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Overview of Types and Researches of Data Controllers in Interactive Electronic Music

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Abstract

In recent years, interactive electronic music is a popular development direction of electronic music. Its design and creation need not only consider the sounds, but also design or create the condition parameters to influence the occurrence and changes of music according to the requirements on works and performance. For composers, one of the ways to obtain the condition parameters is to collect data through the controller and send data to the computer, in order to have the computer influence the occurrence and changes of sounds. During the processing, creation and even the whole process of human-machine interaction, the controller has a great influence. The controller protocol could be mainly classified into OSC, eucon, AES, MIDI and so on. For example, as the most common and normative protocol in electronic music, and from the simple MIDI keyboards with output of 0&1 signals to the complicated Kinect which could realize the data mapping of 11 collection points through capture of actions, MIDI protocol could convert the input data into MIDI signals and influence the sounds. The commonly used data controllers mainly include gravity controller, speed controller, light controller, vibration controller, location controller, breath controller and so on. And the emergence of visual platform of programming language, like MAX/MSP and KYMA for musical creation and media creation, facilitates the human-machine interactive creation and performance.

Comparing with the traditional medium of control such as sound console, controller is a very promising tool with profound impact on how musicians create their works. With regard to the development history of electronic music worldwide, China has transformed itself from a follower in the past to the role of a creator actively innovating electronic music. Therefore, I believe that a historical perspective should be adopted to probe into the principles and technical measures of different data controllers for a better electronic music in the future. With that in mind, this paper elaborates on the principles of several controllers and how they should be applied to the future creations. The integration of technological theories and creations will enable us to spot problems and accumulate experiences. In addition, different practical situations are considered to highlight the significance of innovations in technology and art.

Introduction

Since the creation of *Etude aux Chemins de Fer* by Pierre Schaeffer in 1984, the electronic music, as an emerging profession, has been keeping up with the times and the incessant technology development, from the concrete music era featured by tape collage, oscillator and hardware synthesizer to the computer era with the addition of software synthesizer,

randomized algorithm and controller. Composers realize that the electronic music is not only an independent science but deserves tighter combinations with other new technologies. Therefore, the interactive electronic music was created.

The interactive electronic music results from the combination of technologies and the innovative idea of music. Its establishment is based on the strong power of socialization and commercialization, which propels the rapid development of computer technology and the increasing expansion of the field covered. If what the concrete music, tape music and computer music pursue at the technological and conceptual level is the “result” of music, then it is the “process” that the interactive electronic music chases based on the “result”. In a performance, the random, real-time and improvised control of the sound materials by the composer transcends the invariability and repeatability of the unchanged sound materials. It breaks the constraint of simplicity and mechanics imposed on the music and makes it more expressive.

The development and application of the controller is one of the key technological segments. Todd Winkler defines the interactive electronic music in his work *Composing Interactive Music*: a music composition or improvisation where computer on-site collects real-time data to affect sound production and change of the music. Therefore, the data collection at the stage of human-machine interaction is indispensable for computer data collection. Except for the traditional mouse, MIDI keyboard, microphone and so forth, various controllers have become the inspiration point for the new creation by composers.

In the third part of the paper, I selected the *Water Sleeves* by the Chinese composer Wang Chi that had its premiere in 2015 for analysis of the electronic music development in nowadays China.

Therefore, various ways of changing emerge after composers start to seek different approaches to compose and perform the electronic music. The newly rising ways to some extent affect composers’ creative thinking that is getting more active. However, whether there exists a relatively unified interpretative pattern for these different ways? Whether we could conclude a theoretical method to facilitate our understanding of this field through quantization and systematization based on different characteristics of different controllers when using them for composition? Most interactive electronic music composition shares a certain level of generality that can facilitate our understanding and learning of this type of music. It is the problem that the paper intends to raise and solve to some extent.

Controller in Electronic Music Creation

What is controller?

Controller refers to element or device that can measure and convert human manipulations to output signals that can be identified by computer. Generally, a controller is consisted of sensor element and transmission element. The sensor element can be further classified into the contact and non-contact types. The contact sensor element alters the manipulation data by physical contact. Traditional input equipment such as keyboard and mouse, various MIDI controllers and game console of Wii fall into the contact type; the non-contact sensor element can obtain data without physical contact between the user and the controller, such as Kinect and Leap Motion. The transmission element is capable of sending the collected data to the computer and there are two transmission modes, one being wire transmission and the other being wireless. The wire transmission is stable but has limited activity range and is limited by

the wire length; the wireless transmission has unlimited activity range but is less stable than the wire transmission in case of multiple devices.

