Leap Motion Controller Impact On Music and Music Education

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Abstract

The purpose of this research is to show the potential impact that the Leap Motion 3D controller has on the realm of digital music and music education. The focus of the project was the creation of a digital theremin in order to exemplify the ease of Leap application development, as well as to explore practical uses of the Leap in digital music and music education. For digital musicians, the Leap has the potential to reduce the time it takes to trigger an event (such as queuing a song or changing an effect's properties without the need of multiple knobs and buttons). The Leap benefits musical education through the emulation of traditional instruments that any student with a computer could interact with in 3D space. Both musical educators and digital musicians can benefit from the Leap controller's free and well-documented API that allows for faster development time. We conclude that the Leap Motion 3D controller has great potential as a learning tool for music education and as an aid to digital musicians.

Introduction

Learning to play music requires expensive instruments, feedback from an experienced musician, and repetitive, dull practice. Music performers (specifically electronic performers) also require costly instruments and sometimes a wide array of external hardware in order to interact quickly and efficiently with a computer. However, with a motion capture device like the Leap Motion Controller, learning and performing music can be simplified. The controller (developed by Leap Motion) provides an inexpensive and easy way to capture hand gestures and finger position in interactive software. With the Leap Motion Controller, aspiring musicians and music educators can save money by emulating traditional instruments on computers instead of purchasing multiple instruments, make learning more intuitive with body-centric interaction, and save educators' time by providing the learning musician with digital instruction through the instrument-emulating application. Also, the Leap can benefit electronic musicians by replacing much of the external hardware performers use to interact with the computer with virtual buttons and hand gestures, improve showmanship with more compelling movement by the performer, and expand the creativity of the performer with the new concept of using motion to make music.

Fig. 1. Leap Motion Controller.

Methods and Approach

To display the Leap's potential, we created a virtual theremin for the Leap to exemplify the Leap's ease of use and development. The user's left hand controls pitch, while the user's right hand controls volume. One octave of notes can be played with the left hand and the right hand can make the note as loud or as quiet as possible. To the right is a picture of the theremin being played. The pitch of the note being played is G because of the openness of the user's left hand.

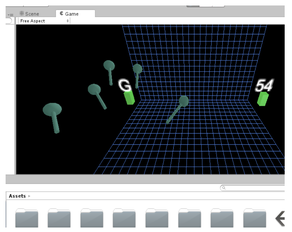

Fig. 2 Virtual theremin application.

Initial Results

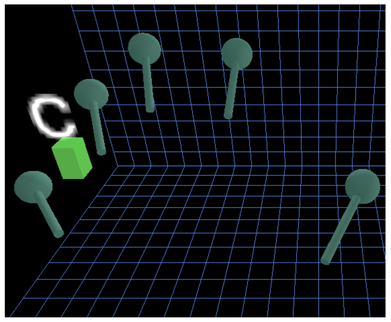

Fig. 3 Virtual theremin hand and note display.

We created our virtual theremin in the Unity 3D game engine. Leap's software development kit came with the hand model and grid shown in Figure 3, which made it easier to focus on the functionality of the theremin during development. The letter "C" is displayed because that is the note being played in the image.

In Figure 4, the number "43" is displayed as the volume that has been set with the user's right hand. The small green shape in the image grows and shrinks as the volume is increased and decreased.

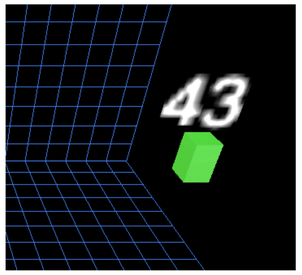

Fig. 4 Virtual theremin volume display.

Figure 5 shows the references to Leap Motion's SDK and the third-party midi libraries used in the theremin application. The IDE in Figure 5 is Visual Studio. Because Unity 3D integrates with Visual Studio, developers for the Leap are able to program in a familiar environment.

