build up to an enormous climax at 4:01.

[39] See Appendix C.

4:01-6:20 In this second section the pen controls the playback of the TAU resynthesis of the recorded text phrase “Ses grands voiles bercés mollement par les eaux,” to shape the pitch, rhythm and timbre. In this section the pen traverses a wide spatial area of the tablet, from top to bottom, from left to right with the rate of movement changing from slower to faster to symbolize the emotional turbulence of Ophelia before she takes her own life.

6:20-9:40 In this final section, sounds related to Ophelia and nature are combined including a low-pitched pulse sound, a higher-pitched bell sound, and a modified version of the voice sound. Eventually, all of the primary sounds are recapitulated and mixed together with the blending of all sound materials together using analysis and resynthesis techniques. 8:43-9:40 functions as the coda for the composition. Sound related to Ophelia at the beginning of the composition is reused and process using a different algorithm.

Sonic Materials and Data Mapping Strategies

As my primary sonic material I used a single line of text from the original poem. In the audio recording that I made, the poem was performed with a balance in rhythm, meter, and timbral variation. I chose to use this line of text as the sound source for one section of the piece, analyzing and resynthesizing it using Kyma’s TAU algorithm. Using the TAU algorithm, I was able to artfully be expressive with the pitch, duration, volume, spectral qualities, and spatial location. One example of the signal flow and control mechanism is shown below in Figure 30 that starts at 4:01 of the video performance. In this example, the *FreqScale* and *TimeIndex* parameters of the four TAU players are controlled by the pen, while I use *PenButton2* to record the results of my performance into a memory buffer for later recall. Later in the composition I use the index finger of the right-hand to trigger the playback of this audio. The index finger's Y-dimension location controls the pitch of this recalled audio in realtime.

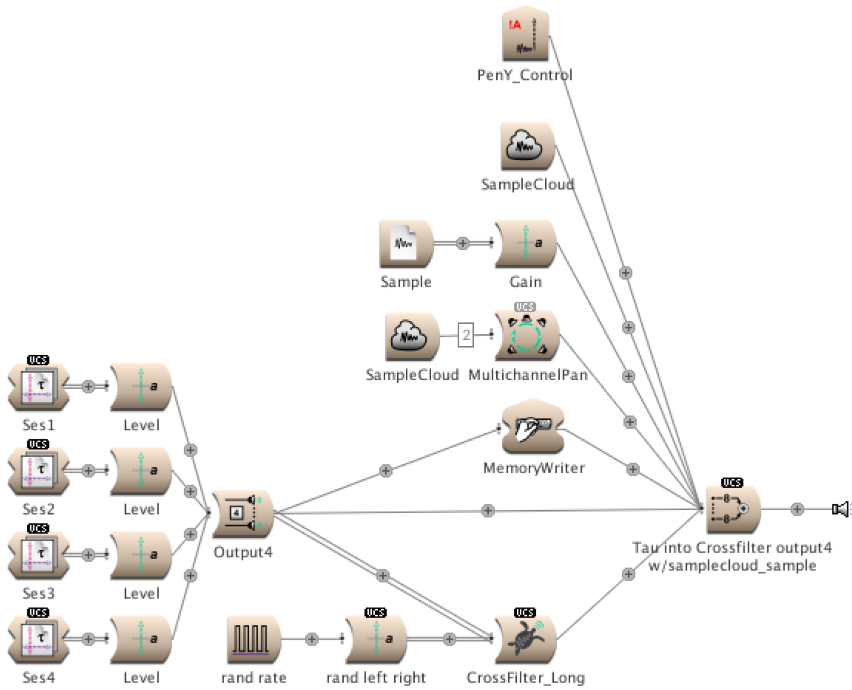

Figure 30. Kyma signal flow graph using pen and finger

In the first section the primary spectral material was derived from the pitched vowel sound "Ahh" that I extracted from the recording of the poem. Figure 31 shows the spectral characteristics of this material. Note the broad spectral content that in some way reflects the dissonance of the poetic narrative.

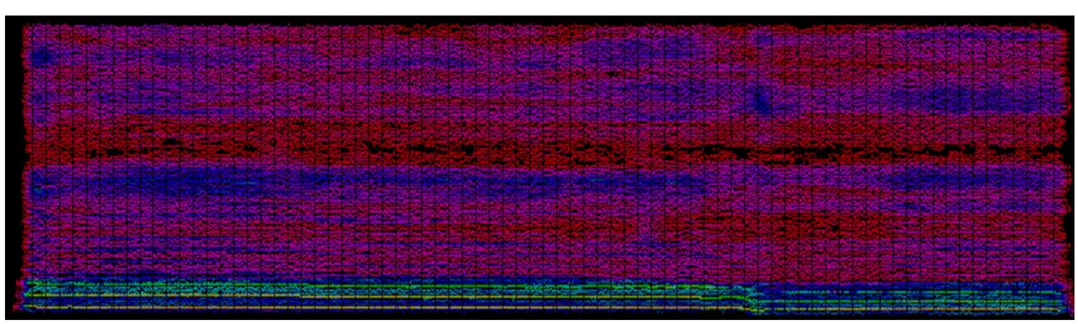

Figure 31. Spectral characteristics of primary material of section one

The pen and finger control sound synthesis algorithms that employ different synthesis techniques, even though they are related in pitch content and dynamic contour. The finger controlled algorithm created in Kyma is shown in Figure 32. This particular algorithm was generated using Kyma's proprietary "Gallery" generative function. In this algorithm, audio representation of the voice is stratified into individual frequency sinusoidal components, with respective amplitude and duration information. The frequency components and their amplitudes together form the spectral content that can be used to control a wide variety of synthesis procedures.

Newly synthesized timbres are produced using vocoder algorithms. In the algorithm shown in Figure 32, my finger positions in the X-, Y- and Z-dimensions are used to control *TimeIndex*, *Pitch* and *Bandwidth* parameters in the resynthesis process.[40]

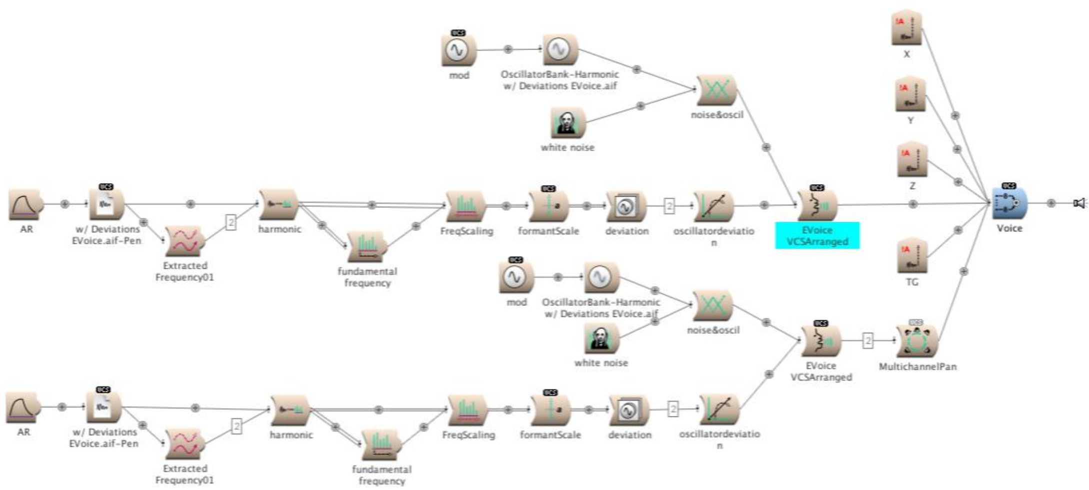

Figure 32. Finger controlled resynthesis algorithm

The pen controls the resynthesized vocal spectrum by using four "SumOfSines" Sound objects. Each of the "SumOfSines" Sound objects was processed with a slight amount of reverb and individually spatialized. Two of these Sound objects had a "stereo

[40] The Z-dimension is derived value based on the size of the contact area of the finger on the tablet.

chorus" added to its signal path. All of the four "SumOfSines" objects are controlled by !PenX, !PenY and !PenDown messages sent from the pen. This algorithm is shown in Figure 33.

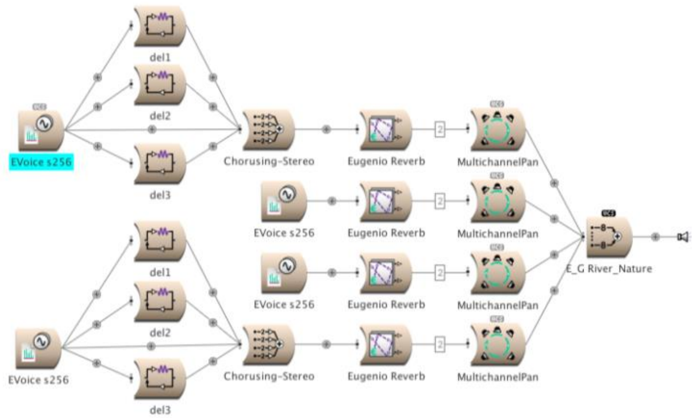

Figure 33. Pen controlled resynthesis algorithm

The Max and Kyma software together with performance instructions were provided to Jon Bellona so that he could include the perform of the composition at the University of Virginia's Technosonics Festival on October 22, 2016. Figure 34 shows an image taken from that performance.

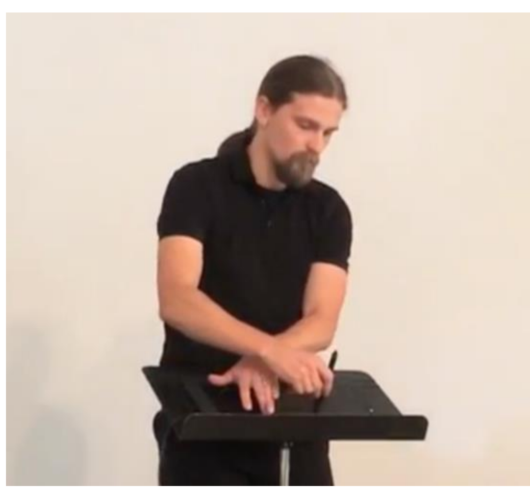

Figure 34. Jon Bellona Performing *Ophelia*

LING YIN

Overview

Ling Yin is a real-time interactive composition for the Gametrak three-dimensional position-reporting system, custom software created in Max, and Kyma. The Ling Yin Temple (灵隐寺) is a Buddhist Temple in Hangzhou, China that I frequently visit. The temple's name can be literally translated as Temple of the Soul's Retreat. It is one of the largest Buddhist temples in the region and contains numerous pagodas and Buddhist grottoes. There are nine main buildings, eighteen pavilions and seventy-seven temple halls built within the temple grounds that are located on a hill.[41] The most formal recitation in each temple is different and occurs at different times during the day. The four main sutras studied in Ling Yin Temple are *Vajracchedikā Prajñāpāramitā Sūtra*, *Suvarṇaprabhāsa-uttamarāja-sūtra*, *Sad-dharma Puṇḍárīka Sūtra*, *and* Karunika-rāja Prajñāpāramitā sūtra. I am moved each time I visit the temple. These essences of Ling Yin Temple provided the spiritual breath of the composition. The performance of *Ling Yin* starts with pulling the string of the Gametrak, and ends with gently releasing the string back to the original state of the Gametrak. The passage from "nothing" to "nothing," metaphorically reflects Buddhism's awareness of the nothingness and of the avoidance of the "self," while simultaneously striving to share and love during the process of life's journey. I have travelled with *Ling Yin* and performed this composition in different countries around the world. At this time, *Ling Yin* has been performed at the Kyma International Sound Symposium, Lübeck, Germany, the International Computer Music Conference, Denton, TX, USA, Future Music Oregon, Eugene, OR, USA,

[41] Lingyinsi Temple introduction, http://en.lingyinsi.org/intro/, retrieved March 19, 2018.

Musicacoustica, Beijing, China; Akademia Muzyczna im. I.J. Paderewskiego, Poznan, Poland; Nanjing University of the Arts, Nanjing, China, International Computer Music Conference, HKU University Utrecht, Netherlands; Society for Electroacoustic Music in the United State National Conference (SEAMUS) St. Cloud, MN, USA; New York City Electroacoustic Music Festival (NYCEMF), New York, USA.

Ling Yin is the first composition composed during my doctoral studies. The Gametrak as a musical device is one of the most capable performance interfaces for creating data-driven instrumental music. The Gametrak controller can be placed on the floor, on a table,[42] hung on the ceiling, placed inside of a container, or hacked and re-imagined as in the case of the Concertronica.[43] Other than *Ling Yin*, I have performed using the Gametrak controllers in two other compositions: *Lariat Rituals* and *Meng*. I have performed *Lariat Rituals* as the final composition during my second doctoral recital as a dedication to my professor Dr. Jeffrey Stolet. I also received a performed commissioned work, *Meng*, a thirty-minute live sonic performance experience work presented at the Portland Biennial 2016. The rich expressive potential, the straight-forward operation, and the dependable technology makes the Gametrak controller one of the most capable data-driven instrumental interfaces.

Design and Implementation of the Data-driven Instrument used in *Ling Yin*

The complete data-driven instrument system for *Ling Yin* is comprised of the Gametrak three-dimensional position reporting system, custom software created in Max that receives, modifies, scales and routes the Gametrak data, which is ultimately received

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[42] *Lariat Rituals* is a composition for Gametrak and Kyma by Jeffrey Stolet composed in 2011.

[43] The *Concertronica* is a performance interface created by Hugh Jones, accessed February 10, 2018, http://crewdson.net/2014/the-concertronica/.

by Kyma whose sound-producing algorithms respond to and are controlled by the data. The complete structure of this instrument is shown in Figure 35.

Figure 35. Basic data flow diagram for *Ling Yin*

The Gametrak is a simple gaming device that uses a patented mechanical system for the tracking position of physical elements in realtime and in three-dimensional space. The base unit is comprised of two identical physical mechanisms, each of which contains a nylon cable on a retractable reel. The two joystick-like mechanisms provide six streams of simultaneous data. Figure 36 shows a Gametrak controller and two reels' and the X, Y and Z orientation in three-dimensional space. The X and Y data is calculated based on the angular direction from the mechanism to the end of the plastic tube. The plastic tube can move within a circular area free of restriction, generating X and Y data. The Z data is calculated based on how far the cable is extended.

