Berklee College of Music, Valencia Campus

Future Is Coming

Virtual Reality Midi Controller Software

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Master of Music in Music Production, Technology and Innovation

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by

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I am deeply grateful to my loving parents, my wife and my family back home who influenced and supported me so much for my whole life. Without your supporting, I cannot come this far to Valencia.

-Wan Zhao

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1. Introduction

The IPhone brought upon us a new lifestyle that fits into a little box-shaped gadget, but what will the future bring to us after these touchable screens? I would predict that it might be virtual reality[1] and augmented reality[2][3] environments.

In virtual reality and augmented reality environments, people can play games, watch movies and also experience life in an entirely new way. I imagine a future when virtual reality and augmented reality become more and more developed.

How would this influence the music industry? The answer is: people will be able to create music, mix music and perform their music all in virtual reality and augmented reality environments.

People would not need to use any hardware devices to perform their music and visuals. And I felt deeply it would be the future of how people perform their music on stage.

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[1] P.22
[2] P.22
[3] P.22

My culminating experience intends, therefore, to anticipate this future by creating a Leap-motion Midi Controller[4] with which you can control your project in digital audio workstation[5] without touching any hardware devices.

[4] P.22
[5] P.23

2. Details Description

My goal is to build a Leap-motion[6] Midi controller desktop software and Leap-motion Midi controller software under virtual reality environment.

This Leap-motion Midi Controller would integrate three main parts:

2.1- Leap-motion Midi Controller Desktop Software Version:

This is midi controller software, which can be controlled by Leap-motion. It includes 8 sliders and 9 push buttons, with moving cloud and moving water for the background.

All of these components were created using the Unity[7] 3D engine. I named every sliders and buttons differently, in order to make users understand which components they are going to map to their digital audio workstation's parameters.

[6] P.23
[7] P.23

I used Leap-motion V2 desktop SDK assets to connect Leap-motion as the controller, and it allows users' hands to pop up in the window when the Leap-motion detects them.

The sliders and buttons are created with Leap-motion V2 desktop's widgets SDK assets. These are Leap-motion interactive user interface components, that can control and display value change. There are 8 sliders and 9 buttons, 6 sliders are vertical and the other 3 are horizontal; 6 buttons are used for simply trigger on/off function, and the rest of 3 used for Play, Stop and Record functions.

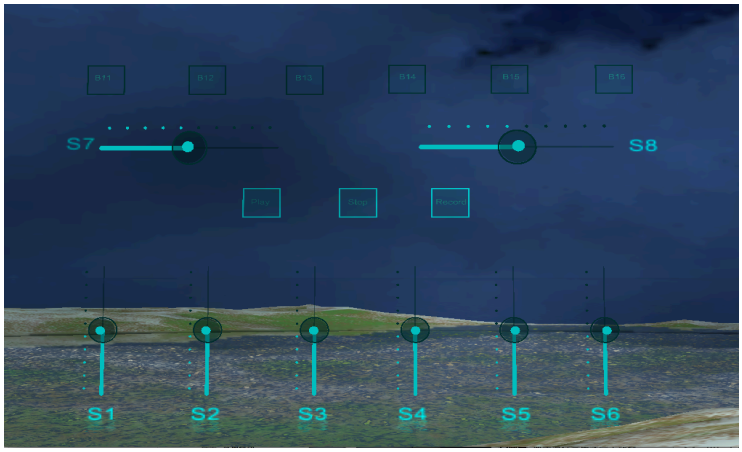

Figure 1, Screen Capture of Leap-motion Midi Controller Desktop Version

To achieve the connection between DAW and this software, I

used UniOSC[8] SDK assets to send OSC data out from Unity 3D.

I used sliders' filled up information to connect to UniOSC's transformer sender script, then I can get OSC data value when the filled up information of sliders are changing. For the buttons, I connected the UniOSC transformer sender to ON buttons function and then the OSC data is activated when the user presses the button.

For the background, I wanted something that could move and look alive. I choose water, land and cloud assets in order to make this world. Water and cloud move by themselves when the software is open. The land is used to create a feeling of standing on the island and being surrounded by cloud and water. I felt like it will make the user feel calm when working, and won't interrupt the workflow.