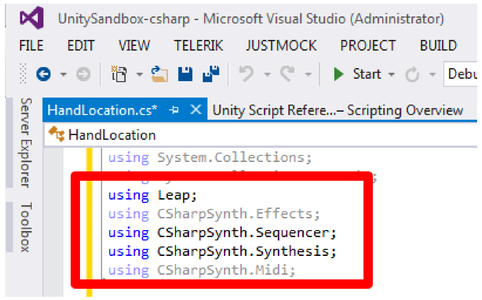

Fig. 5 Visual Studio integration with Unity and Leap

A code snippet from the virtual theremin is displayed in Figure 6. The Update function is called in intervals and determines the pitch and volume that the theremin will play. Leap's SDK includes custom types Hand and HandList which represent actual hands detected by the Leap. The Hand type contains a value representing the radius of a sphere that could fit in a detected hand. The sphere radius is the value we use to determine the pitch and can be visualized by the illustration in Figure 7.

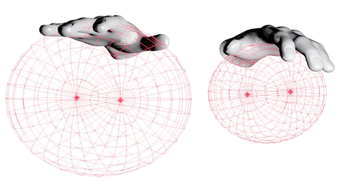

Fig. 7 Leap sphere radius illustration

```
// Update is called once per frame
0 references
void Update () {
    var frame = _leap.Frame(); // controller is a Contro
    HandList hands = frame.Hands;
    Hand pitchHand = PitchHand();
    Hand volumeHand = VolumeHand();
    print(pitchHand.PalmPosition);
    midiNote = Convert.ToInt32(pitchHand.SphereRadius);
```

Fig. 6 Leap SDK logical conventions

Interpretation of Findings

Leap's Benefits For Music Educators and Learners

There is already a range of traditional, Leap-controller-enabled virtual instruments available for download on Leap's app marketplace, Airspace. Namely: Chordion Conductor, AirHarp, and Theremin.

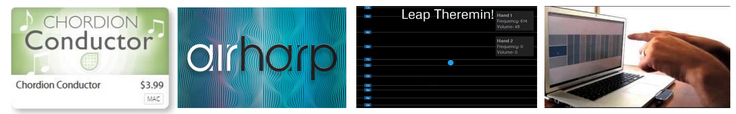

Fig. 8 – 11 Musical Leap Motion Controller applications available on Leap's app marketplace.

The Leap Motion Controller creates a natural user interface that utilizes a person's skills acquired through physical interaction, making the Leap easier to learn with.

Leap's Benefits For Musicians

Electronic performers using the Leap can eliminate the need for many time-consuming, unintuitive buttons and knobs and instead use natural gestures and movements in order to save time.

In addition to making electronic musical performance more efficient, the Leap can also improve musicians' showmanship.

Conclusions/Recommendations

The Leap Motion Controller and similar motion capture devices are beneficial to music education because such devices make traditional instruments more accessible through software-enabled instrument emulation, make learning more intuitive through natural, memorable movement, and allow learning musicians to study independently by receiving instruction from the software. In addition, the Leap benefits performers because it reduces time, improves showmanship, and expands creativity for the performer by replacing many unintuitive buttons with intuitive gestures and motions. Thus, the Leap Motion Controller is a novel device in order to improve the way electronic musicians perform and how music is taught.

Future Work

In the future, we hope to experiment with the design of more traditional and complex virtual instruments and to examine whether it is an effective music learning device.

References

1. Leap Motion Controller. Digital image. *Mashable*. N.p., n.d. Web. 10 Jan. 2014.
2. AirHarp. Digital image. *HandWavy*. N.p., n.d. Web. 10 Jan. 2014.
3. Chordion Conductor. Digital image. *LeapMotion*. N.p., n.d. Web. 10 Jan. 2014.
4. Chordion Conductor for the Leap. Digital image. *Frequency*. N.p., n.d. Web. 10 Jan. 2014.
5. "Leap Motion - 6 Songs in the Key of Leap Motion." *Leap Motion - 6 Songs in the Key of Leap Motion*. N.p., n.d. Web. 22 Dec. 2013.
6. Vikram, Sharad. "Handwriting and Gestures in the Air, Recognizing on the Fly."
7. Hong, Jason, and Mary Baker. "Interaction Platforms, Energy Conservation, Behavior Change Research, and More." *IEEE Pervasive Computing* 12.3 (2013): 0010-13.
8. Fan, Xin, and Georg Essl. "Air Violin: A Body-centric Style Musical Instrument." *Ann Arbor* 1001: 48109-2121.
9. "What's Cool, New and Made with Unity?" *Unity*. N.p., n.d. Web. 24 Dec. 2013.
10. *Leap Sphere Radius*. Digital image. LeapMotion. N.p, n.d. Web. 10 Jan. 2014.