Controllers in Electronic Music

In *Composing Interactive Music: Techniques and Ideas Using Max* by Todd Winkler, he describes five steps for composing a piece of interactive electronic music as follow:

1. Input from human or instruments;
2. Computer receiving information;
3. Information interpretation;
4. Computer processing;
5. Sound synthesis and output.

Among the five steps above, 1 is the inputter, 4 is the computer, 5 is the output device and 2 and 3 are the interactive devices including the controller. In a broad sense, everything that can interact with the computer is regarded as controller, such as keyboard, mouse, microphone, MIDI keyboard, etc. However, in a narrow sense, these devices have fewer interaction with the audience and not enough performability. They are lack of innovation and real-time interaction.

In general, controllers can be divided into the following categories: controller developed based on motion sensing game platform, controller to which the smart phone is changed using software within and specialized controller.

At present, controller developed based on motion sensing game platform is frequently used compared to others. This type of controller is highly commercialized and stable. The Wiimote made by Nintendo and the Kinect made by Microsoft are the most commonly seen motion sensing game devices nowadays. The following section will introduce in detail the Wiimote, as the representative of the acceleration controller and the Kinect, as the representative of the depth controller.



Figure 1: The Game Controller: Wiimote and xBox Kinect

Turning the smart phone to a controller using software is currently the hottest field. Because the smart phone has advantages of extensive application fields and high prevalence rate, a large quantity of developers or manufacturers have participated. Multi-sensor cooperation that general controllers are not capable of can be achieved because of the existence of various sensors in the smart phone, such as iPhone7 by Apple, which has five built-in sensors including barometer, three-axis gyroscope, accelerometer, proximity sensor and ambient light

sensor. However, the original intention of making the smart phone is for the user's self-recreation so it has low volume. Furthermore, because of its volume and purpose for possessing a certain function, it cannot match any specialized controller. Besides, despite much software available on the smart phone platform, most programs have been solidified and the secondary development is not feasible due to limited degree of freedom.

LK is an intuitive and powerful Ableton Live controller.



Figure 2: Turning the smart phone to a controller – Make By imaginando company

Most specialized controllers are developed voluntarily for specific requirements in the work, such as the *Colorful Ball Theatre* by Jeffrey Stolet in 2013.

Controller Protocol and Controller

Controller Protocol

Various controller protocols are the carrier of their own when the controller is transmitting signals to the computer. MIDI, OSC, AES, Eucon and so forth are the common protocols at present. They have their own advantages and defects.

MIDI

MIDI (Musical Instrument Digital Interface) is an industrial standard that describes an electronic communication protocol and defines various notes and play codes. It allows electronic musical instruments, computers and other music devices to connect, adjust and synchronize with one another, to obtain immediate exchanged performance data. MIDI does not transmit sound but only channel information regarding such as which note is pressed or released, program changes and notations, and systematic information such as MIDI time code, music position pointer and music selection.

Since the MIDI protocol 1.0 was established, MIDI so far has become the most commonly used and normative protocol applied in the digital music. Almost all audio hardware and software support the MIDI protocol very well. In addition, this unified standard provides the biggest compatibility and convenience for connections between different platforms, different devices and different programs. The MIDI data form is one of the most used data forms for interactive electronic music transmission and control nowadays.

OSC

OSC (Open Sound Control) is a protocol for communicating computers, sound synthesizers and other multimedia devices based on modern network technology optimization. It brings the

modern network technology's advantages into the field of electronic musical instruments, including interoperability, accuracy, flexibility and enhanced organization and documentation. The OSC protocol was originally intended to share performance data between electronic musical instruments, computers and other multimedia devices. OSC is regarded as an alternative to the MIDI standard. Compared with the MIDI, OSC can connect to the internet, with higher velocity, larger throughput capacity, higher resolution and relatively easier symbolic path, instead of the stated 8-bit digital connection. OSC offers more flexibility to musicians and developers in terms of output transmission.

