3D Positional Movement Interaction with User-Defined, Virtual Interface for Music Software: MoveMIDI

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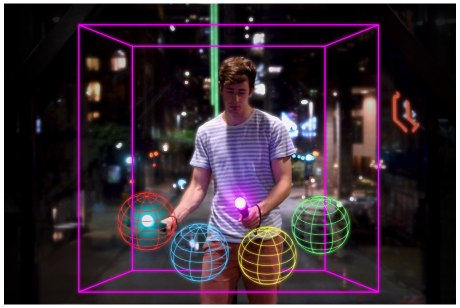

Figure 1: Representation of MoveMIDI's virtual MIDI controller interface. Sphere Icon: ⓒⓘ by Gonzalo Bravo from the Noun Project.

Figure 2: Example of a traditional MIDI controller with piano keys, knobs, and pads. Photo by Cedrik Malabanan from Unsplash.

ABSTRACT

This paper describes progress made in design and development of a new digital musical instrument (MIDI controller), MoveMIDI, and highlights its unique 3D positional movement interaction design differing from recent orientational and gestural approaches. A user constructs and interacts with MoveMIDI's virtual, 3D interface using handheld position-tracked controllers to control music software, as well as non-musical technology such as stage lighting. MoveMIDI's virtual interface contributes to solving problems difficult to solve with hardware MIDI controller interfaces such as customized positioning and instantiation of interface elements, and accurate, simultaneous control of independent parameters. MoveMIDI's positional interaction mirrors interaction with some physical acoustic instruments and provides visualization for an audience. Beta testers of MoveMIDI have created emergent use cases for the instrument.

KEYWORDS

Music; MIDI Controller; Positional Interaction; User Defined Interface; RBI; MR; VR; AR;

CHI'19 Extended Abstracts, May 4–9, 2019, Glasgow, Scotland UK

ACM ISBN 978-1-4503-5971-9/19/05.
https://doi.org/10.1145/3290607.3313267

Figure 3: Example of a MIDI controller with pads, knobs, sliders and buttons. Photo: *CNTRL:R* 🅭🅯 Livid Instruments from Flickr

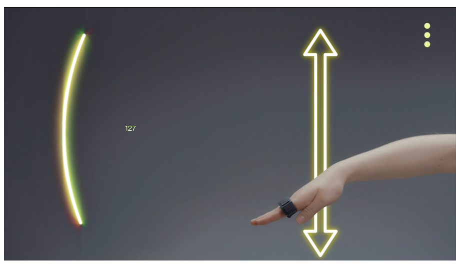

Figure 4: Wave Ring: A MIDI controller which uses orientational interaction. User demonstrates tilt interaction. Still Image from video © Genki Instruments used and modified with permission.

INTRODUCTION

Computers have become a prominent tool for creating and performing music. Natural and expressive interaction to control music software is key for an electronic musician to perform proficiently. This paper explores 3D position-tracked movement interaction for music software with a prototype instrument, MoveMIDI.

Musicians interact with hardware instruments called MIDI Controllers which send digital MIDI signals to music software to produce sound from a computer. MIDI is a standard digital communication protocol for music. By using a MIDI Controller to control to music software, a musician can play the software as an instrument, playing any digital instrument sound in the computer.

In an exploration of user interaction with music software, Arterbury began developing MoveMIDI in December 2016. MoveMIDI uses 3D positional tracking technology to track the location of handheld controllers in space allowing for a user's movements to be interpreted relative to a positional, virtual interface around them. MoveMIDI allows the user to define a virtual, 3D MIDI controller interface layout, map that interface to various functions in music software, and play that interface and mapping combination as a musical instrument. Essentially, users can create and manipulate music by moving their arms in positional space. The initial implementation uses PlayStation Move controllers and the PlayStation Eye camera for tracking 3D position of handheld controllers. Arterbury developed a MoveMIDI desktop GUI application that communicates with the tracking hardware, visualizes the virtual interface, allows the user to specify MIDI mappings, and generates MIDI signals. The software uses the PS Move API by Thomas Perl to communicate with the PlayStation hardware. MoveMIDI for PlayStation Move hardware is now in a beta testing stage with around 19 beta testers. In the future, MoveMIDI intends to support other 3D positional tracking hardware such as VR, AR, and MR systems.