[8] P.24

2.2. Leap-motion Midi Controller Virtual Reality Version Software:

This software is similar to the desktop version, the only difference is that the desktop version is created only for the desktop, and this one is made for VR devices.

I used the same Leap-motion V2 desktop SDK assets to make the connection to Leap-motion, but this time, I used Leap-motion OVR SDK assets inside the V2 desktop SDK assets package to make it work with Oculus OVR SDK assets.

I used the same components as the desktop version but in different amounts for the general development. I created a surrounding console mixer for VR version. It includes 8 sliders and 12 buttons. This time, all 8 sliders are horizontal; 9 buttons are used simply to trigger on/off functions, and the remaining 3 buttons are used for Play, Stop and Record functions.

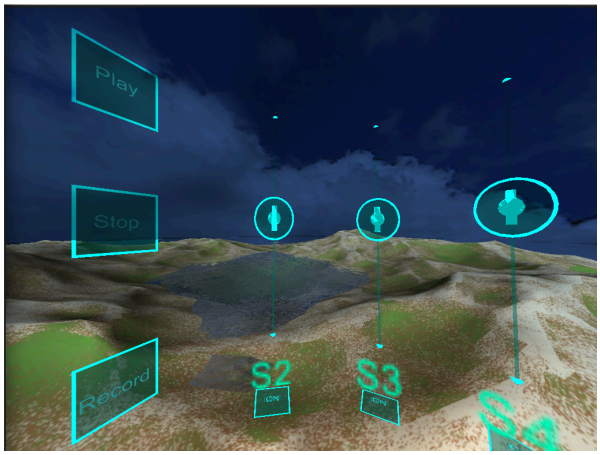

Figure 2， Screen Capture of Leap-motion Midi Controller Virtual Reality Version

To get the connection with DAW, I used the same UniOSC assets as the desktop version for this purpose. To build the environments, I used the same assets as the desktop version's background. But in the VR world, the user has 360 degrees to feel the environment. The aim is to make the user feel peaceful when they are working on their music project.

2.3. Bridge Application for Transfer OSC data to MIDI data:

After creating these software, I needed to have a bridge to transfer OSC data to Midi data in order to Midi map parameters inside DAW.

I used Max/MSP[9] to do this, by creating a Max application that allows users to easily map every component inside the software without conflict. It has a very simple function: users can map every single slider or button inside the software and get the midi data to their DAW.

Because of the OSC data keeps sending signals through my software, I created a sub-patch inside Max to arrange these components that can map for each parameter. I also created switches for each component, the user can simply click which components they want to map and it will close the other components and there will be no signal conflict when the user is Midi mapping. Then I created a "turn all components on" switch and "turn all components off" switch, which can make people easily close the connection between software and DAW when they do not want to use it.

I started learning Max/MSP programming after I came to

[9] P.24

Berklee. After two semesters keep digging into this software, I turned this software into the most useful tool for me. I made a Global Macro Controllable Max for live device and a Drum-pad drawing Max for live device by using Max. It leads me into the programming's world and really shows me the potential of this software.

3. Innovative Aspects

There are no any midi controllers that can connect to DAW for VR or gesture control currently in the market, so this is the first one to have this function and it is my original idea. When VR and AR technology become more developed, it will be more accurate to the user's gesture and more sensitive to value change.

I consider the future of performance and music production should totally get rid of hardware devices. I think the AR environment will be the best option to make this happen. Currently, Microsoft Hololens[10] can offer user the experience without the need of a mother computer because it contains a memory chip, therefore, it can run software without connecting to any other devices. That is the future of my project: provide standalone application that can be stored by AR and VR devices inside their built-in memories.

[10] P.24

4. New Skills Acquired

Without any knowledge in programming and 3D building, I took a huge step to make this happen. I began to study Unity 3D engine through online documentation and tutorials. I found my own way to create the connection between Unity and Ableton[11], which is get the OSC data from Unity 3D through UniOSC. Then trace the filled up position information of sliders to get the right OSC data, and do the same thing to trace buttons' 3D position information. Then use Max/MSP to filter out the useful data and transfer them to Midi data. I even had to use some time to learn C# coding language to make my software work well.

