

MUSIC INSTRUCTION IN A VIRTUAL/AUGMENTED REALITY ENVIRONMENT USING THE CAVE 2 AND MICROSOFT HOLOLENS

By

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Abstract

This project's purpose was to investigate the ability of virtual reality to teach music. An application was developed for the CAVE 2 and Microsoft Hololens, and their ability to teach music effectively was analyzed. Both the applications teach the user how to play 'Mary Had a Little Lamb' on the viola, and each virtual reality platform had its own benefits and drawbacks. An user interface was created for both platforms that shows the user the correct bow direction, tempo, fingering, and sheet music. Additional features included adjustable tempo and a metronome that can be turned on and off. The application was helpful since the user could get visual cues from the graphics while still keeping an eye on his/her instrument. Future goals for the application include songs that can be uploaded by the user, microphone input, more instruments, and better graphics. The results of this research show that music instruction is a viable possibility in a virtual reality environment and will spark developers and musicians to work together to further explore this field.

Motivation

Virtual and augmented reality is becoming a growing field as numerous companies are releasing products that are more immersive and precise. The most popular applications of virtual reality have been in gaming and consuming media; teaching has not been a primary focus. Companies like Harmonix and VRTIFY have already created application that merge VR and music, but nothing has been created to instruct music using VR. VR is ideal for teaching an instrument, such as the viola, since the user can get visual and audio cues from the application that will help them understand the piece while still being able to interact with his/her instrument. The Electronic Visualization Laboratory at UIC specializes in virtual reality with devices like the CAVE 2, HTC Vive, and Microsoft Hololens. Each of these devices has their own benefits and drawbacks. This project focused on the CAVE 2 and the Microsoft Hololens.

CAVE 2-Device Overview

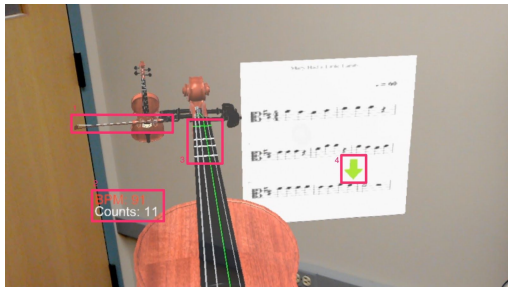
The CAVE 2 is a large-scale virtual reality environment developed at UIC and licensed by Mechdyne. The CAVE 2 is approximately 24 feet in diameter and 8 feet tall, containing 72 seamless passive 3D panels (cite). The CAVE 2 has 18 "nodes" or computers that each drive 4 monitors. These 18 nodes are controlled by a master node. Infrared cameras located around the circumference of the CAVE 2 detect certain patterns in 3D space. These patterns are made as "trackers" that can be placed on certain objects, for example the user's 3D glasses, so the CAVE knows where the user and can adjust to image accordingly. Users can also interact with the

CAVE using PS3 controllers. The CAVE 2 is used by researchers around the world to collaborate, visualize data, and explore virtual reality.

Microsoft HoloLens Device Overview

According to microsoft.com, the “Microsoft HoloLens is the first fully self-contained, holographic computer, enabling you to interact with high-definition holograms in your world,” (microsoft.com). The HoloLens augments reality, therefore the user can see what is around them while using the device. This is useful for teaching since the user can look at his own instrument while getting visual cues that are overlaid on top of their vision. Users can input into the HoloLens through speech, gestures, a clicker, or a keyboard. Speakers are located by the user’s ears or headphones may be used. A major downside to using the HoloLens is its small field of view that limits the amount the user can see at a certain time.

User Interface



There are 4 main parts to the user interface of this application on both platforms: fingering, bow direction, tempo, and sheet music. There are 4 tapes on the instrument that glow green when a finger needs to be placed at that location. Most beginner string players have similar tapes on their instrument so they will be able to relate to what they are seeing. Since the small field of view of the Microsoft HoloLens prevents the user from seeing the bow on the string, a small instrument next to the scroll of the large instrument shows the user which direction and how fast their bow should be moving. In the bottom left of the field of view, the beats-per-minute (BPM) and counts are shown. The user can input the BPM by pressing the spacebar to the beat that they want to play before the piece starts. It can be modified during the lesson as well. Lastly, there is a green arrow present on the sheet music. This arrow moves through the music so the user doesn’t get lost while playing the piece and has an idea of what the music looks like on the page as well. Features can be turned on and off accordingly as the user starts to master the piece.

Application Development

The application for the CAVE 2 was created using Unity 5.2.3 along with the getReal3D plugin developed by Mechdyne. GetReal3D is used to help with synchronization and tracking objects in the CAVE 2. Numerous C# scripts were used to find the position of the user’s head, bow, and instrument. The virtual environment on screen changes accordingly.

In order to develop for the Microsoft HoloLens, a beta version of Unity (version: 5.4.0f1), the HoloLens SDK, and Microsoft Visual Studio are required. Microsoft has a HoloLens Academy

that outlines the basics like camera position and configuring Unity to work with a augmented reality device.

Improvements and Future Goals

For the Microsoft Hololens, audio input from the microphones could be analyzed to understand if the user is playing the notes at the right frequency at the right time. Currently, the Hololens SDK only allows for voice recognition, but in the future this will be a viable option. Additionally, users should be able to upload their own MIDI files so they can play whatever piece they want on any instrument. Lastly, since the display is so close to the user's eyes, the resolutions of certain graphics needs to be bumped so the application looks better.

On the CAVE 2, similar improvements can be made. An additional improvement for the CAVE 2 is to allow numerous musicians play together since the CAVE 2 is such a big environment. Musicians who want to play a duet or string quartet can come together and get instructed by the application.

Conclusion

Virtual/augmented reality is a viable option in instructing music. It lets the user interact with their real instrument while taking cues and direction from a virtual one. The CAVE 2 did a good job at tracking the user's instrument and creating a more immersive environment. The Hololens was a more portable solution that did a better job at instructing because the virtual instrument is overlaid on the real one, so the user can see both without moving their eyes too much. Improvements can be made to both platforms to make them more polished applications, but these applications stand as a proof of concept that music instruction is very possible in a virtual environment.

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