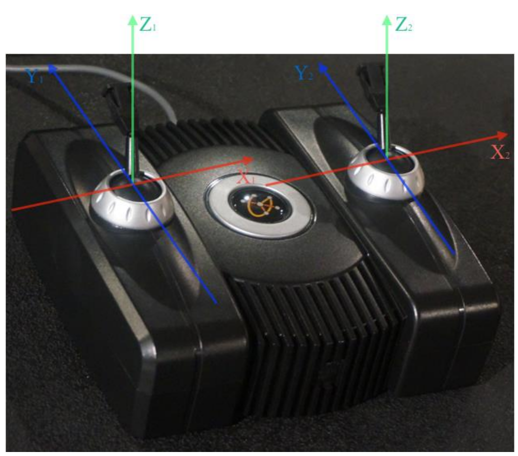

Figure 36. Gametrak's conceptual X, Y, and Z coordinates

Gametrak data is received by Max via USB port (where the Gametrak is connected) and through the "hi" object.[44] The data received in Max has 12-bit resolution with data ranging from 0-4095. The data received through the "hi" object is parsed into different data streams using the route object. Data is acquired without delay and is smooth and accurate.[45] When remaining untouched some jitter in the data streams is noticeable. It should also be observed that some of the X, Y, and Z dimensions possess the full range from 0-4095 and some do not. Figure 37 shows one occasion when data is not full range. Controller numbers 15 and 18 both show X values, and both are situated at the left-most position. Controller 15 of the Gametrak shows a 0 value and can stay stable at a 0 value while controller number 18 shows values around 53-55 with random jitter every 10 milliseconds. Similar data streams characteristics can be seen for other controller numbers. I also invert the data in the two Z dimensions to make the interface feel more intuitive to me.

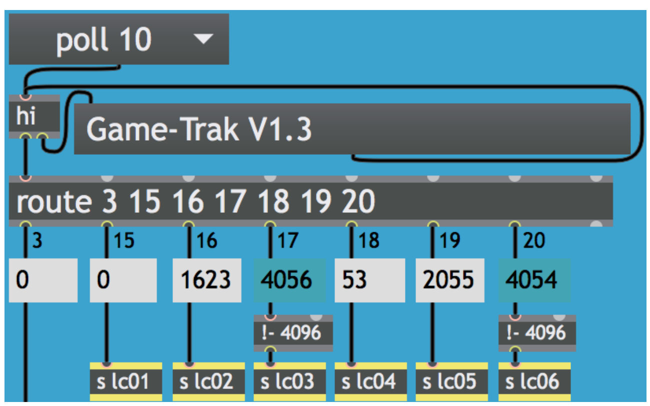

Figure 37. Interfacing Gametrak's data using Max "hi" object

To enhance the data usability, I interpolate additional values and send the

[44] The Max object "hi", standing for Human Interface, receives data from devices that adhere to the HID standard input. Typical devices include trackpad, keyboard, and virtually USB gaming controllers.

[45] The spatial accuracy of the Gametrak is to one millimeter according to Gametrak Developer FAQ. In2Games; accessed June 4, 2008, https://en.wikipedia.org/wiki/Gametrak.

modified data out of Max as 14-bit MIDI continuous controller values. The exact procedure I used is shown below in Figure 38. This interpolation method is similar to that used in Jeffrey Stolet's Gametrak-centric work *Lariat Rituals.*

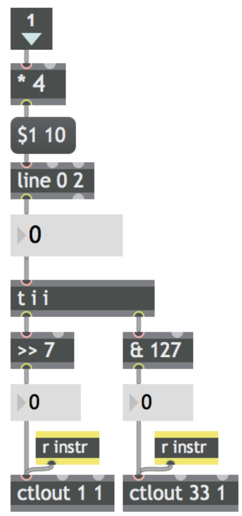

Figure 38. Data interpolation algorithm

To send the MIDI controller data to Kyma I use KymaConnect (see above). The connection can be made as part of the background operating services while using the laptop.

Data is received by Kyma whose sound-producing algorithms respond. While the data received is all continuous controller data, I use this data to trigger the playback of audio files and to control a number of musical parameters including *Frequency*, *TimeIndex*, and *Angle*.

Musical Challenges and Opportunities

The basic operational technique of the Gametrak controller consists of moving the untethered ends of two nylon cables in three-dimensional space. In *Ling Yin*, the Gametrak is positioned on a pedestal, 18-inches above the floor surface. Through the data

I create by my performative operation of the Gametrak I can trigger singular musical events and provide ongoing control over multiple sonic parameters. An overly simplified description of the performative actions I applied the most commonly during this composition include "pulling the string," "releasing the string," and "rotating the string." Because the performance interactive space defined by the Gametrak is rather sizable, the opportunities created for the performer are both dramatic and liberating.

Performance Techniques Employed using the Gametrak Controller

Both "pulling" and "releasing" of the strings indicate accumulating energy and resolving in causing and resulting sound changes. In the beginning, the first impact sound is created by the release of the two strings. The energy flow from a higher location to a lower location causes the initiation of the sound. This sound contains bells, arpeggio scale, low voice sustain drone, and drum sounds. This fast releasing performative action is used many times in the performance. Each time triggering different sounds with different functions. Many times, the pulling and releasing are a pair of performative actions executed one immediately after another. The end of one sound world is the beginning of another. Different sound worlds can be exited and re-entered by pulling the strings. Both strings can be pulled and rotated together creating a joint and simultaneous entry into two sound worlds.

Compositional Structure

The experience of bathing myself inside of the seemingly timeless ritual and listening to the recitation ceremony strikes me as a significant emotional journey. Buddhism is the religion of the individual, although Buddhist believe that there is no

“Self” and we are all part of the “One.” As part of this realization my composition starts and ends in silence with music actualized between the two areas of sonic nothingness.

Ling Yin can be divided into eight sections of unequal duration.

0:30-1:49 The first section functions as a sort of exposition for the entire composition. I start the performance by pulling up the string into a performance-ready position, using the most dramatic performative action to cause the most dramatic sound in this piece. The first sound in this composition contains many sonic elements that are used as motivic material later in the piece. At 0:48, the pulling string action causes bells to be triggered; at 0:57, the circular action causes the granulated ringing sound to change pitches. As the circular action continues, more and more sounds become part of the musical texture leading to a second impact sound triggered by the release of the string.

1:49-4:43 In this second section, the rapid pulling of either of the two strings triggers the appearance of new sound worlds. The string is pulled six times during the section, each time triggering the manifestation of different, but related sound worlds. The juxtaposition of one sonic fabric with another recalls the musical form of call and response that one might experience in sacred and spiritual contexts within many different religions around the world. The section culminates with the recurrence of the motive that opened the composition.

4:43-6:44 As the previous section this too uses a musical strategy that is predicated on the idea of an antiphonal structure. In this section, however, the timbrally opposing sounds are juxtaposed to one another over an insistent rhythmic pulse that gives the section much of its musical personality. The rhythm drives the music to its ultimate climax at approximately 6:16.

6:44-7:58 The final section functions as the coda for the work articulating sonic material derived from a modified frequency spectrum introduced at the beginning of the composition. This section emerges gradually by crossfading with the previous section after the previous section's climax. At the very end, only high frequency components remain as if there was a heavenly ascension that resolved in peace.

Sonic Materials and Data Mapping Strategies

I recorded one session of the recitation and tried to analyze the journey by listening to it over and over again. I realized that the experience only exists in the actual process of execution. I selected parts of the recording as sonic material, together with synthesized sounds put in motion. To perform the piece, I operate the two contractible strings of the Gametrak to control how this sound material will be actualized, moving them between different states of tension and release to express the emotional journey between the individual as an outsider and the experience of exposure to the Buddha Recitation.

The primary musical material of the composition arises from recordings of the Buddhism recitation I observed during my visit to Ling Yin Temple. The bell sounds were recorded separately in the Future Music Oregon[46] studios. The unpitched elements were generated through additive and granular synthesis. Figure 39 shows the signal flow developed to shape the bell sounds. Each bell sound initially is triggered by meeting certain conditions created for the string X-, Y- and Z-axis data. Once the bells sounds are triggered and their pitches specified, sounds are sent to Pacarana memory buffers that hold the sounds so that they may be granulated and spatialized. Each time a bell sound is

[46] The Future Music Oregon studios are the main study and composing studio complex of the Music Technology Department at the School of Music and Dance, University of Oregon.

triggered the original triggered audio file is simultaneously delayed by four unique times, thus generating the effect of the sounding of four individual notes.

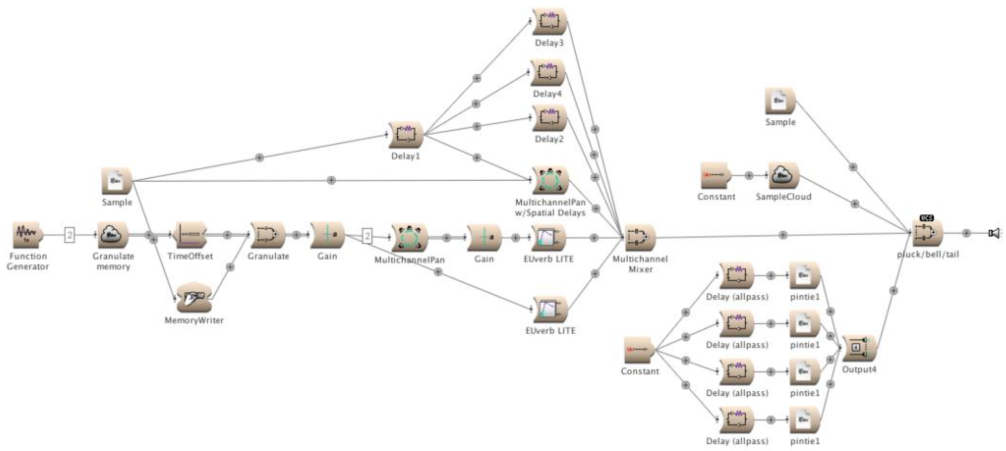

Figure 39. Bell sounds texture algorithm signal flow graph

To further develop the initial sonic material exposition, I transformed the bell sound in a number of ways. One of the sound design approaches that I employed was to apply a repeating amplitude envelope to the two versions of the triggered bell sound. In the same audio path, I also applied time delay and high-pass filtering. Figure 40 shows the sound flow constructed using this sound design approach.

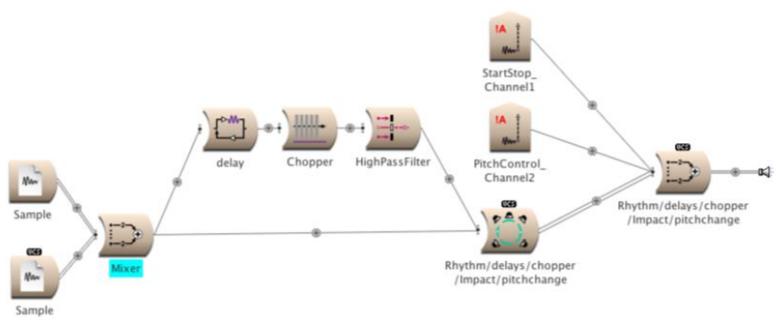

Figure 40. “Chopped” bell sounds algorithm signal flow graph

To shape the initial sound sources, I used a range of sound synthesis techniques including analysis and resynthesis that are combined with a Kyma granular synthesis techniques which dominate the opening and middle sections of the composition. One sound synthesis signal flow graph is shown in Figure 41.

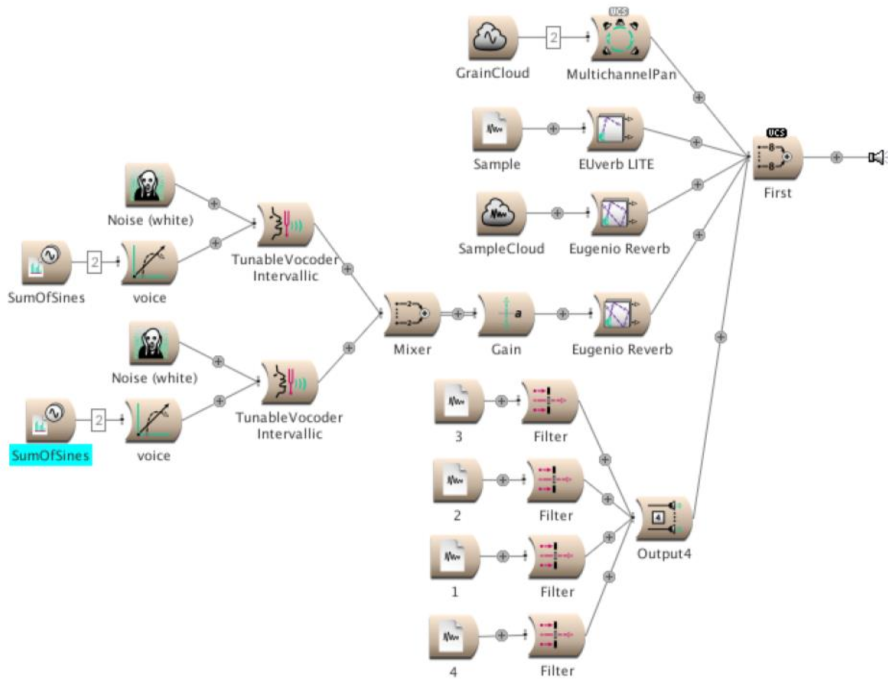

Figure 41. Initial impact sound signal flow graph in *Ling Yin*

Data mapping is applied both in Max and Kyma. Initially, as I described in the design of the data-driven instrument system section, I use Max to interpolate new data points. This data is added between the original data points generated from the Gametrak. The extra smoothness of this data was especially helpful when trying to control the pitch-shifting of the vocoded spectral content of the voice. Figure 42 shows the sound structure of the real-time controlled analysis and resynthesis algorithm.

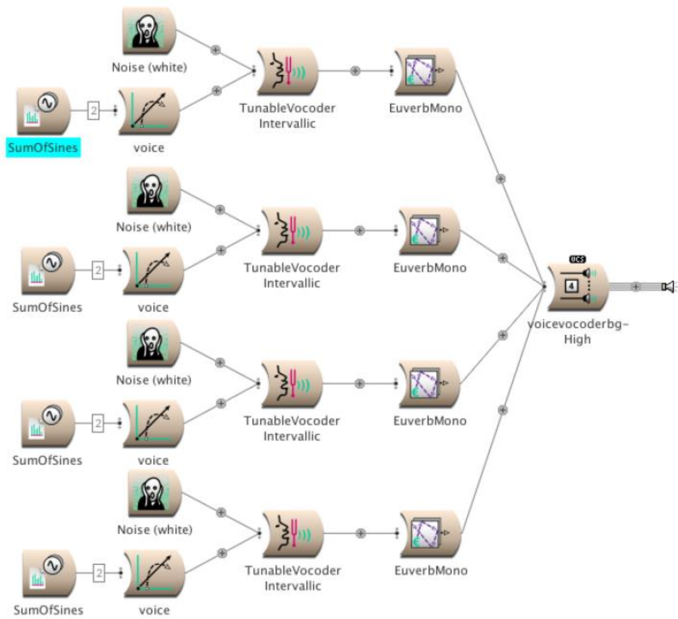

Figure 42. Pitch-shifting of the initial sound signal flow graph

As I perform *Ling Yin*, the software serves as a score by providing information about what performative actions need to be executed and when they need to be accomplished. The Kyma timeline for *Ling Yin* provides the primary timing information. I set the timeline to be at the right zoom-in level so I can focus on certain algorithms as they pass into and out of existence as the composition progresses. When I need to see the whole composition, I can view the whole timeline, including markers that can initiate VCS[47] actions. The timeline also shows running time and images that provide detailed performance instructions. Figure 43 shows the whole timeline with markers, sound algorithms, conditional algorithms, time control algorithms, VCS, and clock.