RELATED WORK

Motion Interaction for Electronic Instruments

The idea of using human motion to control electronic musical instruments is not a new idea. In 1920, Leon Theremin invented the Theremin, a musical instrument played by moving one's hand towards and away from electronic antennae to create sound. Recently, steps have been taken to use motion interaction to control MIDI. The Wave MIDI ring tracks **orientation** (pan, tilt, and roll) of the user's hand to control music software. The Mi.Mu Gloves, created by Imogen Heap, and the Satta MIDI Glove, based on research by Elena Jessop, detect changes in **gestural** hand postures to manipulate music software [3] [2]. A natural extension of these motion interaction practices with music software is **positional interaction**, which MoveMIDI explores.

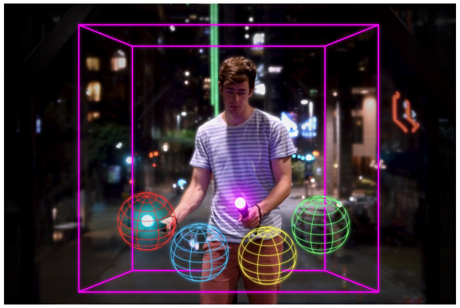

Figure 5: Representation of MoveMIDI's Hit Zones as 3D spheres and Morph Zone as a cuboid volume. Sphere Icon: 🅭🅯 by Gonzalo Bravo from the Noun Project.

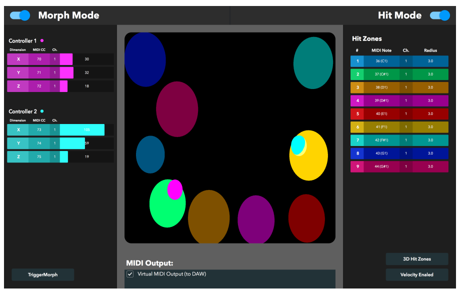

Figure 6: MoveMIDI's application GUI with visualization of 3D Hit Zones and handheld controller positions and MIDI mapping settings.

MOVEMIDI: DYNAMIC, USER-DEFINED VIRTUAL INSTRUMENT

MoveMIDI allows the user to define a virtual instrument construct with which they will interact. This instrument definition consists of three parts: the **virtual interface layout**, the **MIDI mapping** of that interface, and the **MIDI target** which receives the MIDI messages. First, the user defines the 3D positions and sizes of virtual interface elements with which they will interact. Second, the user creates a mapping from actions done on the virtual interface to MIDI signals which should be sent to the MIDI target. Third, the user chooses the target to receive the MIDI messages. The target is most often a piece of music software which can generate sound from the MIDI messages it receives.

To construct the virtual interface layout, the user positions multiple instances of the two types of virtual interface elements. **The first interface element is a Hit Zone**. Hit Zones are spherical volumes in 3D space. When a user hits a Hit Zone with their handheld controller, the zone will generate an associated MIDI Note message. MIDI Note messages are often mapped to trigger musical notes or audio samples. The harder a user hits a Hit Zone, the louder or more harsh the sound becomes. Hit Zones are great for "air-drumming". **The second interface element is a Morph Zone**. Morph Zones are cuboid volumes in 3D space which a user may move their hands through to send MIDI Control Change messages which are often mapped to manipulate timbral parameters of sound. A user can map each of the X, Y, and Z components of their hand's location in a Morph Zone to independent parameters. Morph Zones are great for manipulating effects and are advantageous for manipulating many parameters simultaneously, yet independently, and accurately. On traditional MIDI controllers, users are limited to the number of knobs or sliders they can manipulate accurately at once. With MoveMIDI, 3 independent parameters can be manipulated simultaneously per handheld controller as accurately as the user is able to move their hands through space.

