The Vibrobyte: A Haptic Interface for Co-Located Performance

Kyle McDonald Dane Kouttron Curtis Bahn Jonas Braasch Pauline Oliveros

Rensselaer Polytechnic Institute

{ mcdonk, kouttd, crb, braasj, olivep }@rpi.edu

Abstract

The Vibrobyte is a wireless haptic interface specialized for co-located musical performance. The hardware is designed around the open source Arduino platform, with haptic control data encapsulated in OSC messages, and OSC/hardware communications handled by Processing. The Vibrobyte was featured at the International Computer Music Conference 2008 (ICMC) in a telematic performance between ensembles in Belfast, Palo Alto (California, USA), and Troy (New York, USA).

Keywords: haptics, interface, telematic, performance.

1. Introduction

Telematic performances regularly rely on audio and video transmissions, but haptic communication is generally neglected. The reason for the latter is partly the high cost for haptic displays such as motion platforms for larger audiences. The Vibrobyte is the result of an exploration into low-cost, reconfigurable wireless interfaces and protocols for controlling haptic actuators.

The Vibrobyte operates as a haptic connection between spaces, allowing a composer to send haptic signals to performers, or for performers to haptically affect each other. Each location has a single wireless transmitter and multiple Vibrobytes. Control data is sent from one location to other locations via OSC messages.

2. Related Work

There are numerous examples of haptic displays for musical performance. A good overview on haptic displays can be found in the work of Altinsoy[1]. Gillespie summarizes the role of haptic perception for music applications[2]. Haptic displays are used for a number of reasons, including: teaching technique[3], providing a haptic component to otherwise purely sonic systems[4], and replicating specific musical haptic sensations while exploring the meaning of those mappings[6].

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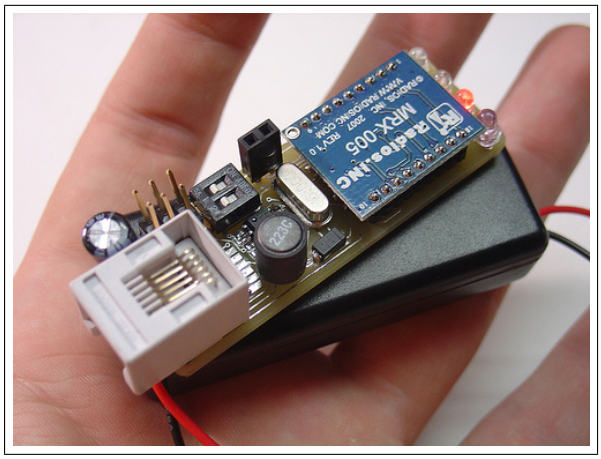

Figure 1. Current revision Vibrobyte prototype.

The Vibrobyte's closest relative is *OROBORO*[5], a system where two musician face each other across a table with two hand orientation controllers to negotiate/improvise with a virtual instrument across a network. Other interfaces that have made heavy use of vibrating motors include: The *Shoulder Pad Vibrotactile Display*[7], which uses a small array of pancake motors (coin motor) to mimic social conventions like shoulder-tapping for capturing attention or to provide guidance; and *Feelspace*[8], which uses a linear array of pancake motors in the form of a belt, connected to a compass, allowing for directions or headings to be communicated.

3. Implementation

The current revision houses an efficient DC-DC converter, ICSP header, microcontroller, four high power LEDs (red, green, blue, IR), RJ-11 jack, MOSFET power amplifiers, and a breakout for extra GPIO. It is functionally similar to an Arduino Mini [1] , in that uses the Atmel ATmega 168 microcontroller, running off an external crystal oscillator at 16 MHz. It can be programmed using the Arduino IDE [2] and an AVR ISP MKII programmer (or a serial connection and the Arduino bootloader). The dimensions of the current revision are similar to a stick of chewing gum. To power exter-

[1] The Arduino Mini is a small microcontroller board based on the ATmega168 microcontroller. See `http://arduino.cc/en/Main/ArduinoBoardMini` for more.

[2] The Arduino hardware is complemented by a free, open-source IDE that can compile and upload C code to the board using AVR-GCC and other open-source software.

nal devices two dual MOSFETs [3] are used, which have been tested on outputs ranging from vibrating motors to solenoids and Peltier devices. Actuators are connected via an RJ-11 jack. The connector also has a direct path to the on board battery, for recharging. Finally, the wireless receiver operates on the 915 MHz band with a trace antenna on the PCB. Testing indoors and line-of-sight, we observed a maximum reliable unamplified data rate as 115200 baud @ 1 meter, 600 baud @ 10 meters.

Open Sound Control (OSC 1.0) [4] is used to address the Vibrobytes or send data across the network. The OSC protocol is aimed at maximum flexibility for Vibrobyte control and reconfiguration, while being easily translated to dense serial messages for maintaining low latencies. A Processing [5] application running at each location translates the OSC messages to serial packets and load-balances them before wirelessly transmitting them.

4. *Tele-morphosis*: Performance and Composition

During ICMC 2008 we coordinated a co-located performance between the *Roots Ensemble* in Belfast, *SoundWire* in Palo Alto, California and *Tintinnabulate* [6] in Troy, New York. Vibrobytes were employed for the first time in this performance to help coordinate the ensembles. Each performer in the three groups was provided with a Vibrobyte. A Max/MSP composition written by Curtis Bahn sent messages to each Vibrobyte, cueing the performers with dynamically varying intensity, rhythm and instrumentation combinations. The performers (with the exception of Pauline Oliveros who was wearing a prototype of a vibrating haptic device) could observe bright multicolored LEDs bringing them in and out of the improvisation. Players entered when their LEDs were on and exited when off accordingly. Furthermore, players could interpret the rhythms and intensities of their LEDs freely when on. This first test of the Vibrobyte helped to shape the music in a new way that had not been possible before.

5. Future Work and Conclusion

Development is currently focused on artistic explorations with these devices. These devices will be useful in situations where complex multi-tempo compositions are desired, or where a haptic connection is feasible but visual connections are not. The intimacy of touch suggests the possibility of more intimate co-located performances, like heartbeat-driven interaction and haptically guided improvisation between dancers and musicians.

Future technical development includes: resonant inductive charging as a more efficient way of powering many devices in large ensembles, using the IR LEDs to uniquely track Vibrobytes in space over time, and exploring other wireless modules. [7] Future development would be aided by prototyping on Arduino Minis (which fulfill the size requirement while remaining accessible and inexpensive), and creating a mini-shield that implements the extra functionality (output amplification, LED indicators, and wireless communication).

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[4] Open Sound Control is an open-ended and simple protocol for communicating between multimedia devices, optimized for modern networks. See `http://opensoundcontrol.org/` for more.

[5] Processing is an open-source programming language and IDE for prototyping interactive media art based on Java. See `http://processing.org/` for more.

[6] `http://www.myspace.com/tintinnabulate`

[7] For example, XBee, Radiotronix, and the Nordic nRF2401A modules are all readily available from distributors like Sparkfun (`http://www.sparkfun.com/commerce/categories.php?c=16`) in the US for ∼$20-$40 USD – more expensive than the current wireless modules, but better supported and documented.