[47] VCS is a Symbolic Sound's Kyma acronym standing for Virtual Control Surface.

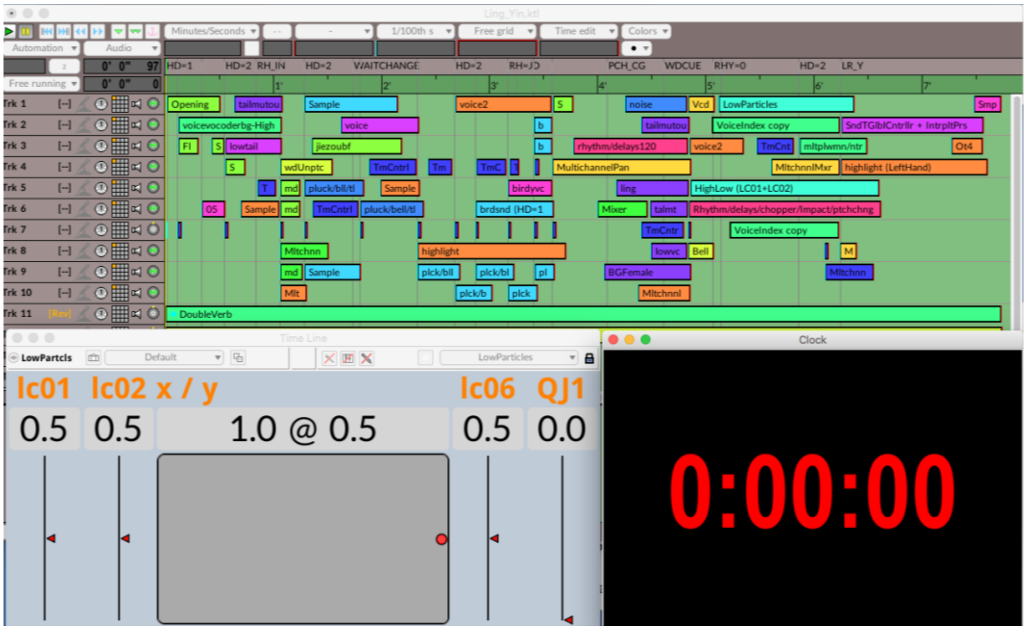

Figure 43. Software score of *Ling Yin*

The picture embedded in the VCS in Figure 45 shows “ST2 > 0.3” at the beginning of the composition, reminding me to meet ST2 > 0.3 so I can get ready to start the piece. Depending on which reads more easily during a performance, instructions can be written with an orientation towards data condition instructions or performance actions instructions. Figure 44 shows the pictures with instructions I created for *Ling Yin*.

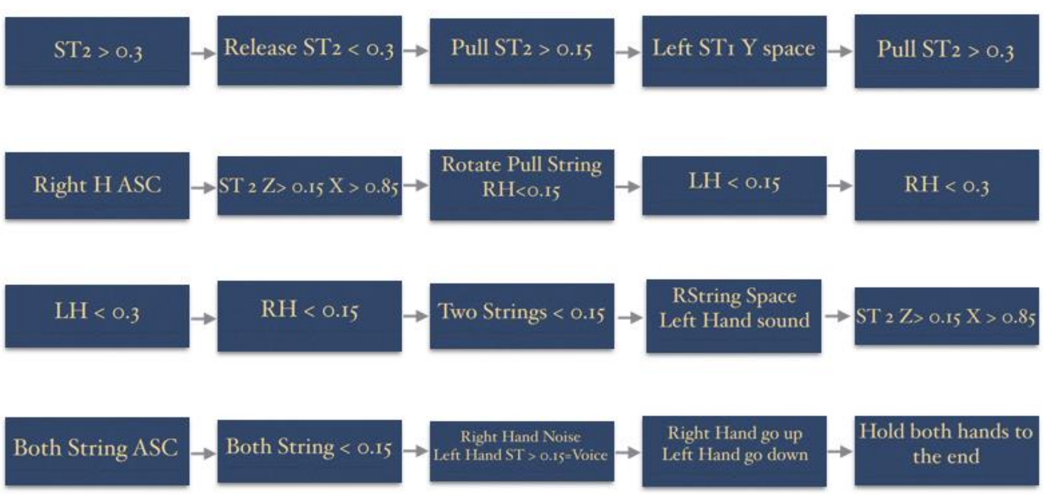

Figure 44. Performance instruction slides embedded sequentially in VCS

All of the instructions are embedded in the VCS, and are triggered as requested. In the context of a *Ling Yin* performance, timeline markers include functions that permit specified information to be shown. Together with the “ImageDisplay” Sound object, a sequence of performance cues are made viewable for me to see as the composition progresses. Figure 45 shows the algorithm that facilitates this image display function.

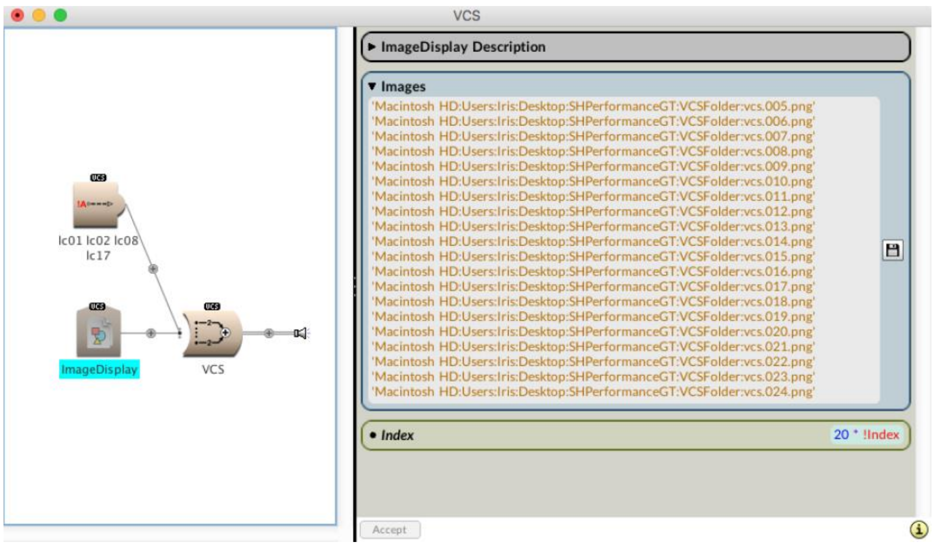

Figure 45. Kyma “ImageDisplay” Sound object setup for software score in *Ling Yin*

<u>FLOWING SLEEVES</u>

Overview

Flowing Sleeves is a real-time interactive composition approximately seven minutes in duration for eMotion™ Wireless Sensor System, custom software created in Max, and Kyma. In Chinese Opera, water sleeves can be an essential part of characters’ costumes. Water sleeves, extra-long sleeves, are part of women’s traditional Chinese dance costumes. During performances, the long flowing sleeves can be flicked and waved like water to articulate emotive body movements and is associated especially with female characters in Chinese operas. My composition *Flowing Sleeves* is inspired by a Ci (词)

poem Pusa Man (菩萨蛮) by Wen Tingyun (温庭筠)[48] of the Tang Dynasty that depicts the women's ritual of preparation in dressing, the art of face makeup, and the spiritual routine before the daily exposure to the public. The entire poem is 44 words in length and articulates two moods.[49] Most of the text describes in detail the beauty of well-cultivated ladies, including their facial expressions, costumes, and body movements. The text, however, also indicates the inner loneliness of women who were depressed by the restricted feudal ethical rules. In contemporary times, Chinese culture still views restricted beauty as a special type of beauty that symbolizes a woman's discipline and good behavior. In this composition, the musical expressions are created to depict the poetic persona's nuanced, yet rich internal emotional world that is placed in direct contrast with the minimalistic body movements and the costume's cultural references.

Design and Implementation of the Data-driven Instrument used in Flowing Sleeves

In *Flowing Sleeves* the complete data-driven instrument is comprised of an interface formed by an eMotion™ Wireless Sensor System, custom software created in Max, and Kyma. The complete data-driven instrument for *Flowing Sleeves* is shown in Figure 46.

Figure 46. Basic data flow diagram for *Flowing Sleeves*

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[48] Wen Tingyun, 812-870, is generally regarded as the first truly distinctive writer of *ci* – a Chinese lyric poetic form.

[49] The entire poem and its translation is given in Appendix C.

The eMotion system is comprised of data acquisition modules called the Twist and Accelerate that are paired with a receiving base station called the Fuse via a WiFi network connection.[50] Because the Twist and Accelerate are wireless, they are powered by onboard batteries that must be charged. The base station is connected to the central laptop computer through a USB connection. The wireless transmission range is said to be up to 100 feet. An image of the eMotion system is shown in Figure 47, with a Fuse base station with antenna, a Twist, and an Accelerate. Each twist and accelerate is indexed with different numerical numbers and can be seen when synchronized with the base station through the OSC protocol.

Figure 47. eMotion™ Wireless Sensor System Fuse, Twist, and Accelerate

Data sent to the base station reflects the moment to moment statuses of a 3-axis gyroscope, accelerometer, and magnetometer that report the inertia, acceleration, and position (nine total data streams). I perform *Flowing Sleeves* using an eMotion Twist in my left hand and an Accelerate in my right hand. Both can be indistinctly seen through the flowing sleeves of the costume as the LED signal lights of the two modules peak through the semi-transparent fabric of the costume. The choreographic movements as well as the performative actions are designed for the costume. The two together control the shape of the visual and musical experience in realtime.

[50] eMotion Technologies Wearable Tech for Performers was created by Chet Udell; accessed June 10, 2017, http://www.unleashemotion.com/products/.

I use the eMotion BASIC™ application to configure and verify the initial calibration and the ongoing data transmission between the eMotion™ Wireless Sensor System and the laptop. The eMotion basic application interface is shown in Figure 48, where the USB serial device is selected from the drag-down menu. The On/Off button can be toggled on and off to initiate the pairing process. Port and IP addresses are required to establish a connection. Once the Twist and Accelerate modules are found, calibration of the modules can occur.

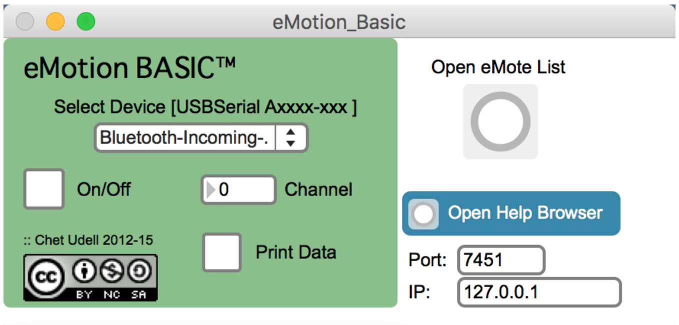


Figure 48. eMotion BASIC™ application interface

Data sent to the base station is observable in Max. Being able to view this data is helpful, both before a performance to verify connectivity between all instrumental components, and during the performance to observe moment to moment data flow. Each time before the performance, both the Twist and the Accelerate require calibration. The ideal calibration requires both modules to be placed on a flat surface parallel to the earth. The data produced by both modules typically vary over time because the sensors themselves produce a random jitter in the data streams they output. This data jitter is not inherently problematic if it occurs exclusively within an expected range; however, these random variations become quite a challenge to deal with if the random variation causes the expected range of the data's value to expand or contract. Such expansions and contractions of the data stream's range makes the scaling of the data difficult. Within

Max, I created a "data range set" and "smooth" algorithm to further condition data before it is mapped to musical parameters in Kyma. Scaling and the data jitter reduction were two procedures that were important details in maintaining the consistency of the eMotion's control signals.

The process and algorithm is shown in Figure 49. In this algorithm, data can be observed in realtime once the connection between devices is established. Only after this connection is established, can the Twist and Accelerate be synchronize and calibrated. The operator (the musical performer) then can define the data range of the TwistX, TwistY, TwistZ, AccelX, AccelY, and AccelZ values and scale it to the 0 to 1 range, the desired range of most parameters within Kyma. I also use a smooth algorithm in Max to interpolate between each data every 20 milliseconds. After I apply arithmetic to offset the data upwards or downwards, each data stream is labeled with a new name and sent as OSC messages to Kyma. To send OSC messages from Max to Kyma I use KymaConnect (see above for more complete description of KymaConnect).

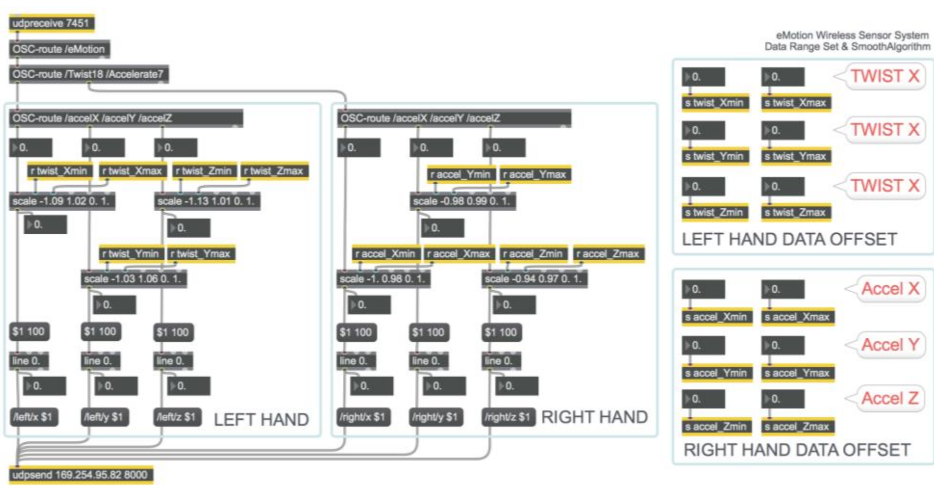


Figure 49. Data range setting and smoothing algorithm for *Flowing Sleeves*

The costume, while not literally part of the data-driven instrument, is an important component in this composition. Because the Twist and Accelerate modules are each small enough to be held by a single hand, underneath the lengthy sleeves, they become almost invisible. This invisibility narrative can be very well interpreted since sleeves are considered as an implicit and artful indication of the arms in the costume design within the Chinese theater tradition. The eMotion Twist and Accelerate modules can be seen in performance in Figure 50. The two frames at the beginning of the performance show how the Twist and Accelerate are picked up and hidden in the sleeves.

