MIDI Motion: Interactive Music Composition Gloves

Kristofer Klipfel
University of Colorado
Boulder, CO, 80302
krkl5448@colorado.edu

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Abstract
Midi Motion Gloves is an interactive wearable that is used to manipulate, organize, and construct audio patterns for the purpose of composing music. Acting as an interface between the user and a Digital Audio Workspace, or DAW, the gloves give a user complete control over customization of sounds, effects, tempo, recording, looping, and other musical elements. MIDI Motion gloves utilize organic human movement like finger bending, hand rotation, and finger tapping to trigger audio clips or add effects and filters, ultimately allowing the user to efficiently compose and visualize complex musical patterns in a three-dimensional space.

Author Keywords
MIDI, music, motion, gloves, composing, tangible, patterns, sensors, pressure, flex sensor, wearable

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

Introduction
The techniques that an artist develops to physically interact with a musical instrument are vital to the creative composition process. Reliable research has demonstrated that areas of the brain involved in musical performance and composition may work in

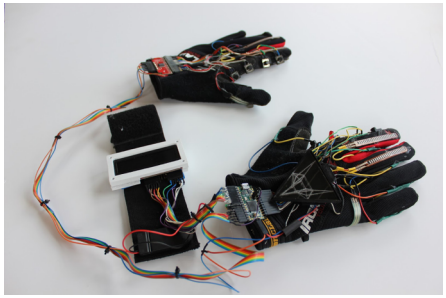

Figure 1: Working Prototype

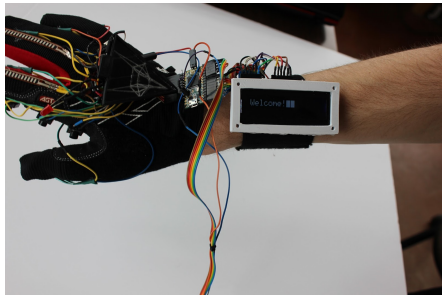

Figure 2: LCD Interface

association with other areas that are dedicated to motor skills [1]. Using a computer to create music in a Digital Audio Workspace can therefore cause a user to feel disconnected from the natural flow of musical composition, since the tactile nature of playing an instrument has then been eliminated. By constantly typing, clicking, stopping and restarting the music, the process may become tedious, choppy and end up thwarting the creative process. MIDI Motion gloves bridge the gap between user and software, in order to transform this static creation process into a more dynamic, tangible, and natural approach to digital music composition. The gloves are a functional composition tool because the link between each movement and each sound is predictable, controllable, and fully customizable. By quickly being able to toggle between a variety of sounds the user is capable of layering and composing, ultimately strengthening the artist's connection to the music as they develop musical patterns.

Technical Implementation

MIDI Motion utilizes a variety of sensors and buttons to translate tactile data into musical information interpreted by the music composition software. On each fingertip there is a force sensitive resistor (FSR) also known as a pressure sensor that registers touches and taps and in response triggers corresponding pitches and variable volume based off the speed at which the sensor collides with a surface. On the back of the index and middle fingers of each hand there are two flex sensors that, when bent, send values ranging from 0-127 to control variable effects like volume, frequency, and panning. On the side of each index finger there are four buttons that each correspond to different controls within the program such as navigation, sound toggling, undo/redo, stop/start, and up octave/down octave. To extend customization and functionality, an LCD screen (Figure 2), strapped to the wrist, acts as an interface between the gloves, the user, and the program, allowing the user to program the finger pitches to any scale in any key. (Major, Minor, Blues, Pentatonic). Lastly, a microcontroller (Teensy 3.2) on the right hand receives analog and digital signals from the sensors and then communicates with the computer through serial, keyboard, and MIDI signals.

Design Process

The design approach was developed by exploring the pros and cons of various composition and music development methods. By recognizing the major challenges and pitfalls that are present in the current music production process I was able to develop an efficient and interactive approach for making music composition a fluid, expressive, and enjoyable experience. Also, by analyzing the usage of certain commands and controls (undo, redo, up, down) I was able to make informed decisions on what features would be most valued among users.

When determining placement for sensors and controls, ergonomics was the primary consideration. Sensors on each hand are placed in locations optimal for ease of use and quick access. For example, the FSRs on the fingertips were placed just above the pads of the finger taking advantage of the natural curve of the fingers, providing a comfortable resting position and tapping angle. Control buttons were placed along the sides of the index fingers allowing easy access while simultaneously being non-intrusive to surrounding fingers. This allows the user to comfortably trigger sounds at a variety of speeds.

Related Work

While there has been a lot of research on futuristic musical interfaces, for example reacTable at TEI 2007 [2] or fabric-based multi-touch musical controllers presented at NIME [3], the most popular commercial tools for composition and performance are MIDI devices [4]. This is because of their customizability, versatility, and ease of use compared to a plain keyboard and mouse. Ableton Push is one of the most popular pieces of hardware on the market for arranging, performing, and sequencing audio [5]. Push communicates with Ableton Live, music production software, and contains velocity sensitive push pads that give the user tactile feedback while composing and arranging [5]. MIDI Motion expands upon this design by providing the user with a simpler and less constraining interface. The ability to flexibly move the hands in space allows for a more natural creative environment. Another similar technology developed by British artist Imogen Heap employs the use of three-dimensional space to manipulate pre-recorded sound. Heap's wearable presented at WIRED 2012 Conference is able to use changes in hand position to synthesize, manipulate, and alter certain sounds in a pre-recorded track. [6] MIDI Motion further expands upon this design by not only allowing the user to change sounds, but also create replicable musical patterns and rhythms.

Discussion

Interactive music gloves like MIDI Motion are the next step in tangible and interactive musical development. The ability of a musician to use their fingers to quickly layer and compose musical patterns in an unconstrained physical space allows them to be more emotionally involved and connected to the music being created. This also makes music production and performance more intuitive and less complicated for users not familiar with musical concepts. MIDI Motion immerses users into a fluid musical experience by employing natural movement to musically express and compose. While gestural MIDI gloves have a number of advantages over other forms of MIDI control and musical sequencing, there are limitations. MIDI Motion gives the user full control to program fingers to different pitches and scales but because the human hand has 10 fingers, users must track which pitches correspond to which finger as there are only 8 notes in any given scale. MIDI Motion gloves provide the user with a unique sound and motion experience combining the benefits of a traditional MIDI pad controller with those of other gestural MIDI devices on the market. In the future, allowing greater software navigation control and sequencing options will give the user more freedom to customize and control music throughout the composition process.

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