Mid-Air Haptics for Digital Musical Instruments

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Abstract
For this workshop, we discuss our work implementing the Ultrahaptics system as a tactile display for music interaction. With the provided API we have compiled modules for the popular music programming environment Max, and extended an existing digital musical instrument with haptic capabilities.

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Haptics, feedback, HCI, digital musical instruments.

ACM Classification Keywords
H.5.2 [User Interfaces]: Haptic I/O; H.5.5 [Sound and Music Computing]: Systems.

Introduction
The incorporation of haptic and multimodal feedback into new digital musical instruments (DMIs) has been an important step in music interaction design. One of the defining features of digital musical instruments is the physical separation of user interface from means of sound production [2]. While this affords limitless opportunities in interaction and sound design, much of the natural haptic feedback that an acoustic instrument would produce is no longer present, which can lead to an instrument that is more difficult to control and less expressive. Therefore, the option to implement active haptic feedback into a digital instrument can benefit

the performer by restoring some of the “feel” of an acoustic instrument [1].

Many of the haptic feedback systems that are currently being used in musical applications rely on low cost, low fidelity vibrotactile actuators that must be attached to the body and commonly experience issues with consistent surface contact and skin sensitivity. Furthermore, in the context of instrumental performance, the physical bulk of devices, clothing, gloves, etc., may hinder free movement. Thus, the ability to deliver hands-free high resolution haptic signals shows great potential for music applications.

Mid-air Haptics for Max/MSP

Open air controllers are a frequent choice of control in the design of DMIs, where the performer produces gestures in air, to evoke specific musical results. Max[1] is a modular programming environment that DMI designers and performers often use to define the behavior of DMIs. Here, we first encapsulate the Ultrahaptics array technology into the Max environment as a self contained module (Max Object), thereby allowing a DMI designer to define haptic behavior for an instrument using only higher-level parameters such as the position of haptic stimulus in space, intensity of the stimulus, and the frequency of vibration of the stimulus. Because Max is a popular and flexible programming and prototyping environment for DMI and music interaction design, this step provides an accessible tool for musicians and designers to implement mid-air haptic technology into use.

Case Study: AUMI

Next we demonstrate the ability to extend an existing instrument with haptic capabilities. The Adaptive Use Musical Instrument[2] (AUMI) is a software-based musical instrument designed to enable individuals with very limited controlled movement to participate in music making [3]. The primary user interface uses a web camera and computer vision library for Max to track the user’s movements and trigger musical events across a grid displayed on the screen.

Using the Ultrahaptics Max module, we have created an alternate input device for AUMI that incorporates haptic feedback in an open-handed interface. The user controls the instrument with one hand over the haptic array, which generates a haptic image of the grid that the hand moves across. In this way the user should be able to feel discrete boundaries that can contribute to a better spatial awareness of their movements and control over the instrument.

Discussion

By implementing mid-air haptic feedback into a commonly used music programming environment, we were able to experiment with the technology while performing musical tasks, and can reflect on the potential success and efficacy of such a system in music interaction contexts.

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[1] http://cycling74.com
[2] http://aumiapp.com