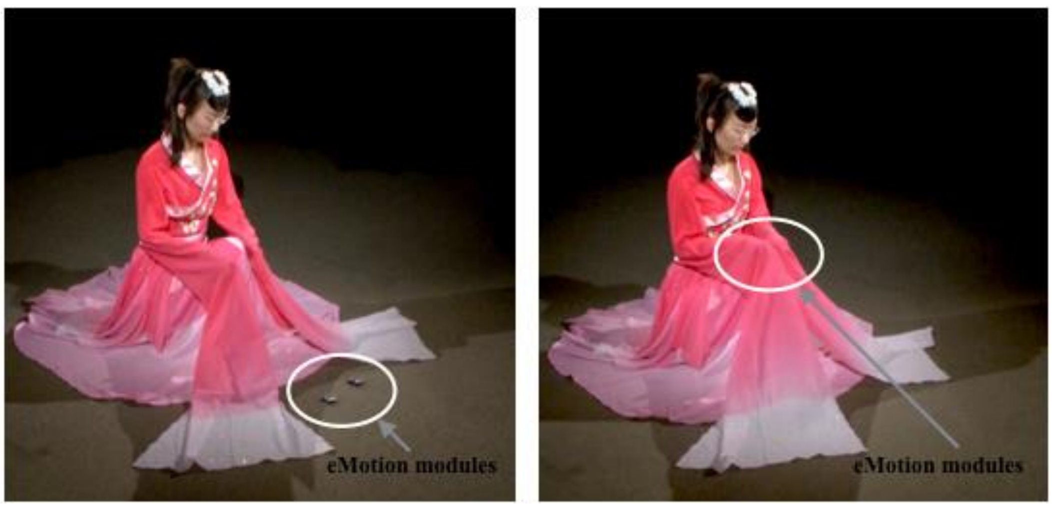


Figure 50. Twist and Accelerate hidden in sleeves

Musical Challenges and Opportunities

In *Flowing Sleeves* expressions described in the original Pusa Man (菩萨蛮) text are brought into the composition in abstract form through different choreographed physical movements. Because I committed to using a special costume for the composition, I needed to bring into association multiple sonic, visual, and performative elements that included (1) the costume that is a Chinese cultural signifier, (2) the choreographed physical motion related to the text, but not related to the actuating and control of the music, (3) the performative action that actually caused musical events to occur, and (4) the sonic material I selected to be part of the musical fabric. This means the single major challenge of the composition related how to respond to such questions like "How do I make the performative actions required to produce the desired sounds also move and "operate" the costume in a beautiful and also culturally meaningful way?" Or, "What is an effective balance between choreographic non-musical motion and non-choregraphic performative actions?" Or, "How can I assure that I don't generate unintended performance data when I am executing non-musical physical motion?" In the next section I describe several of my responses to this fairly complex, multi-level challenge.

Performance Techniques Employed using the eMotion System

While the eMotion system enables the performance by facilitating data transfer, the most influential element guiding the actual performance technique is my attempt to bring into association the metaphorical aspects of the complete visual dimension with the musical fabric. Some of the physical movements including "throw," "shake," "hold," "wave," and "turn around," for instance, indicate the expression of certain emotions in Chinese culture. In *Flowing Sleeves*, I chose to use the physical movements "throw," "flip" and "wave" as body movements that connected sound, performative actions, choreographic beauty, and cultural metaphor. To execute those body movements, I coordinated the holding positions of the Twist and Accelerate modules to ensure smooth translation of data acquirement from the performance movements. In this composition, sometimes the physical action "throw" triggers a singing phrase, while sometimes the physical action "flip" triggers a rhythmic pattern sounded by a synthesized drum. I also use the choreographed "turn around" action to scrub through the *TimeIndex* parameter of the singing of a song – perhaps sung by a maiden with flowing sleeves.

Because my costume is not part of typical daily dress in Chinese modern society, the connection between music and performance needs to be established during the realization of this composition. To highlight the sleeves performative actions, during performance, my facial expression is controlled, with my focus directed towards my sleeves in an effort to project better my musical expression. Figure 51 captures one moment during the performance with my focus directed towards my hand that is producing control data.

Figure 51. One performance movement technique

Compositional Structure

Flowing Sleeves can be divided into five sections of unequal duration.

0:40-2:33 The first section begins with me picking up the pre-positioned Twist with my left hand and the Accelerate with my right hand. Both hands hold the devices relatively level, turned counterclockwise about 130 degrees. The musical culmination of this section is accompanied by my status of posture, standing up with my visual focus directed downward.

2:33-5:04 The second section is where sonic texture slowly develops through several repetitions of the same sung phrase with the pitch content of D, Eb, and F being emphasized. This sung phrase is transposed to a different pitch level each time I "throw" one of my sleeves to trigger musical events. These performative actions ultimately lead to the formation of a polyphonic texture that is further expanded with the inclusion of bells, granular particles, and filtered noises.

5:04-6:17 This third section is fast and rhythmic, where a variety of metric patterns are created each time I "flip" my sleeves. Simultaneously, a sharp metallic sonic texture is created by my right hand as I gradually turn clockwise and attain greater heights, reaching the musical culmination (at 6:17 in the documentation video).

6:17-6:57 This brief fourth section musically contrasts the previous section primarily using resynthesized singing to metaphorically depict the inner emotional experiences of the women described in the Pusa Man text.

6:57-7:59 The last section of this composition is the only portion of the work that uses the spoken human voice, resynthesized and performatively controlled in realtime. In this section, I accompany the sonic world that I have created, slowly exiting the stage while gently waving the costume's sleeves. This section corresponds with the narrative of the poem depicting the completion of the preparation of the dressing ritual.

Sonic Materials and Data Mapping Strategies

The sonic materials that form the basis for the composition include the sounds of a female voice, a large plastic bottle being struck, bells, the rubbing of a rim of a glass, and the striking of a large metal cabinet shelf. These sounds were largely selected based purely on how I needed to provide a diversity of musical resources. For instance, sounds that articulated rhythm clearly were required; sounds that produced sustained tones were required; and sounds that could be pitched high and low were required. On the other hand, tremendous weight was given to extra-musical aspects of this piece. For instance, the female voice provided timbral makeup that related directly to the extra-musical focus of the composition: women; the bells related to the ritual of the composition; and the large metal cabinet provided grandness of sound that offered accentuation when moments of the musical spectacular were required.

Data mapping in the composition rested extensively on the concept of breaching thresholds to trigger an event or series or events. The "throw," and "flip," performance techniques developed in this composition has special significance in both producing data and symbolic cultural references. Both of the two performative actions can produce sudden changes in data in all the data streams I chose to acquire. For example, the drum pattern changes are initiated by the "flip" of the sleeves that can be sequentially selected from fourteen pre-composed rhythmic patterns. The selection of one of the fourteen rhythmic patterns occurs when the control data (caused by the execution "flip" of a sleeve) exceeds a value of 0.8 or is less than 0.2. If either one of the conditions are met, a trigger message is created causing the rhythmic pattern to proceed to the next preset. An example of the Capytalk code that used in this, and instances like this, is:

```
!osc_right_z
```

Figure 52 shows the signal flow graph of the drum sound design and the two "SoundToGlobalController"[51] Sound objects parameter fields settings. Sounds are triggered, filtered, spatially distributed and replicated at various moments of the work.

[51] A SoundToGlobalController Sound object can receive a number, a pasted Sound, or an Event expression as its input and generate a corresponding EventValue (changeable in realtime).

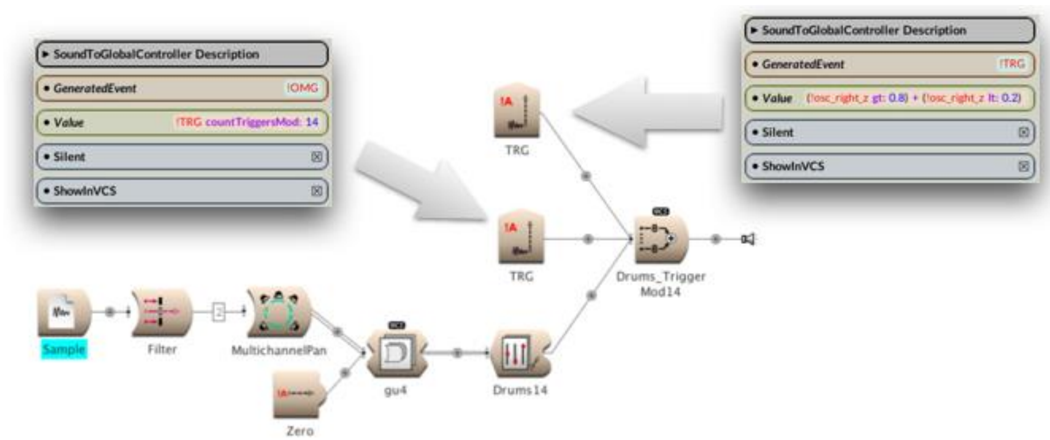


Figure 52. Drum sound design algorithm signal flow graph and data mapping

Figure 53 shows how the "throw" performative actions (contained in the second section of the video document) are converted into !PenDown messages and used to control sound-producing algorithms in Kyma. The resynthesized sound is produced through the SumOfSines prototype. A !PenDown message is created when the TwistX and TwistY data both meet specified conditions. After each sound is triggered subtle changes of pitch and duration can additionally be accomplished.

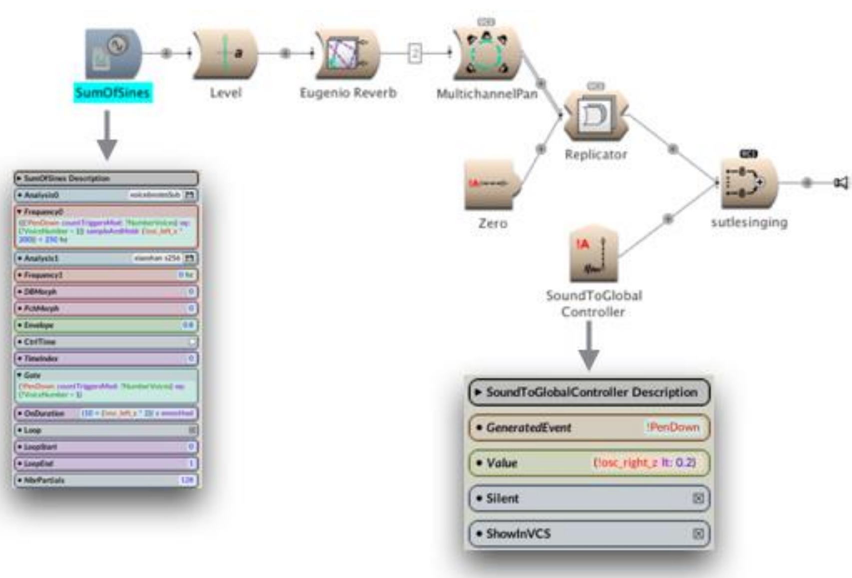


Figure 53. "!PenDown" message and !osc_left_x message controlled algorithm

PEONY GARDEN

Overview

Peony Garden is a real-time interactive composition of approximately twelve minutes for four suspended Nintendo Wii Remote controllers (Wiimote for short), OSCulator, custom software created in Max, and Kyma. *Peony Garden* is inspired by the Chinese traditional Kunqu Opera *The Peony Pavilion* by Tang Xianzu, the greatest poet playwright of the Ming dynasty. In *Peony Garden,* I attempt to create a data-driven musical adaptation of the masterpiece of traditional Chinese Kunqu opera, *Peony Pavilion*, with aspects of textual and poetic narrative, period instruments, and love and death dramatics.

Peony Pavilion Kunqu opera reveals romantic yearnings and afflictions of love endured by the young in the feudalistic society of China. Its central theme proclaims the significance of an ultimate triumph of "love" over "reason"—love conquers all. This avant-garde subject for its time, which is an attempt against the suppressive tradition, together with the moving poetics of the language, makes the poet's endorsement of freedom of love between the two young protagonists a lasting force in the history of Chinese literature and theater. In its original written form, the drama consists of fifty-five scenes that would have been performed over several days. Because the complete performance is difficult to realize as a sequence, and some sections are better received over time, the structure of the whole opera is organized in acts – one act or one scene is called one "zhe" or one "chu"[52], and any subset of the whole sequence can be selected and performed. In *Peony Garden*, I used the idea of "zhe" as my compositional unit, and

[52] *Zhezi xi* is a one-act or one-scene performance of a play that originally included multiple acts.

I compressed the entire plot into two compositional versions – one twenty minute and one twelve minute, both of which are comprised of four sections. For my dissertation, I use the twelve-minute version and provide analysis and description about the work. In my composition, I focus on the love story between Du Liniang and Liu Mengmei. In the original plot, Liniang, the daughter of a high official, falls asleep in the Peony Pavilion while enjoying a beautiful spring day in her family's garden. She dreams of a romantic encounter in the garden with a promising young scholar, Liu Mengmei, whom she had never met in real life. So devoted is she to her "dream" lover that she painted a painting of herself before she passes away. This portrait of herself, is concealed by the pavilion near her grave beneath a plum tree. Later, Liu Mengmei, on his way to the capital to take the imperial civil service examination spends a night in the garden. There, he discovers the portrait and falls in love with Du Liniang. Recognizing that Du and Liu are fated to be wed, the Lord of the underworld, restores Du Liniang to life. Trusting in each other's love, the lovers are united. The two scenes I chose as my inspiration are *A Dismal View* (游园) and *A Surprising Dream* (惊梦).[53] Du Liniang, accompanied by her maidservant, enters the garden for the first time in her life. The spring flowers are in full bloom. The young lady is struck by the beauty of nature and suddenly feels the joys, as well as the pains, of life. Tired from the stroll in the garden, Liniang falls asleep in her chamber and dreams that she returns to the garden, encounters a young man under a plum tree, and has an intimate moment with him. Du Liniang's dream is ultimately interrupted by a flower petal falling on her.

[53] There are total of fifty-five scenes in the original *Peony Pavilion*. For my composition I selected two scenes, scene five and ten. The title of the scenes *A Dismal View* and *A Surprising Dream* were translated by Zhang Guangqian.

