OCAD University Research Summary

slug: research2

Adam Tindale Michael Cumming 2014-8-27

Vibrotactile Arrays for Haptic Information Display

Description

Haptic arrays can be at various resolutions and serve various purposes. The body only has so much capacity to perceive discrete haptic stimulation, therefore with a wrist-worn device there is limited real-estate to place tactors and only so much density that haptic arrays can achieve. This influences the type of information that be represented using haptic arrays.

Progress

Two wrist device have been built with haptic arrays. Two rubber wristbands, one consists of 1x 8 tactor array and another with a 3x8 tactor array with buttons and LEDs. Two felt bands, one with a 1x8 tactor array, and another with a single tactor. The user interfaces are basic in all these bands. One is automatically controlled from an Arduino, one has buttons corresponding to tactors, two have variations of ‘Simon Says’ games using buttons as user input.

Notation For Vibrotactile Arrays

Description

Haptic arrays consist of many tactors, often in grid configurations. Each motor can vibrate in time with a given intensity. The function of these arrays is varied: they can be used to notify wearers of incoming messages on social media, to tell when the wearer is geographically near a point of interest, or for showing directions to a desired destination. They can also be used to entertain the wearer with stimulating patterns that evolve over time, similar to musical structure.

Authoring and programming such arrays can be difficult because of the lack of a standardized notational system and standard file format. Typically, each implementation of haptic arrays uses bespoke programming, and much effort is duplicated unnecessarily. We propose that standard musical notation is appropriate and useful for the design of patterns utilizing such arrays. The implementation on the microcontroller is provided using the MIDI format: a standard digital format with a strong ability to represent time and discrete events, which fulfills the criteria to control each motor effectively.

It would be advantageous if a wide variety of people, including those with music composition backgrounds, could author these patterns rather than wearable device technologists who are likely unfamiliar with musical patterns and both standardized and innovative approaches to their notation. The feedback from embodied patterns to musical expression is an area of future investigation.

Using standard musical notation and associated techniques affords several interesting possibilities, including: opportunities to represent patterns in more sophisticated ways, to offer a canonical method for researchers and technologists to exchange haptic patterns, and to apply this knowledge to non-musical, or quasi-musical devices.

Progress

There are two problems to address: 1. How to notate the haptic activations such that they appear similar to Standard Musical Notation (SMN) so that similar musical techniques can be applied to this progress. 2. how to take this notation and play it on the device, automatically or semi-automatically. Fortunately, modern musical engraving software can accomplish both of these at the same time: provide an authoring environment as well as automatically create the Midi code that controls to the designed activations. The connection between the notation and the device is via Arduino and the Arduino Midi library package. The notation software is called Lilypond (and a related front-end interface application called Frescobaldi). Lilypond is a text-based engraving engine, that is, software for producing traditional sheet music in SMN.

Tactors used in devices can be represented either as pitched or unpitched notations. Tactors appear to be more like unpitched instruments, where the notation needs to describe hitting or activating the instrument but without concern for pitch. However, using pitched notation has the advantage of being able to represent more things at the same time, since each individual note has a related Midi number that can be easily mapped to an individual tactor, or groups of tactors. If using unpitched notation, then you don’t have information on pitch and must create information with channels other than pitch, including note or part annotations that can be converted into tactor-appropriate data.

Using Midi for Haptic Activation on Devices

Description

Vibe bracelets need activation patterns to operate. It is unclear how to design such patterns in a standardized way. One obvious way is to use the Midi control language to activate these devices. Two issues are: how to compose rhythmic patterns that can be played on a vibrotactile band, and how to translate these patterns into a form that the band understands using Midi control data. One way of creating midi control patterns is to compose music in such a way that midi data describing the music is produced as a side-effect. This, of course, is standard procedure in modern music production. One way of producing midi is by using the text-based music engraving and compositional tool Lilypond.

Progress

Tactors can be seen as a type of percussion instrument. Their activation has timing and intensity but they lack the pitch of pitched instruments. Pitched notes in musical notation when represented in midi each have a Midi number corresponding to its pitch. This Midi number can be used to distinguish one tactor from another. Therefore, even when driving an unpitched tactor, representing notes as pitched is useful. It is not clear however, if this is the useful method for design tactor rhythmic patterns. An alternative approach would be to recognize tactor as arrays of identical percussion instruments and to notate them in a similar way to musical compositions for many percussion instruments, in which there be few staves when these instruments play in unison and many staves when they are play separate parts. This increases the complexity compared to the pseudo-pitched note approach above, but means there might be less information redundancy. It is unclear which of these two general approaches is more suitable.

3D printing of components for devices

Description

OCADU has 3D printing facilities. 3D printing is extremely useful for creating quick prototypes for components suitable for wrist-wearable devices including battery enclosures, LED mounts, and bracelet components. 3D printing typically prints things using rigid plastic. This material is generally unsuitable for final production versions of wearable components. 3D printing depends crucially on the quality of the input files. These files (of type .STL) are generated by 3D CAD applications. Once a suitable drawing CAD file is created then the actual printing process is fully automated when using the MakerBot Replicator 2 printer.

Progress

The question then becomes how to draw CAD files efficiently, suitable for wearable devices. There are two general approaches: draw visually in a 3D space (say be using Sketchup), or draw analytically in a more abstract mathematical space. Our experience seems to favour the second approach using an application called OpenSCAD. The advantages of this approach is that often complex geometries are more easily described, parameterized models are much easier to create, and finally, it is much easier to refine and tweak a CAD model in which variables are explicitly defined. Drawing this way requires thinking in terms of Constructive Solid Geometry (CSG), which creation of form is based on simple mathematical operations such as union, difference and intersection.

Extending the Nexus Data Exchange Format (NDEF) Specification

The Nexus Data Exchange Format (NDEF) is an Open Sound Control (OSC) namespace specification designed to make development of OSC-based systems easier by allowing for the identification of OSC nodes and the exchange of OSC messages among nodes. In order to make NDEF more useful for these tasks, new message types have been added to the namespace. Node management has been improved with the addition of messages to handle the pinging of nodes to determine their status. New namespace addi- tions allow nodes to change messages on other nodes.

When musicians can spend less time on the configuration and setup of their computer-based performance systems, it is obvious that they can then spend more time on their ac- tual performances. Yet it is often the case that the setup of computer music performance systems ends up taking time away from what performers should focus on, rehearsing and performing their actual music. This can be especially acute in the setup of laptop orchestras with large numbers of per- formers or in internet-based network performances, to name just two scenarios. Even when the technology works flaw- lessly, both scenarios often require so much time for setup that rehearsals are either rushed or do not happen at all. In general, networked performance systems could benefit from tools that make setup easier.

Published: New Interfaces for Musical Expression 2014. London, England.

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