Currently, there have been a number of OSC devices, including real-time sound and multimedia processing working platform, web interactivity tools, software synthesizers, dozens of programming languages and hardware devices.

UDP

UDP (User Datagram Protocol) is a simple datagram-oriented network transport layer protocol. UDP does not provide a guarantee of reliability and it only sends out the datagram that is transmitted from applications to the IP layer but does not guarantee the datagram can be delivered to its destination. Because UDP does not establish connections between clients and servers prior to datagram transmission and applies no mechanism of timeout re-transmission, it has high transmission speed.

Because of its high transmission speed, UDP has low delay thus generally used for long-distance transmission.

Eucon

Eucon control protocol is based on the IP Ethernet technology. Its transmission speed is 250 times faster than that of the MIDI protocol with 8 times higher resolution. It also supports the user interface of extremely high resolution. The high-speed connection provided by Eucon can dramatically increase the response rate to control. Users feel they are controlling the same mixer when controlling other devices.

Eucon applies TCP/IP protocol to conduct communications between the control interface and applications. All of the Eucon control interfaces are connected to the 100Mb/s Ethernet, whose bandwidth is three more orders of magnitude than that of MIDI thus dramatically increasing the transmission speed. Eucon employs the idea of object-oriented coding. The Eucon programmers do not necessarily see the contents in the data package under the TCP/IP transmission. Then only need to create, cancel or use the object to control the interface. It not only lowers the development difficulties but also maintains the independence of the Eucon transmission.

Common Controllers

Light Controller

Light controller is one of the first controllers used in the interactive electronic music. It can alter values according to the amount of light input. The D-Beam, integrated in the Roland synthesizers, represents the commercialized application of the light controller. The D-Beam controls sound by identifying hand movements.

Acceleration Controller

Acceleration controller allows performers to send control messages via body movements, unlike the use of fingers in the past. The Wiimote developed by Nintendo for its Wii console is one of the representatives.

The Wiimote has a built-in triaxial acceleration sensing chip (not a gyroscope), which can sense $\pm$ acceleration along three axes and obtain information such as dip angle, acceleration and position. When used as the human-machine interactive device for interactive electronic music, the Wiimote is very useful in expressing the performance process of a performer. The *Art Finished by Fingers* by Prof. Jeffrey Stolet from the University of Oregon in the United States is one of the representatives.

Depth Controller

In 2010, Microsoft released the Kinect, a motion sensing device. Compared to the Wiimote, the Kinect is more concise and intuitive without the constraints of the additional controller and has higher precision. The Kinect uses a camera (RGB) to catch the human image information to obtain a 3D image of the whole human body. The image it catches has depth information therefore there is no need for media to be touched and multi-touch across the air can be achieved. Interruptions from other objects in the performance site can be avoided.

The core principle of the Kinect is the application of infrared matrix dots sensing to identify the user's movements. The Kinect projects very dense infrared dot matrices and determines the distance from each dot to the reflector based on the return time difference for each dot, thus obtaining the status and position of the movement of an object in the whole space. The Kinect has a built-in model containing twenty human joint movements that each dot will try to match and connect to the system, for the purpose of precise identification of the human joint movements.

In the interactive electronic music, the Kinect provides a brand-new interaction mode in which performers do not need to be supported by any tools but can interact with the music through the use of their body only.