Design and Implementation of the Data-driven Instrument used in *Peony Garden*

In *Peony Garden*, four Wiimote controllers are attached to a suspended wooden curtain rod through retractable keychains. This wooden curtain rod is suspended on two microphone stands at a height of approximately 6.6 feet (2 meters) and is held in place by two microphone clips attached to the tops of the microphone stands. Figure 54 shows the components comprising the performance interface for *Peony Garden.*

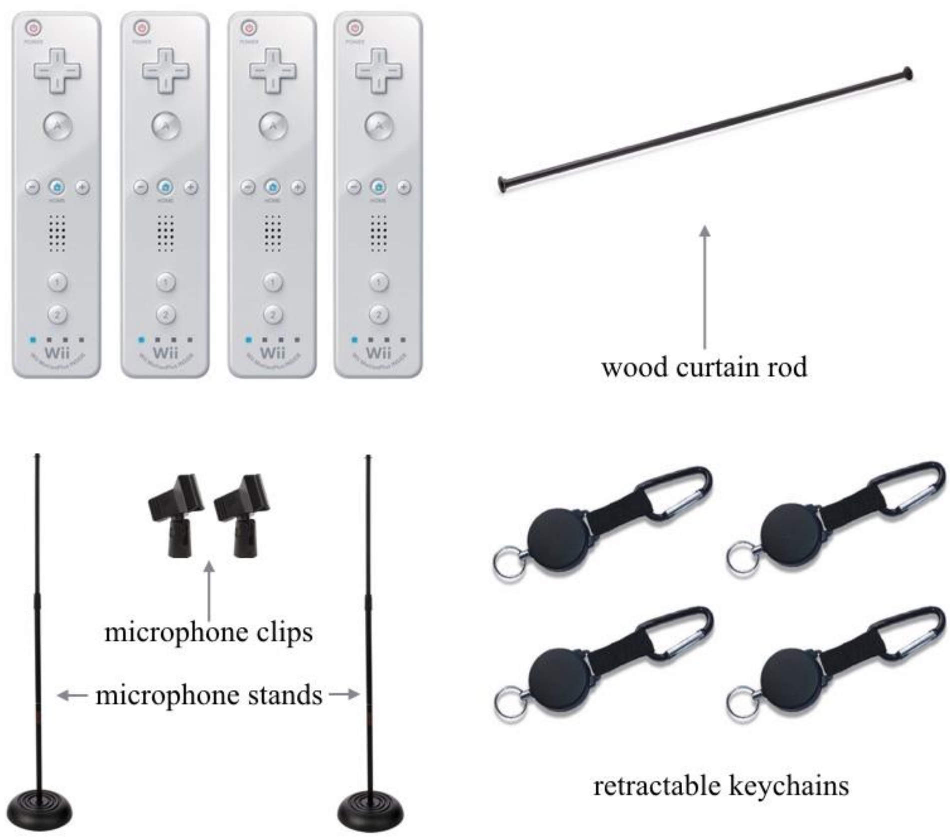


Figure 54. Components of performance interface for *Peony Garden*

Figure 55 shows the complete assembled interface in a performance context. As an important aside, I should note that the entire performance interface for *Peony Garden* is based on repurposing of existing articles: keychains no longer hold keys, the curtain rod does not elevate a curtain, microphone stands and clips do not hold or position mics, and Wiis are transformed from game controllers into elements of aesthetic and musical control.

Figure 55. Performance interface setup for *Peony Garden*

The physical positions of the four suspended Wiimote controllers were inspired by Bianzhong – an ancient Chinese musical instrument consisting of a set of bronze bells. These sets of bells were used as polyphonic musical instruments and were usually hung in a wooden frame and struck with a mallet. During the time of the establishment of Kunqu Opera practice, the Bianzhong was newly added to the ensemble of Kunqu Opera. The four suspended Wiimote controllers abstractly represent the Bianzhong within the data-driven instrumental form and serve as a front-end for data generation and control, starting and stopping individual musical events, progressing from section to section, and providing on-going control of musical parameters. My repurposing of Wiimote controllers in a form where they are suspended in a fashion similar to the bells of a Bianzhong creates a modern instrumental analog where ceremonial meanings of the Bianzhong are mapped onto the cultural meaning of a game controller and vice versa.

The data sources used to construct the narratives are acquired through the four suspended Wiimote controllers through OSCulator using a Bluetooth connection. Each Wiimote controller is connected to OSCulator through a unique address. OSCulator reports the Wiimote controllers' data by categorizing data into different message types, including *pitch*, *roll*, *yaw*, *accel*, and buttons with number and letter identifications. The acquired data then is routed to Max through 7-bit MIDI continuous controllers on MIDI channel 1. In Max, data is received as assigned continuous controller values (between continuous controller numbers 1-8, 11-18, 21-28, and 31-38). Some data is best described as data streams while other data may better be described as data packets. Based on these differences, different data-mapping strategies are applied – with data streams providing ongoing control and data packets functioning well as initiators of discrete events. Max modifies data then routes it to Kyma's sound-producing algorithm through the middleware agent KymaConnect as MIDI continuous controller values. The data flow is depicted in Figure 56.

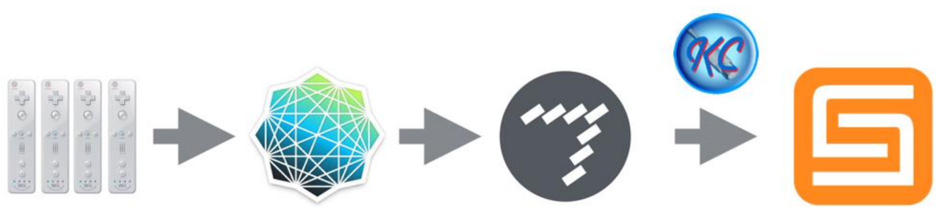
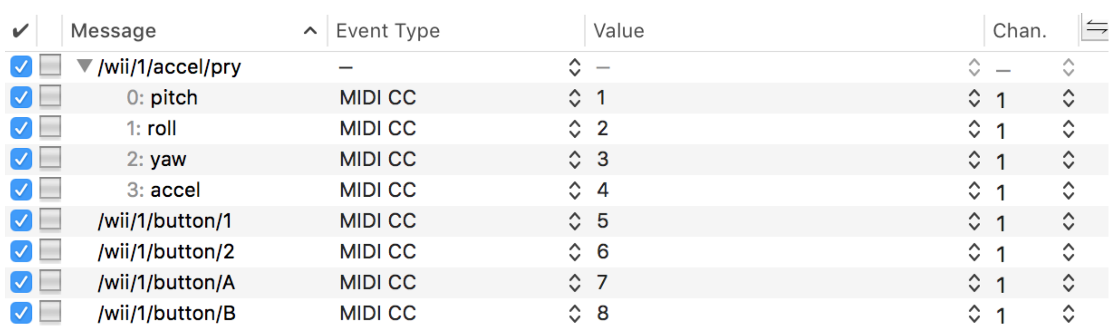


Figure 56. Basic data flow diagram for *Peony Garden*

Musical Challenges and Opportunities

Understanding the unique data signatures exhibited by the four suspended Wiimote controllers was crucial in making decisions about how data would be mapped and routed as well as how performance techniques would be developed. The setup and data routing for all four Wiimote controllers are identical, however, the data that is output from each Wiimote is not identical due to two factors. First, Wiimotes are inexpensive devices so some variation between Wiimotes was predictably expected. Second, the precise angle at which each of the Wiimotes is suspended varies slightly, thus causing variation in their orientations. In the performance technique that I developed to play the work, I found that I had to compensate for these variations.

Once the data is produced by the Wiimotes it is assigned to a MIDI channel, converted to MIDI continuous controller values by the middleware software OSCulator, and then sent to Max. OSCulator is middleware software that facilitates the movement of data between and among software environments and physical interfaces. While OSCulator can be used for data scaling and related matters, I more overtly use it to change one data type to another. One Wiimote's data routing and conversion scheme executed in *Peony Garden* by OSCulator is shown in Figure 57.



✔	Message	Event Type	Value	Chan.
✔	/wii/1/accel/pry	–	–	–
✔	0: pitch	MIDI CC	1	1
✔	1: roll	MIDI CC	2	1
✔	2: yaw	MIDI CC	3	1
✔	3: accel	MIDI CC	4	1
✔	/wii/1/button/1	MIDI CC	5	1
✔	/wii/1/button/2	MIDI CC	6	1
✔	/wii/1/button/A	MIDI CC	7	1
✔	/wii/1/button/B	MIDI CC	8	1

Figure 57. Conversion and routing scheme used in OSCulator

Data coming from the Wii was conceptually categorized and reported using the Cartesian coordinate system being associated with *yaw*, *pitch*, and *roll*, respectively. Positions of the device associated with acquiring X, Y, and Z and *yaw*, *pitch*, and *roll* are depicted in Figure 58.[54]

[54] "Wiimote FAQ," OSCulator; accessed March, 3, 2017, https://osculator.net/doc/faq:wiimote.

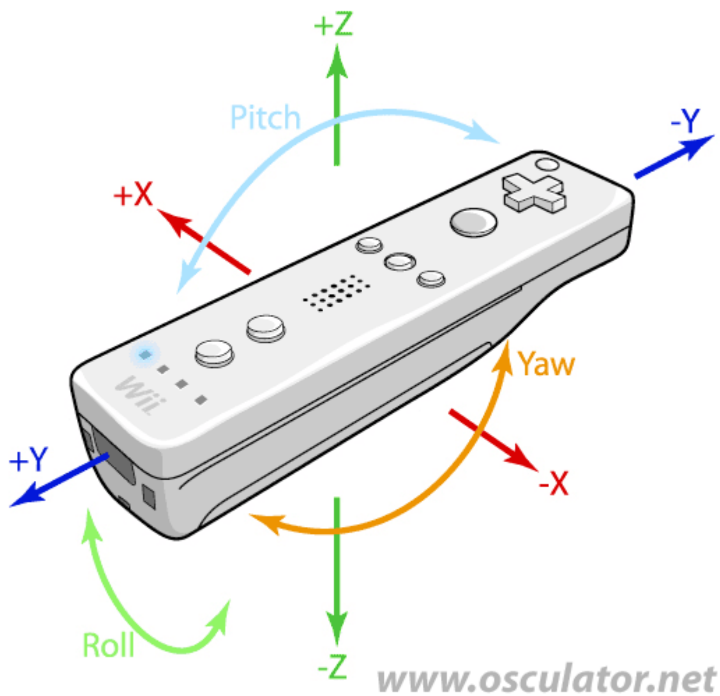


Figure 58. Wiimote X, Y, and Z and *pitch*, *yaw*, *roll* orientation

To best understand the characteristics of the data from the four Wiimotes I wrote their data into Max “table” objects to visualize and study. Viewing this data and its micro-variations was helpful in understanding the characteristics of the data output by the Wiimotes and influenced how I would apply the data output from the Wiimotes to musical parameters. The visualization of the data within a specified timespan helped me to understand how data was produced, the data’s history, the moment to moment changes, and the interconnection of one control stream with other control streams. Being able to visualize this data influenced how I would ultimately think about each of these unique data sets and how I might performatively apply these data streams. The size of the “table” in Max was set to be 500 (X-axis). This corresponded to data points distributed over time. The value range was set to accommodate a range of 0-127 (Y-axis) to correspond with the typical MIDI continuous controller range. The visualized data is slightly modified from original Wiimote controller data by an algorithm that smooths the data. Figure 59 shows one test when four Wiimote controllers are hung on the rod without any external forces, other than gravity, applied to them.

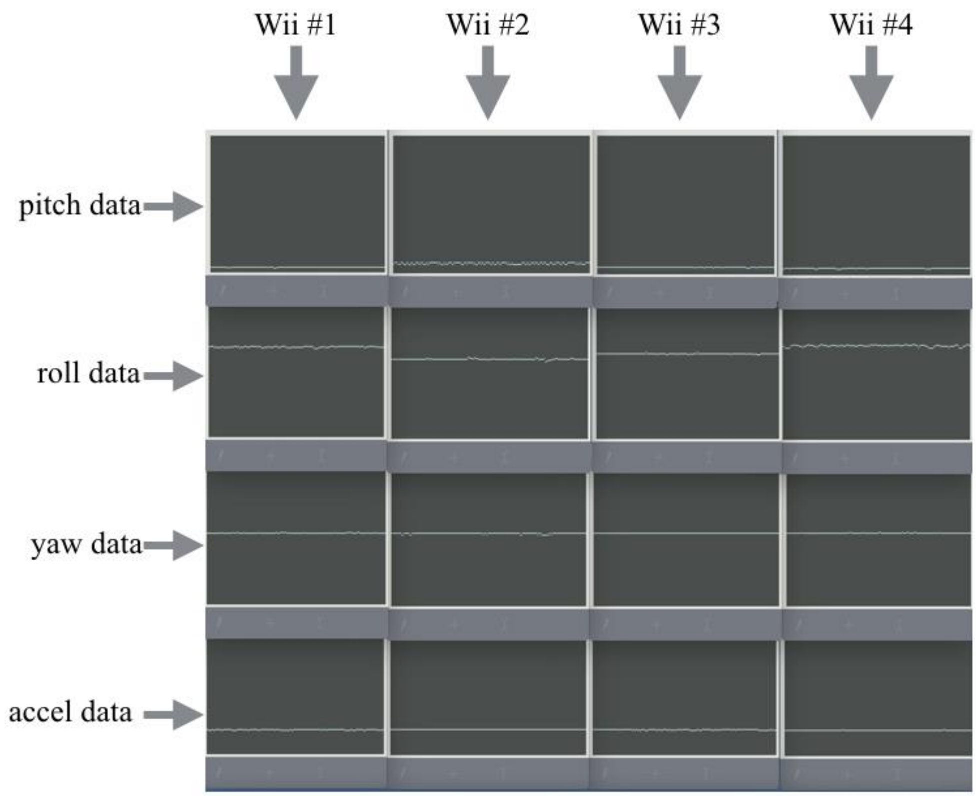


Figure 59. Sample data screenshot of four suspended Wiimotes in *Peony Garden*

This type of analysis led me to observe that the data deviation of *roll* is rather large as compared to the deviation of *pitch*, *yaw*, and *accel* data. I also noted that *pitch* data had the largest expansion of its range from its place of rest. This second observation led me to use the *pitch* data streams with all four Wiimote as the primary control at the beginning of the piece. Together with the choice of sparse percussive sonic material I seek to represent the narrative of nature's reviving power that breaks the winter's silence.

Another effective way of initiating a sound is through buttons provided by Wiimote controllers. However, in music composition, individual sonic events are always connected with other sonic events, resulting in a complex web of intertwined organized sounds. Therefore, a button can never be considered without its context. In *Peony Garden*, I bring buttons that trigger events into association with other continuous controllers. For example, a button can be triggered to initiate a sound when *pitch* is continuously controlling the sound that lead up to the sonic event or the result of the special sound event triggered by the button. This performative actions sequence can be influenced from watching data streams and even more importantly – through sound design that has controllable options.

A final and more complex challenge that I will note within this document relates to the management of the simultaneous and accurate control of multiple Wiimote devices. In a gaming context, only one Wiimote device at a time is normally operated. When operating more than one controller the coordination of data streams that provide ongoing control becomes a challenge for memorization. In addition, I found that the operation of multiple Wiimotes directly related to performance techniques I developed for this composition and influenced the non-performative chorographic design of the movement.

Performance Techniques Employed using Suspended Wiimotes

Imitation and contrast are two very important ideas I use in performing my array of Wiimote controllers, providing opportunities to create layers of expressions that are visually and sonically in counterpoint with each other. There are, however, a number of ways that I specifically engage the four suspended Wiimote controllers during the performance of *Peony Garden*. Generally speaking, the three grouping options for the four controllers can be understood as consisting of left and right, inner and outer, or every other. In *Peony Garden,* I have employed each of these possibilities and their permutations to perform the work.

Compositional Structure

Peony Garden has four sections, with the first section depicting the narrative of nature, the second section focusing on the transition of reality to the dream world of the poetic persona, the third section capturing the desirous pledge between Du Liniang and Liu Mengmei; and the fourth section returning back to reality where Du Liniang believes the dream is real and commits to waiting for Liu Mengmei.

My composition has clear scenes and each scene can be performed separately without interrupting the continuity of the composition. For simplicity and clarity, I refer to the times as they occur in the video performance of *Peony Garden* that is contained in the dissertation.

0:33-4:01 The first section attempts to text paint the spring's arrival in a beautiful garden using percussive sounds. The musical texture progresses from individual percussive sounds to a dense sonic texture. This initial section begins with an antiphonal style of organization and reaches its climax when three Wiimote controllers are being operated at the end of this section.