[11] P.24

5. Challenges

My entire project is full of challenges. I began with an empty 3D world in Unity 3D.

The first challenge that I faced was learning how to import a Leap-motion asset to Unity and make it work well, since the newest and best Leap-motion assets are only allowed to run on Windows systems. For this reason, I had to choose the beta version of Leap-motion in order to make it work. This version didn't have a good enough calculator of gestures and motions, so it made it very hard for my software to detect gestures. Nonetheless, it will work effectively when used with a Windows system and a better video card.

Then I created a whole user interface inside Unity and then came to the biggest challenge of my project: how to get UI data out and connect it to DAW? Should I use Midi data or OSC data?

After many hours of research, I discovered that the best option

for my user interface's information was using OSC data.

Since I can get OSC data from my software, I used Max to create a patch that allows me to transfer OSC data to Midi data, and I need to setup every component inside Max to the right value to then transfer them to 128 Midi value.

6. Connect with the music world

After I make sure my software can work well. How should I connect my software with the music world?

For demonstrating my software, I used Ableton Live Suite 9 as DAW to get Midi signal from my software. Then I can map every function inside Ableton, the same as normal Midi controller.

For both versions of my Leap-motion midi controller software, I used the same music project but with different midi mapping setting. I set up 1 DJ set for my software demonstration. It has 8 sliders to map to 8 different parameters, 3 buttons for control play, stop and record function, and the other buttons for trigger different scenes or clips. I also used Global Macro max for live device made by myself for organizing the parameters I need to map.

See inside my music project, I used session view for DJ set, and put two channels separately set up on deck A and deck B. Put

auto filter and flanger audio effects on both tracks, also reverb on send A and ping pong delay on send B. Because of I only have 8 sliders inside my software, I need to prepare and pre-wrap all tracks that I need to use. I used 4 sliders to map each channels auto filter's macro and flanger's macro. Used 2 sliders for mapping each channel's send B value. The rest 2 sliders inside my software I used one for cross-fader to cross fade deck A and deck B, the other one use for tempo change, and the amount of tempo change set up from 90 to 150.

After setting up all the sliders, I still have 6 buttons can map to what I want. I used 1 for tap tempo function, 1 for triggering next scene function. Then put beat repeat audio effect into both channels, used 2 buttons map to each channels' beat repeat on/off buttons. The rest of two buttons I used to trigger 2 scenes that I think it is an important scene in my set.

I have learned all these knowledge about how to set up the

digital audio workstation and how to set up my own project work best with my own usage habit when I studying in Berklee. Ableton Live had officially turned to my favorite digital audio workstation. I had finished few original electronic music by using Ableton Live in Berklee.

7. Future Ramifications and plans

After graduation, I intend to purchase a Windows system computer and a very good video card to use the newest assets for VR devices, Leap-motion, and AR devices. I already found an investor who is interested in my software and looking forward to seeing what will happen on AR devices. They promised to sponsor a Microsoft Hololens to help me build my software in an AR environment.

I will also try to collaborate with a programmer who is more familiar with 3D building and C# programming to work together to improve this software.

I would love to separate the future plan of my software in 3 main parts.

7.1. VR Console Mixer and AR Console Mixer:

For VR it will be 360-degree unlimited consoles that detect

your hand gestures by using Leap-motion. It can be controlled just like a real console without having any hardware console.

For AR, it will be a console that can be created by using AR devices brought into the real world. People can see the console pop up in front of them and surround them.

7.2. VR Instrument Synthesizer and AR Instrument Synthesizer:

I will start by building a VR abstractive synthesizer that has 4 different oscillators and 2 filters as well as LFOs and envelopes built inside. After this, I will build 3D models for the instruments used such as drums, guitars, and keyboards. These instruments will be controlled through gestures.

For AR, I will create a real-time generator for keyboards, instruments and synthesizers that can be projected into real world surface by using AR devices.

7.3. VR and AR Digital Audio Workstation:

The final step of my project would be to build an independent digital audio workstation for both VR and AR environments. It should include multiple audio and midi channels, mixers and synthesizers and virtual instruments. Users can easily use this DAW as creative input as well as to mix and perform their music in VR and AR environments.