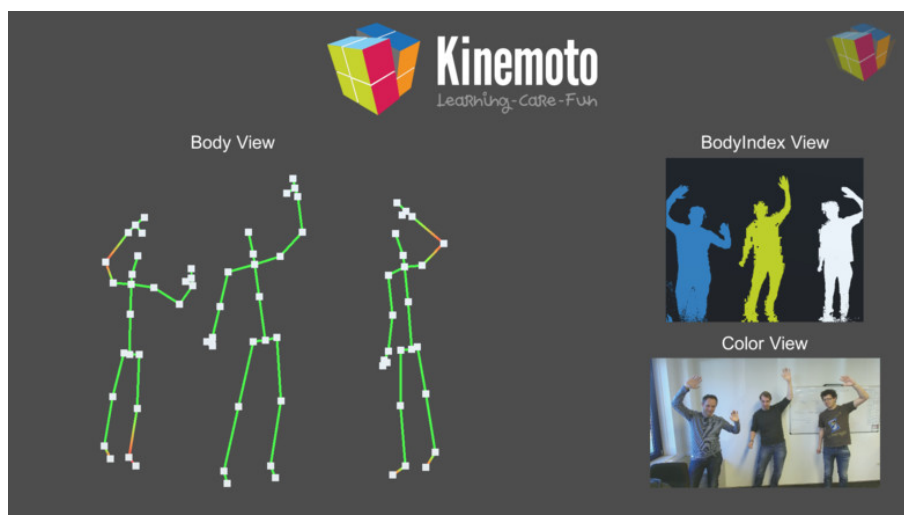


Figure 3: the Kinect's response

Application of Interactive Electronic Music Controller in Nowadays China – Analysis of *Water Sleeves*

Background Introduction of *Water Sleeves*

The *Water Sleeves* was created by Wang Chi in the University of Oregon in the United States in 2015, through the use of eMotion system and Kyma.

The “water sleeves” are a specific costume in the Chinese classical opera. The water sleeves are pieces of white silk stitched on the sleeves of various opera costumes (Mang, Po, Guanyu or Zhezi) with the length of 30 to 45cm in general. One can use the water sleeves to achieve various motions to express emotions and enhance the aesthetic perception.

Technological Analysis

eMotion System

The eMotion is an acceleration controller developed by Chet Udell in 2014. The eMotion’s advantages include compact size and excellent expansibility. A complete set of the eMotion devices includes a receptor that connects the computer and two tiny sensors. The sensors can operate independently using its own power supply or connect to other devices via the USB port. Meanwhile, the eMotion system can also be expanded to accept other sensors such as the pressure sensor, tension sensor, etc. Therefore, it can be used in the musical instruments as well.

In this work, because of the uniqueness of the water sleeves, the long sleeves can cover the hands and the sensors thus avoiding the loss of the sense of beauty in the performance.

Kyma

Kyma is a visual programming language platform developed by Symbolisound, which was designed for the interactive programs of music and multimedia. Compared to the most popular MAX/MSP platform at present, Kyma has independent hardware called “pacarana” or “paca” so the speed is faster in synthesizing large quantities of particles.

Conclusion

Positive Effects of Controller on the Interactive Electronic Music

From the trend in recent years, the interactive composition is increasingly becoming the dominant force. More and more artists get involved in the related fields and innovation has become their common goal. The manifestation modes vary greatly no matter in the field of multimedia or interactive work. They use music to control and change images, “play” the music using light, joystick and game controller. The musical notes are interactive with the bouncing images. Controller can also catch the lightening, dancing and motions. When people are enjoying the dizzying performances, they also want to know how to achieve all of these. Sometimes, we attribute the performance to a certain artist who is an electronic circuit expert as well, or a professor behind whom a team is standing. Ultimately, none of these performances will exist without the interactive devices – controllers, as listed above.

Today, with more and more interdisciplinary cooperation and involvement of various art forms, the work of electronic music is no longer a monotonous transmission of linear information. Instead, it can apply many other multimedia to help its manifestation. The

establishment of various controllers endows the music with high ornamental values and the work with great vitality, by involving different kinds of media into the performances.

Meanwhile, the electronic music is no longer an art form made behind the closed door in the field of art but drawing close to “technology”. For example, certain “toys” combine many types of media and technologies such as the smart phone designed by Apple. The meaning of electronic music is no longer about its own only but has transformed to the users’ interactive experience. The individual experience is the case instead of the music in itself. Such open form of interaction brings the electronic music into every corner of our lives and everyone gets a chance to create and feel the music.

Confusions and Defects of Controller to the Interactive Electronic Music

Positive effects of controllers on the interactive electronic music are summarized above but the confusions of controllers should not be ignored.

As we know, controllers and ever various kinds of interaction approaches are developed for music composition. Therefore, whether the music composition in itself is overshadowed which is neglected when we excessively focus on how to use the controllers or even how to make a unique controller? It necessitates our thinking and research on the balance of music composition and controllers.

Composers should be cautious about whether “the controllers serve the music” or vice versa. One should be alert for the latter. “Interactive electronic music” is music in nature. If not, the situation will be “effects of interactive controllers on the music”.

In this paper, it is hoped that controllers have more positive effects on the development of electronic music than negative effects, and more outstanding interactive electronic music works will emerge to facilitate positive development of the electronic music.

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