4:01-7:02 The second section also rest on a musical depiction Du Liniang's first view of the garden, her excitement of walking through the garden in spring, and her emotional exchange with her maid, Chunxiang. This section focuses on the vocal transformations placed in contrast to sharp percussion sounds, but also includes as contrasting material symphonic musical textures.

7:02-10:27 The third section strives to mimic Du Liniang's inner emotional turbulence, from excitement to longing, from inspiring to anxious searching. The original play describes Liniang's cause of death as longing for love – a traditional "waiting" weak ending of life. I actively interpreted this scene from Liniang's point of view where she fights to express her thinking using the most powerful expressive representation available to her – *nian bai* (念白).[55] The musical fabric of this section is dominated by rapid percussive sounds with the vocal sounds receding into the background.

10:27-11:30 The duration of the fourth section is variable and can be made to be quite short or extremely long. This section depicts Du Liniang's spirit that accompanied her beloved, Liu Mengmei, who conquered the life/death barrier and return from the dead. Each Wiimote controller has the capability to control granulated bell sounds, chorused vocal sounds, a rhythmic pulse, and rhythmicized unpitched percussive sounds. In the short version, this section serves as the coda of the composition without a full development of the musical material.

Sonic Materials and Data Mapping Strategies

In *Peony Garden*, I used pre-recorded voice and percussion instruments that are presented as modified versions or as analyzed and resynthesized transformations of the original sounds to depict the transformations of the characters contained in the narrative. The primary sound materials are Chinese percussion instruments (naobo, drum, bell, gong, and shenbo) and Kunqu operatic voices (a female voice singing long melismatic lines). The sonic materials are presented in various ways over the course of the piece. The percussive sound materials are presented in different transpositions, rhythmic patterns, and combinations. The vocal materials are analyzed, resynthesized, harmonized, granulated, randomized, and re-imagined in time.

[55] Nian bai refers to recitative narration in Chinese opera.

There are three fundamental data mapping methodologies that I use in *Peony Garden*. The first of these involves the use of buttons on each of the Wiimotes. Buttons A and B are used for control to start and stop individual sound events. Most of the percussion sounds of the piece are triggered using one of the four pairs of A and B buttons. The A and B buttons are also mapped to be able to start formal sections or to activate a sound-producing or sound-processing algorithm. Button functionality is also achieved by breaching a defined threshold using a continuous controller. Such a technique transforms a fader-like control into a button-type control. An example of this technique is found at the beginning of the composition where I use continuous controller 17 in Kyma to exceed a value of 0.9. The specific Capytalk used is:

!cc17 gt: 0.9

A second data mapping strategy that I use involves the application of continuous controller data to provide ongoing control. The principal controls that I use are the Wii's *pitch*, *roll*, and *yaw* data streams. These data streams are converted to MIDI continuous control messages via OSCulator and then passed to Kyma to control different musical parameters including *Frequency*, *GrainDur*, *Reverb*, and *TimeIndex*.

Sometimes the Wii's buttons and fader-like functionality work in tandem to achieve multi-conditional control. In several instances, continuous control output is functional only when a button is pressed. Because the Wii's *pitch*, *roll*, and *yaw* data streams are, in essence, flowing all the time, being able to turn on and off a particular control stream of messages is vital.

QIN

Overview

Qin is a real-time interactive composition of approximately eight minutes in duration for two custom-made performance interfaces, custom software created in Max, and Kyma. Qin (琴) is a special symbol in Chinese culture and literature that is associated with delicacy, elegance, confidence, power, eloquence, and longing for communication. The symbol Qin appears in literature as early as the time that the *Book of Songs* was collected.[56] Qin is also a Chinese instrument. Qin[57] has been played since ancient times, and has traditionally been favored by scholars and appeared in literature as an instrument associated with the ancient Chinese philosopher Confucius. In my composition *Qin*, I took as inspiration the shape of the original Qin instrument and mapped some of the traditional functions on to my custom-made performance interface, replacing the traditional Qin performance techniques with newly developed techniques that draw the desired data from the controllers. This performance data is created by sampling output of analog sensors, transforming this raw sensor data into MIDI data, and routing this MIDI data through a USB connection to a computer. This control data is routed to Max and Kyma where it is modified to control musical parameters in realtime. The sonic materials for the composition are drawn from recordings of different performance techniques playing the Chinese traditional instrument, the Guzheng (古筝), which is an instrumental descendent of the Guqin. Plucking, sliding fingers along strings, and tapping the body of the instrument are part of the repertoire of sounds from which I selected my source

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[56] *Lu Ming*, one poem from the *Book of Songs* dates from between the 11th to 7th centuries BC.

[57] The ancient Qin is called Guqin in modern times.

material. To augment this family of sounds, I also recorded Chinese cymbals and bamboo flutes as secondary sonic material. Through the application of a variety of sound synthesis techniques, the concept of a data-driven Guqin is invented. For listeners, both inside or outside of the Chinese culture, these sounds might function as kinds of cultural signifiers evoking extra-musical significance.

Background Information about Guqin, the Inspiration Instrument

The Guqin is one of the oldest Chinese instruments and an important Chinese cultural symbol. The ancient Guqin originally had five strings. The instrument was played by plucking or sliding the fingers along the strings. The Guqin is one of the oldest types of Qin instruments having many different styles and shapes. Figure 60 shows one type of Guqin – 灵峰神韵.[58]

Figure 60. Guqin front and back

The performance practice for ancient the Guqin instrument has always been regarded as possessing a wide range of musical expressivity. The Guqin is capable of realizing both monophonic and polyphonic textures as well as melodic effects such as vibrato, tremolo, and other musical expressions. The physical construction and design of the instrument evolved over different periods of Chinese history. The Guqin originally had five strings, representing the five elements of metal, wood, water, fire, and earth. The

[58] Charlie Huang. "Guqin." Wikipedia, Wikimedia Foundation, 21 Feb. 2018, en.wikipedia.org/wiki/Guqin.

surface board of the instrument represents “heaven” and the bottom board represents “earth.” with the dimensions of the instrument’s sides being three *chi* (尺), six *cun* (寸) and five *fen* (分), representing 365 days of the year. The entire instrumental body of the traditional Guqin represents the “dragon.” The different parts of the instrument can be seen in Figure 61.[59]

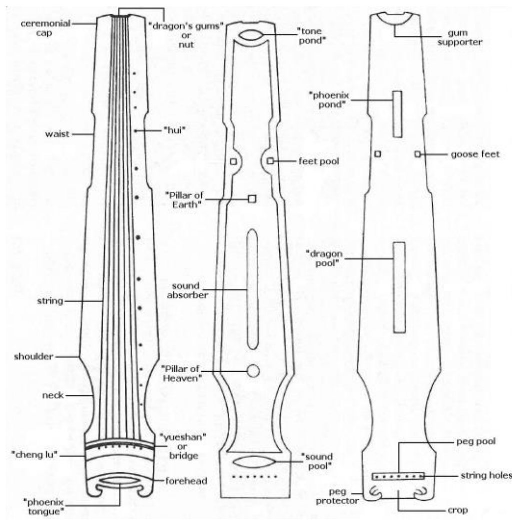

Figure 61. Guqin three parts

Literary descriptions about the traditional Guqin regarding its performance techniques and design and construction come from sources in multiple Chinese dynasties. Additionally, paintings have survived that visually depict its appearance and how it fits into social and cultural contexts. According to the book *Cunjian Guqin Zhifa Puzi Jilan,*[60] one of the most popular instruction manuals during the time it was written, there are around 1070 different finger techniques used in playing the Guqin. Presently, most of Guqin’s performance techniques are considered to be obsolete, however, there are still

[59] Ibid.

[60] Fuxi Zha *Cunjian Guqin Zhifa Puzi Jilan* (Beijing: People’s Music Publisher), 1958.

three categories of sound production that can be considered useful: *san yin*, *fan yin* and *an yin*. *San yin* (散音) literally means “scattered sound,” and relates to the production of fundamental frequencies that are produced by plucking an open string. *Fan yin* (泛音) is a technique that relates to the plucking of a string with the right hand and the gentle tapping a specific note positions on the string with the left hand to produce overtones. *An yin* (按音) is a technique that relates to the pressing of a string of a specific pitch on the surface board with a thumb, middle or ring finger of the left hand, then the striking of the string with the right hand to create a sound effect similar to modern “pitch bend” technique. Each finger is said to have different performance techniques for interacting with the strings. Figure 62 shows thumb (*Pi*), index finger (*Tiao*), middle finger (*Gou*), and ring finger (*Bo*) performance techniques.[61] For each finger, a technical description is provided including how energy should be used, applied, and distributed. Additional information is provided about appropriate performance posture. I used this body of information as a non-literal, inspirational guide when I was developing my performance techniques for my composition *Qin*.

The poetic analogy of each performance technique is described in Guqin notation books. Figure 63 shows two examples of this notation, *Pi* and *Tiao* performance techniques, taken from the book *Qinxue Rumen*.[62] In this metaphor, hands symbolically become the crane, which through its movements is a favored animal symbol associated with special artistic conceptions.

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[61] He Zhang, *Qinxue Rumen*, volume 1, leaves 39, 40, 43 and 47, 1864.

[62] Ibid.

Pi (劈)

Tiao (挑)

Gou (勾)

Bo (拨)

Figure 62. Guqin performance techniques examples

poetic analogy of Gou (勾)

poetic analogy of Tiao (挑)

Figure 63. Guqin performance techniques metaphor

Design and Implementation of the Data-driven Instrument used in *Qin*

My most challenging design issue in moving the Qin interface from conception to realization was to bring the essence and original musical expression of the Guqin to recent technology. My custom-made, sensor-based performance interface seeks to mimic elements of the ancient instrument Guqin using two slide controlled potentiometers (Softpots) and a single infrared proximity sensor. The two slide potentiometers are installed on the top of a clear acrylic case that is 12” x 3” x 2.5”. All electronics are contained in the case with a point of connectivity provided through USB cabling installed at the opposite end of the infrared sensor. Four rubber feet hold the interface in place on a table-top surface completing the device. The clear acrylic box and feet are shown in Figure 64.

Figure 64. Qin interface case and legs

The microprocessor used to initially acquire the analog data of three sensors is the Arduino Pro Microchip. Arduino is an open-source computer hardware and software company that designs and manufactures single-board microcontrollers.[63] The boards are equipped with sets of digital and analog input and output pins that may be connected to other expansion boards and circuits. The Arduino Pro Microchip shown in Figure 65 provides four analog inputs and is compatible with the Arduino MIDI USB library. The Arduino MIDI USB library allows data to be encoded in MIDI protocol, largely simplifying the process of communication between performance interface and computer.

[63] A more comprehensive description of the Arduino technology can be found at “What is Arduino?” Arduino; accessed February 10, 2018, https://www.arduino.cc/en/Guide/Introduction.

Figure 65. Arduino Pro Micro

The SoftPots I used in my interface are linear position potentiometer sensors manufactured by Spectra Symbol (part number: SP-L-0200-103). The Softpot membrane potentiometer is a resistive element, which is comprised of a conductive resistor, a sealed encasement, and a simple wiper assembly. A membrane potentiometer can also function as a voltage divider. The SoftPot is a three-wire system with two resistive output channels and an electrical collector channel.[64] The infrared proximity sensor I used, manufactured by Sharp (part number: GP2Y0A41SK0F),[65] has an analog output that varies from 3.1v at 4 cm to 0.3v at 30 cm with a supply voltage between 4.5 and 5.5 VDC. Both the Sharp infrared sensor and Spectra Symbol SoftPot linear potentiometer sensors are shown in Figure 66.

Figure 66. IR Proximity sensor and SoftPot Linear Potentiometer sensors

[64] Spectra Symbol's SoftPot data sheet; accessed May 1, 2018, http://www.spectrasymbol.com/wp-content/uploads/2016/12/SOFTPOT-DATA-SHEET-Rev-F3.pdf

[65] Sharp's Distance Measuring Sensor Unit data sheet; accessed May 1, 2018, http://www.sharp-world.com/products/device/lineup/data/pdf/datasheet/gp2y0a21yk_e.pdf

The sensors are connected to the Arduino Pro Microchips via jumper wires and soldered on to a copper shielded micro breadboard. Finally, the three sensors are connected to the computer via a USB connection. Figure 67 shows the breadboard schematics made using Fritzing[66] and circuit schematics designed using CAD[67].

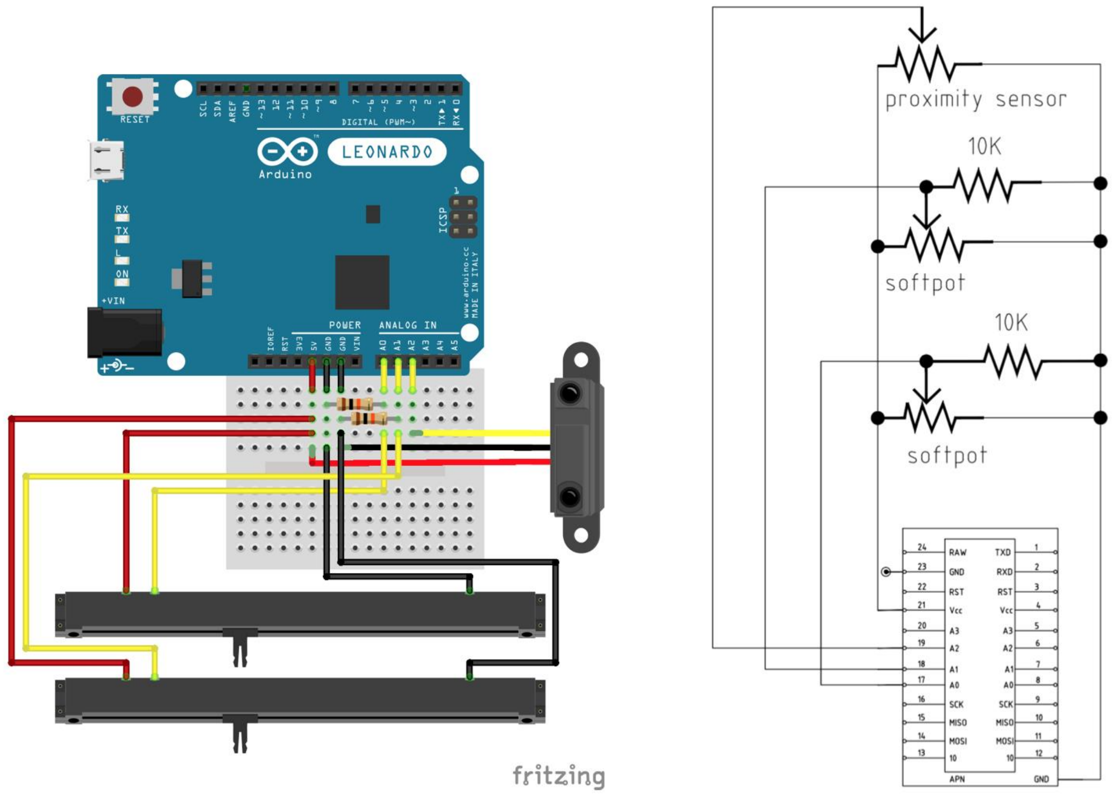

Figure 67. Breadboard schematics designed using Fritzing (left) and circuit schematics designed using CAD (right)

I produced two versions of the Qin interface, both of which are shown in Figure 68. Both versions provide three streams of 10-bit MIDI continuous controllers values.