8. Conclusion

My culminating experience is to develop a VR midi controller that has 360-degree controllable components. It has buttons and sliders included and can easily to map to the parameters inside digital audio workstation.

I learned how to build 3D environment and programming language in order to make this happen, and choose the nature environment for my software, which I think will make user more comfortable when they put on the classes.

I created music project to demonstrate my software. With this music project, I can perform music with my software and demonstrate to the world.

Since more and more new technology comes out, the music industry has suffered tremendous changes in few years. The main purpose of my project is to push the music industry into the next level and give musicians a more interesting and freer way to

produce and perform their music.

I envision a day when musicians will not need to bring their heavy instruments with them. They will just bring VR classes or AR classes, which can store DAW and all their music projects inside built-in memory, and the audience can easily watch what musicians are doing when they are on the stage. It will influence music industry, encompassing everything, from the audience to musicians.

Let us turn on the next page of the music industry and use our imagination to create a virtual experience for music.

9. Bibliography

1——Virtual Reality:
https://en.wikipedia.org/wiki/Virtual_reality

Virtual reality (VR), also known as immersive multimedia or computer-simulated reality, is a computer technology that replicates an environment, real or imagined, and simulates a user's physical presence and environment to allow for user interaction. Virtual realities artificially create sensory experience, which can include sight, touch, hearing, and smell.

2——Graham, M., Zook, M., and Boulton, A. "Augmented reality in urban places: contested content and the duplicity of code." Transactions of the Institute of British Geographers, DOI: 10.1111/j.1475-5661.2012.00539.x 2012.

3——Augmented Reality:
https://en.wikipedia.org/wiki/Augmented_reality

Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data. It is related to a more general concept called mediated reality, in which a view of reality is modified (possibly even diminished rather than augmented) by a computer. As a result, the technology functions by enhancing one’s current perception of reality.

4——MIDI Controller:
https://en.wikipedia.org/wiki/MIDI_controller

In practice, MIDI controller refers to a device that controls

parameters of a performance. The MIDI Controller can be populated with any number of sliders, knobs, buttons, and other sensors, and may or may not include a piano-keyboard.

The term MIDI controller can be used literally or point to a particular scenario of how a device is used.

Used literally, MIDI controller refers to any hardware or software that generates and transmits MIDI data to MIDI-enabled devices.

5——Digital Audio Workstation (DAW) :
https://en.wikipedia.org/wiki/Digital_audio_workstation

A digital audio workstation (D.A.W.) is an electronic device or computer software application for recording, editing and producing audio files such as songs, musical pieces, human speech or sound effects.

6——Leap Motion:
https://en.wikipedia.org/wiki/Leap_Motion

Leap Motion, Inc. is an American company that manufactures and markets a computer hardware sensor device that supports hand and finger motions as input, analogous to a mouse, but requires no hand contact or touching.

7——Unity Game Engine:
https://en.wikipedia.org/wiki/Unity_(game_engine)

Unity is a cross-platform game engine developed by Unity Technologies and used to develop video games for PC, consoles, mobile devices and websites.

8——Stefan Schlupek, UniOSC:
http://uniosc.monoflow.org/

UniOSC is a tool to easy creates Unity3d applications, which can be controlled by hard/software that uses the OSC protocol for communication. OSC is protocol for distributed systems that is mainly used in the music industry and is often used as an alternative to MIDI.

9——Cycling 74 Max 7:
https://en.wikipedia.org/wiki/Max_(software)

Max is a visual programming language for music and multimedia developed and maintained by San Francisco-based software company Cycling '74. During its history, composers, performers, software designers, researchers, and artists to create recordings, performances, and installations have used it.

10——Microsoft Hololens:
https://en.wikipedia.org/wiki/Microsoft_HoloLens

Microsoft HoloLens, known under development as Project Baraboo, is a pair of mixed reality head-mounted smart glasses developed and manufactured by Microsoft Corporation. HoloLens gained popularity for being one of the first computers running the Windows platform under the Windows 10 operating system.

11——Ableton:
https://en.wikipedia.org/wiki/Ableton

Ableton AG is a Berlin-based music software company that produces and distributes the production and performance

program Ableton Live and a collection of related instruments and sample libraries, as well as their own software controller Ableton Push.