MOVEMIDI: POSITIONAL INTERACTION

The primary difference between MoveMIDI and other motion based MIDI controllers such as Mi.Mu Gloves is MoveMIDI's use of positional interaction relative to the virtual interface around them. The difference between gestural and positional is easily seen in the use case of "air-drumming". In a positional approach, the user places a set of positional triggers in various disperse locations, mapping each zone to a unique drum sound. The user then strikes the zones as if they were physical drums to play the sounds. With a purely gestural controller it is not possible to vary location of gestural interactions to result in different sounds. A user could map a strike gesture of each hand to different drum sounds, but to add additional drum sounds they would need to define variations of the gesture by modifying orientation or direction of the hand. The user could not simply translate the same gesture to a different location in a room to result in a different drum sound or mapping.

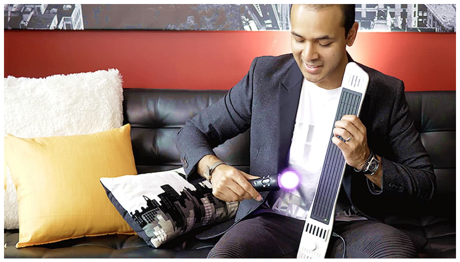

Figure 7: Sanjay Christo playing MoveMIDI and the Antiphon Instrument 1 as a virtual cello. Photo by Sanjay Christo from YouTube video thumbnail.

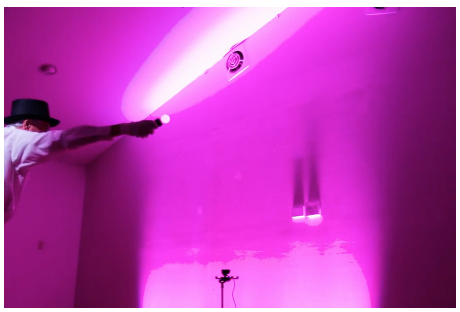

Figure 8: Jeff Firman controlling stage lighting with MoveMIDI. Still image by Jeff Firman from YouTube video.

While gestural and orientational approaches are useful, there are advantages to a positional approach. We all interact with the physical world in a positional way. MoveMIDI's positional approach aligns with themes of RBI (Reality-Based Interaction) and may be natural for users due to their pre-existing knowledge of the physical, non-digital world [1]. Positional interaction eliminates some interface-specific skills the user would need to learn to interact with MoveMIDI.

A user's prior knowledge of physical acoustic instruments strengthens the positional interaction approach. Many acoustic instruments require positional interaction. On a piano, low pitched notes are on the left of the keyboard and high pitched notes are on the right. Each drum in a drum-set is a positional element. Positional movement of a bow relative to the strings of a cello creates sound. This relation to acoustic instruments can also be a metaphor which a performer employs to contribute to the audience's understanding of a performance. MoveMIDI's strike and wave motions promote visual metaphors with acoustic instruments for an audience.

EMERGENT USE-CASES, CONCLUSION, AND FUTURE WORK

Beta tester Sanjay Christo used MoveMIDI to metaphorically bow a virtual cello in a video demonstration. Jeff Firman used MoveMIDI to manipulate stage lighting sequences and sound simultaneously in a video demonstration. Past research and user usage/feedback imply that MoveMIDI concepts may benefit human interaction with digital musical instruments. MoveMIDI's positional interaction differs from recent gestural and orientational interaction approaches. MoveMIDI's abstraction of a user-defined virtual instrument definition leads to emergent use-cases. To improve MoveMIDI, Arterbury plans to combine interaction styles, provide better visualization with VR/AR/MR, and explore better haptic feedback solutions. Arterbury plans to explore future use-cases of MoveMIDI in music education, accessibility, dance, and multi-person instruments. To learn more about MoveMIDI, visit https://movemidi.com.

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