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[66] Fritzing is “an open-source hardware initiative that makes electronics accessible as a creative material for anyone.” Additional information is available at http://fritzing.org/home/; accessed March 22, 2018.

[67] CAD stands for Computer Aided Design. CAD is the use of computer system to aid in the creation, modification, analysis, or optimization of a design; accessed March 1, 2018, https://en.wikipedia.org/wiki/Computer-aided_design.

Data streams are stable and smooth. The major difference between the two versions is the length of the SoftPot sensors.

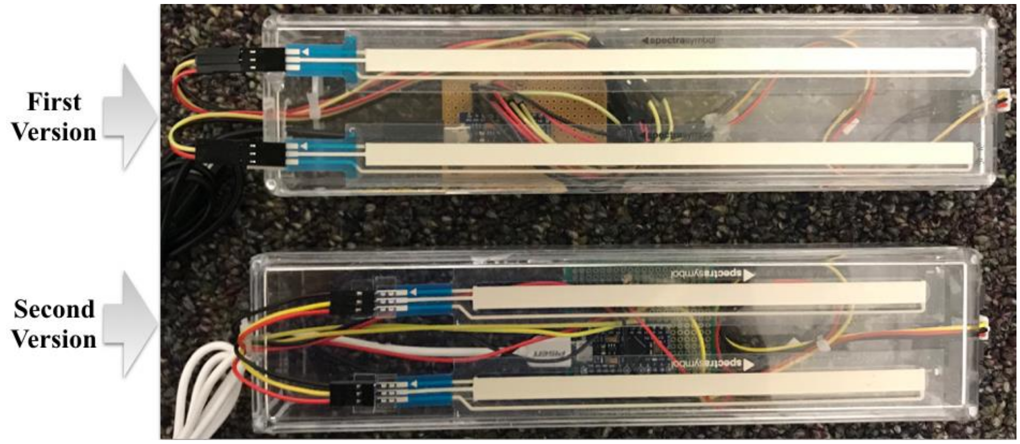

Figure 68. Two versions of Qin interfaces

The challenge presented by the first version of the Qin interface had to do with its protection during transporting the interfaces. Although it provides the finer resolution of control using 200 mm SoftPot sensors, the connectors and jumper wires are not firmly attached to any surface. I fixed this shortcoming by replacing the 200 mm SoftPot sensors with 150 mm SoftPot sensors, gluing them on to the top of the clear acrylic casing and employing six jumper wires that would ultimately be bound together to assure better protection and a more stable positioning. The layout of the sensors can be observed in Figure 69.

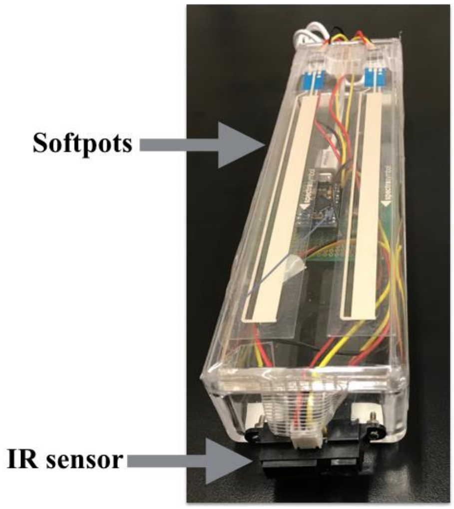

Figure 69. Qin interface sensors layout

The three sensors embedded into one interface provide data streams that are singular in their dimensions. Although data-driven instruments have the capacity to evolve over the course of a composition, playing music where the performative actions have clear sonic associations can have the effect of making the musical expression clearer.

Therefore, in the composition of *Qin*, I use two interface controllers – positioned side by side, with two IR sensors facing outward and with USB cables connected to the laptop. The incoming data then can be received within Max as six individual MIDI continuous controllers. The layout of the two interfaces is shown in Figure 70.

Figure 70. Interfaces layout during performance

In a performance of the composition *Qin*, the relationship of the interfaces to performer is shown in Figure 71.

Figure 71. *Qin* performance setup

A diagram of complete data-driven instrument used in *Qin* is shown in Figure 72.

Figure 72. Basic data flow diagram for *Qin*

Musical Challenges and Opportunities

Custom-made interfaces often have the advantage over mass-produced interfaces by virtue of the fact that such devices produce unique data signatures. Such is the case with my Qin interface as the data streams output by the IR proximity sensors are not as predictable as wanted and are often "confused" by objects placed in front of them. In addition, I observed that these IR sensors were dramatically influenced by shadows and lighting conditions and were biased deeply based on the angle the sensors were directed. Therefore, I found that accurate mapping of data originating from IR proximity sensors was difficult when actuation of very particular musical events was the objective. In addition, the applied pressure needed to sustain and continuously control steady data outputs from SoftPots required extended practice. Different SoftPots, depending on their linearity, produce different data personalities. Physical interfaces are not replaceable for certain types of musical parameter controls. Further, the SoftPots data update rate is designed to be extremely fast. Even though I employed a speed limiting algorithm within Max, the creation of a one-to-one relationship between action and sound was not especially promising. My solution to this challenge was to generate MIDI "note-on" messages within a time-varying pitch-range as I created longer and shorter sequences of notes. Because of the difficulties and challenges Qin interfaces provided, performance techniques were adjusted in association with the sound design process.

Performance Techniques Employed using the Qin Controllers

The basic options available in the operation of the SoftPot and IR sensors include, but are not limited to:

1. pressing and holding SoftPot sliders with fingers or with spectra symbol wipers,
2. moving hands slowly in front of the IR sensors,
3. tilting the interface and modulating the physical distance between the table surface and the sensors, and
4. moving hands quickly into and out of the beam of the IR sensors.

The above four operational actions are ones that a human operator may choose in the playing of the complete data-driven instrument. Variations of these four actions can be observed throughout the performance video associated with this composition. In my composition *Qin*, number 1, 2, 4 are used as the most as basic performative actions.

Compositional Structure

Qin is a through composed composition with three distinctive sections. The musical narratives depicted in this piece capture different facets of interaction with the instrument from producing bright, clear, and sparkling sounds, to sounds with darker sustained textures, to sounds with the clear articulation of pitch in order to produce vibrato effects, to the generation of non-pitched glitchy sounds.

0:38-2:33 The composition begins with a reversed and granulated Guzheng pluck string sound, followed by bell sounds and regular triggered Guzheng pluck string sounds. Both IR sensors control the production of the string sounds, while all four SoftPot sensors control the bell sounds.

2:33-5:42 The second section creates musical contrasts between two types of sounds. The left hand controls pitched sounds that articulate bright timbres, while the right hand controls unpitched sounds that create a glitch effect.

5:42-7:00 The third section uses sampling techniques as the primary sound production method applying control data generated from all four SoftPot sensors to expressively control pitch bend, loop, glitch, and scrubbing over *TimeIndex*.

Sonic Materials and Data Mapping Strategies

The initial sonic material I chose to use in the composition are Guzheng timbres, including pluck Guzheng strings, sounds generated by hitting the body of the Guzheng, and the scrubbing of Guzheng strings. As a secondary source, I also used both high- and low-pitched bell sounds. The sound synthesis techniques used to achieve broad musical expressivity are granular synthesis, analysis and resynthesis, cross synthesis, and sample playback techniques.

For example, Figure 73 shows the entire signal flow and sound structure for the first section of the composition. Bell sounds are triggered at different pitches through generated MIDI “!KeyDown” messages. In Figure 73, the right part of the image shows the parameter field setting of where “!KeyDown” message is applied and how different pitches are generated as well as how the attack portion of the bell sound is handled. Simultaneously, the IR sensor data is mapped to control the vibrato.

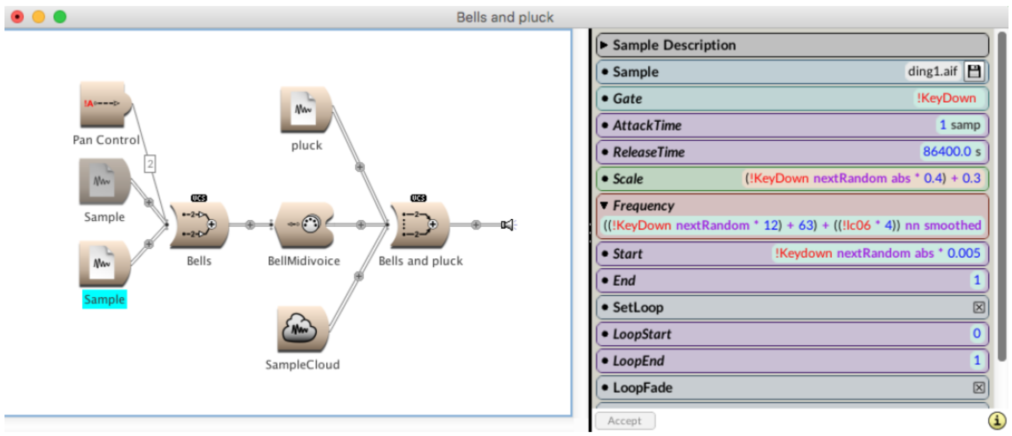

Figure 73. Bell sounds algorithm signal flow graph

Sampling playback procedures, especially looping techniques, are used heavily in the second and third sections. The signal flow graph shown in Figure 74 illustrates the basic sound design that is reproduced four times by Kyma’s Replicator object. Within Kyma’s Sample prototype, many of its parameters are controlled in realtime including *frequency*, *loop duration*, *attack time*, and *pitch transposition* created by the four replications of the basic sound structure.

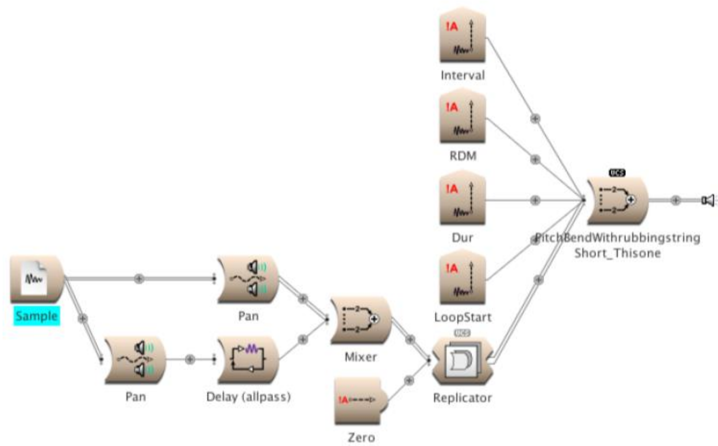

Figure 74. Sampling synthesis signal flow graph

In the signal flow graph shown in Figure 74, there are four "SoundToGlobalControllers" Sound objects, each of which receives one data stream generated by one of the SoftPot sensors. This data is smoothed and scaled, then routed to specific parameters in the Sample prototype. The specific mapping strategy is shown in Figure 75.

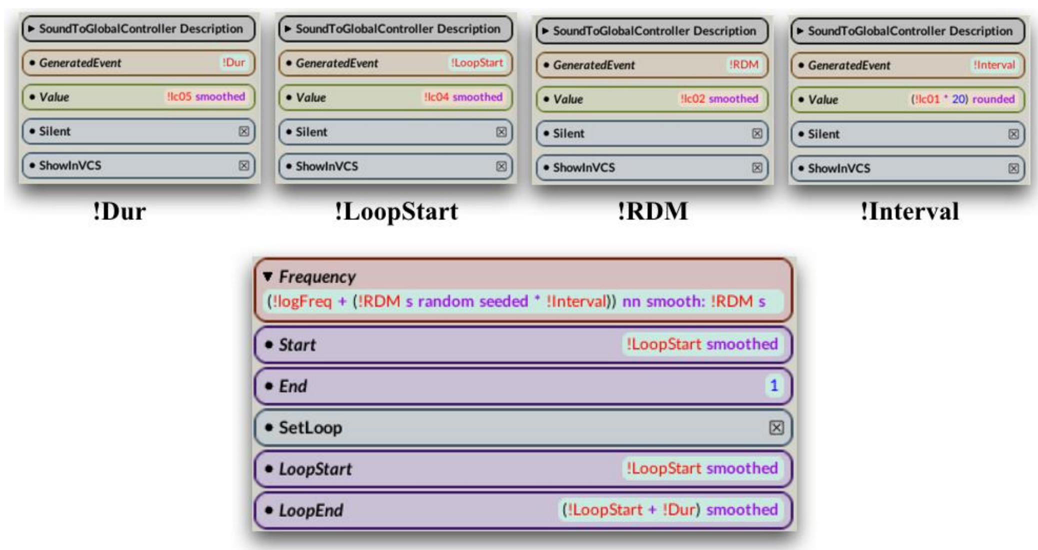

Figure 75. Sampling synthesis parameter fields setup

An Extended Project with OEDO

The easy-to-use features and straight forward control mechanisms allow Qin to be an ideal controller for ensemble performance. In my composition *Kurukullā*, I explored the use of Qin interfaces with the Oregon Electronic Device Orchestra (OEDO) – a fourteen-member ensemble. Each member of the ensemble operated a Qin interface connected to their own personal laptop running custom-made software and sound-producing algorithms created with Max/MSP. Creating a performance with fourteen electronic musicians is an ongoing exploration process. Multiple layers of musical and personal interactions and performative decisions were involved in the collaborative ten-week journey that helped create the work. The relationship between each performer and the custom-made interface, the connection created between the sonic materials and the performative actions, and the software score created through practice and rehearsal, all were significant challenges and successes (to one extent or another) that culminated in an enriching musical and educational experience.

The interface design of the software and the ensemble's software score were extremely important in the development of the composition. Figure 76 shows the software interface when rehearsing and performing with the ensemble.

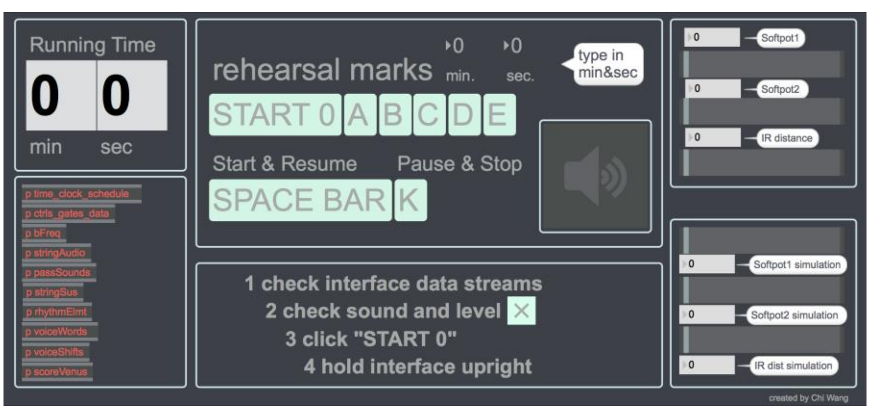

Figure 76. Software interface

Different sections of the composition have different instructions as performance-time unfolds. Among the more interesting features of this scores is the fact that performers are not listed by their function in the ensemble, but rather by name. For example, in the upper left corner, one can observe the listing by first names of the performer "Troy-Tiana-Olga-Yifan-Nini-Lexi." Other lists of players are created on a first name basis on five additional occasions. There are also a number of indications that tell the ensemble to look at me and I am named in the score, not as conductor, but rather by my Western first name "Iris." Figure 77 shows instructions as performance-time unfolds.

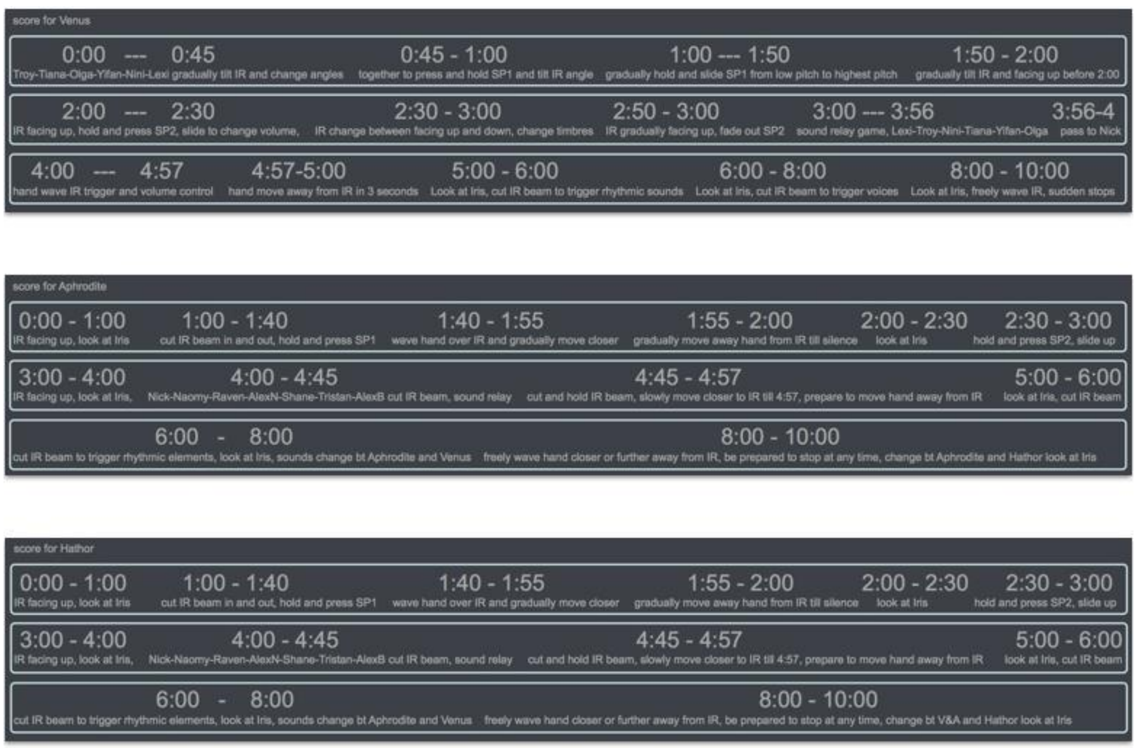

Figure 77. Software score parts for *Kurukullā*

The score for the conductor of the ensemble is especially important. Being able to see the instructions for all the performers at once is informational and helpful during the composition's rehearsal and performance. Figure 78 shows the complete score.[68]

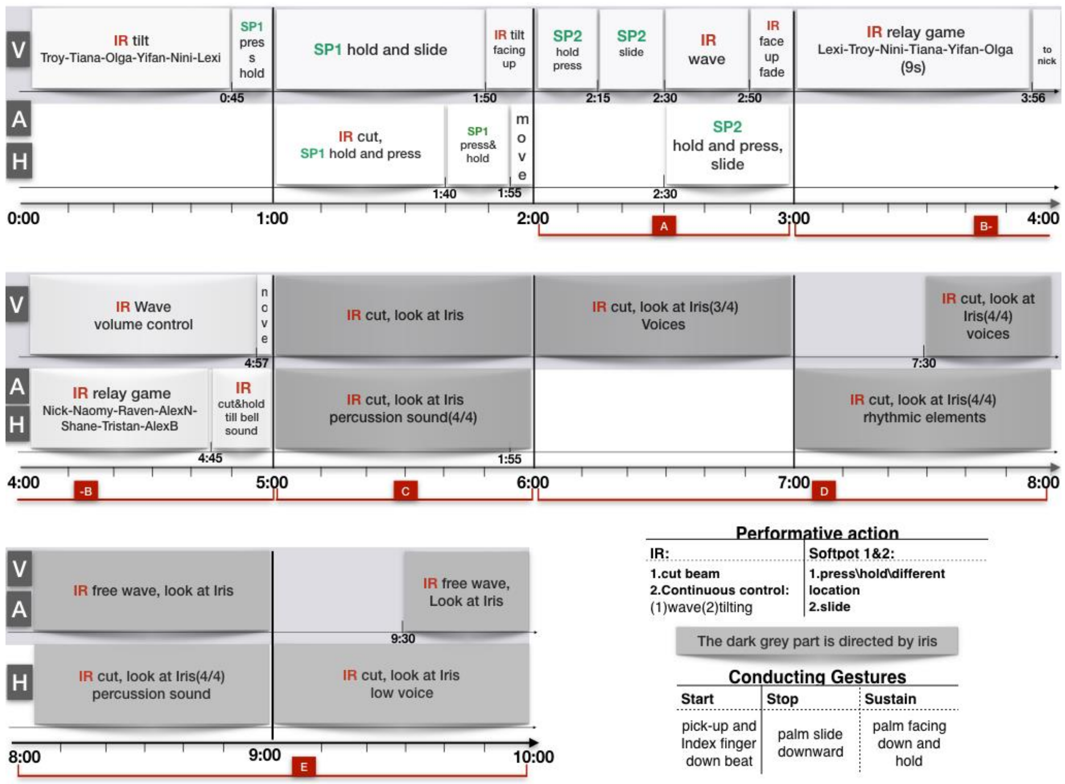

Figure 78. Software score for *Kurukullā*

[68] Score graphic was designed by ensemble member Xiaoni Zhuang using Keynote and edited by Chi Wang.

CHAPTER IV

SUMMARY

The original compositions of Narrative to Action in the Creation and Performance of Music with Data-driven Instruments were initiated broadly and in a general manner by the concept of narrative. The concept of narrative, is, of course, a gigantic idea that involves things that are real and imaginary, that, in my chosen narratives, arise from music, from Eastern and Western poetry, from important symbols, and Buddhist Sutras, to the stories and histories related to the entwinement of poetry and music, and music and numbers.

If I were to make only a single comment about my own compositions it would be that the journeys of transformation in each of my compositions, where sound worlds come into being, develop, flower, dissolve into a silent invisibleness, are somehow my own personal story and my own personal narrative. That these narratives and journeys were driven and shaped by numbers not only ties this work to my earlier education as an electrical engineer, but also connects it to the data-rich world we live in today.

The expressive and adventurous journeys created by using human judgement to select data sources, mapping strategies, sonic material, and performative actions, to name just a few points human judgement imprinted itself on the narrative of the creation of this dissertation, ensured that the compositions contained within can form a multi-dimensional experience for a listener.

This dissertation, a digital portfolio dissertation, fundamentally breaks from the tradition of terminal academic documents whose form and content rest on text. This document also moves away from the “notes on paper” music that has dominated Western music for hundreds of years. Instead, the form and content of my digital portfolio dissertation, asserts that a set of rich audio video media documents much better and more precisely creates a record of my music, the music of this time, and allows for future generations, should they be inclined to do so, to study a historical record that is much closer to actuality than any text description or notation of my music could ever hope to achieve.

Just imagine how many thousands of pages of text description might be supplanted with only a single audio/video recording of Beethoven performing even a single movement from one of his sonatas. Such a recording would be transcendent in its importance and meaningfulness.

As we look back through the history of human activity and its records one can easily observe that we have proceeded from etching our activities first on rocks, which were difficult to move from place to place, but lasted a long time, then on paper, which was easier to move about, but was more fragile, and now to disks and clouds. These data-based records, stored in places that we cannot see or touch (like clouds), that are dramatically fragile, that protect themselves through massive replication on a scale that neither rock or paper documentation could ever hope to achieve, beautifully and magnificently relate to the intangible ephemeral qualities of music. I like that my concluding creative statement, this dissertation, exists in a medium that shares the wonderful intangible qualities of music.

APPENDICES

SCORE OF OP. 48, NO 7, "ICH GROLLE NICHT"

Ich grolle nicht, und wenn das Herz auch bricht. Ich sah dich ja im
Trau_me, und sah die Nacht in dei_nes Her_zens Rau_me, und sah die Schlang,' die dir am Her_zen
frisst, ich sah, mein Lieb, wie sehr du e_lend bist. Ich grol_le nicht, ich grolle
nicht.
cresc.
ritard.

“ICH GROLLE NICHT” BY HEINRICH HEINE

“Ich grolle nicht”

Ich grolle nicht, und wenn das Herz auch bricht,
Ewig verlor’nes Lieb, ich grolle nicht.
Wie du auch strahlst in Diamantenpracht,
Es fällt kein Strahl in deines Herzens Nacht.
Das weiß ich längst.

Ich grolle nicht, und wenn das Herz auch bricht,
Ich sah dich ja im Traum[69],
Und sah die Nacht in deiness Herzens Raum[70].
Und sah die Schlang, die dir am Herzen frißt,
Ich sah, mein Lieb, wie sehr du elend bist.

“I Bear No Grudge” (English translation provided by Paul Hindemith)[71]

I bear no grudge, even when my heart is breaking!
Love lost forever! I bear no grudge.
Although you shine in diamond splendor,
No beam falls into the night of your heart.
I will know that for a long time.

I bear no grudge, and when my heart is breaking!
I truly saw you in my dreams
And saw the night in the room of your heart,
And saw the snake that bits your heart;
I saw, my dear, how truly miserable you are.

[69] Schumann: “Traume”

[70] Schumann: “Raume”

[71] English translation provided by Paul Hindemith, The liederNet Archive; accessed February 11, 2018, http://www.lieder.net/lieder/get_text.html?TextId=7545.

“OPHELIA” BY ARTHUR RIMBAUD

Ophelie

I
Sur l'onde calme et noire où dorment les étoiles
La blanche Ophélia flotte comme un grand lys,
Flotte très lentement, couchée en ses longs voiles...
- On entend dans les bois lointains des hallalis.
Voici plus de mille ans que la triste Ophélie
Passe, fantôme blanc, sur le long fleuve noir
Voici plus de mille ans que sa douce folie
Murmure sa romance à la brise du soir
Le vent baise ses seins et déploie en corolle
Ses grands voiles bercés mollement par les eaux;
Les saules frissonnants pleurent sur son épaule,
Sur son grand front rêveur s'inclinent les roseaux.
Les nénuphars froissés soupirent autour d'elle;
Elle éveille parfois, dans un aune qui dort,
Quelque nid, d'où s'échappe un petit frisson d'aile:
- Un chant mystérieux tombe des astres d'or

II
O pâle Ophélia ! belle comme la neige!
Oui tu mourus, enfant, par un fleuve emporté!
C'est que les vents tombant des grand monts de Norwège
T'avaient parlé tout bas de l'âpre liberté;
C'est qu'un souffle, tordant ta grande chevelure,
À ton esprit rêveur portait d'étranges bruits,
Que ton coeur écoutait le chant de la Nature
Dans les plaintes de l'arbre et les soupirs des nuits;
C'est que la voix des mers folles, immense râle,
Brisait ton sein d'enfant, trop humain et trop doux;
C'est qu'un matin d'avril, un beau cavalier pâle,
Un pauvre fou, s'assit muet à tes genoux !
Ciel ! Amour ! Liberté ! Quel rêve, ô pauvre Folle!
Tu te fondais à lui comme une neige au feu:
Tes grandes visions étranglaient ta parole
- Et l'Infini terrible éffara ton oeil bleu!

III
- Et le Poète dit qu'aux rayons des étoiles
Tu viens chercher, la nuit, les fleurs que tu cueillis;
Et qu'il a vu sur l'eau, couchée en ses longs voiles,
La blanche Ophélia flotter, comme un grand lys.

Ophelia (English translation by Oliver Bernard)[72]

I
On the calm black water where the stars are sleeping
White Ophelia floats like a great lily;
Floats very slowly, lying in her long veils...
In the far-off woods you can hear them sound the mort.
For more than a thousand years sad Ophelia
Has passed, a white phantom, down the long black river.
For more than a thousand years her sweet madness
Has murmured its ballad to the evening breeze.
The wind kisses her breasts and unfolds in a wreath
Her great veils rising and falling with the waters;
The shivering willows weep on her shoulder,
The rushes lean over her wide, dreaming brow.
The ruffled water-lilies are sighing around her;
At times she rouses, in a slumbering alder,
Some nest from which escapes a small rustle of wings;
A mysterious anthem falls from the golden stars.

II
Pale Ophelia! beautiful as snow!
Yes child, you died, carried off by a river!
It was the winds descending from the great mountains of Norway
That spoke to you in low voices of better freedom.
It was a breath of wind, that, twisting your great hair,
Brought strange rumors to your dreaming mind;
It was your heart listening to the song of Nature
In the groans of the tree and the sighs of the nights;
It was the voice of mad seas, the great roar,
That shattered your child's heart, too human and too soft;
It was a handsome pale knight, a poor madman
Who one April morning sate mute at your knees!
Heaven! Love! Freedom! What a dream, oh poor crazed Girl!
You melted to him as snow does to a fire;
Your great visions strangled your words
And fearful Infinity terrified your blue eye!

III
And the poet says that by startlight
You come seeking, in the night, the flowers that you picked
And that he has seen on the water, lying in her long veils
White Ophelia floating, like a great lily.

[72] Arthur Rimbaud, *Collected Poems*, trans. Oliver Bernard (London: Penguin Classics Publisher, 1987).

"PUSA MAN" BY WEN TINGYUN

菩萨蛮 **温庭筠**

小山重叠金明灭

鬓云欲度香腮雪。

懒起画娥眉，

弄妆梳洗迟。

照花前后镜，

花面交相映。

新帖绣罗襦，

双双金鹧鸪。

Deva-like Barbarian (English translation provided by Xu, Zhongjie)[73]

Sunlight shimmers on a picture,
Carved in perspective on bed-screen.
The hair on her temples appear,
As clouds which, against her cheeks, lean.
Slowly she rises from her bed;
Paints her brows like a crescent moon.
She takes her own time, unhurried;
Completes her toilet none too soon.
Her flowered head between two mirrors
Interlay with face in beauty made.
On a jacket, tastefully cut
Are two partridges in brocade.

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