

Beat Boxing: Expressive Control for Electronic Music Performance and Musical Applications

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ABSTRACT

This paper describes the design and implementation of Beat Boxing, a percussive gestural interface for the live performance of electronic music and control of computer-based games and musical activities.

Keywords

Performance, Gestural Mapping, Music Controller, Human-Computer Interaction, PureData (Pd), OSC

1. INTRODUCTION

Beat Boxing is an attempt to add a more active performance element to electronic music in a manner both intuitive and engaging for audiences and performers. The goal is to enable musicians to control electronic instruments through expressive musical gestures or dance movements, while maintaining or enhancing playability. Beat Boxing attempts to accomplish this through an intuitive interface, a pair of light-weight boxing gloves. Each glove is equipped with a digital accelerometer that registers punches or “hits” and provides a basic characterization of the gesture; both also come equipped with a Force Sensitive Resistor (FSR) mounted under the thumb for more fine-grained control. Data is processed using an Atmel AT-Mega16 microprocessor and a personal computer, with core software written in Miller Puckette’s PureData (Pd) graphical environment and supplementary applications in C and Java.

2. BACKGROUND

While the use of computers to create music is becoming ever more sophisticated, performing computer-based music remains problematic for many musicians. Common interfaces, particularly laptop computers, provide little opportunity for expressive on-stage performance. The clear connection between the movements of the performer and the music provided by traditional acoustic instruments is absent; this creates a barrier between the performer and the audience’s musical experience, and in many cases between the performer

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and his or her own instruments. This emotional disconnect has been directly related to the lack of gestural connection between the on-stage performance and the music [1]. A similar disconnect exists off-stage; the lack of an intuitive gestural connection can present a major stumbling block when composing with electronic instruments, using virtual synth studios or playing music-based games. This barrier is particularly pronounced for children or those new to electronic music.

3. DESIGN

Beat Boxing attempts to overcome this barrier by mapping natural percussive movements to the control of electronic instruments and music-based activities. It maps motions such as table drumming, dancing and shadow boxing to control parameters, allowing the musician to move freely and use these rhythms to incorporate their entire body into the composition or performance. The intuitive nature of boxing motions has been explored in a variety of artistic applications, such as the TelephoneBoxing installation [2] and the Soundslam punching bag [3]; however, these are designed as interactive art installations and lack the flexibility for involved performance. A closer musical predecessor can be found in electronic drum pads such as the Yamaha DTX series or electronic drumstick controllers such as the AoBachi [4]. The Beat Boxing gloves build on this intuitive boxing paradigm, interpreting incoming data as a series of “hits” characterized according to power and a number of gestural characteristics. in terms of power, arc of motion, etc.



Figure 1: Beat Boxing gloves

3.1 Mechanicals

The Beat Boxing controller consists of two light-weight “speed bag” boxing gloves that allow the hands considerable freedom of movement. Each glove is equipped with an FSR and a Procyon Engineering [5] ADXL ADC digital accelerometer board. Both boards house a pair of bidirectional accelerometers, mounted perpendicularly to provide acceleration data in three dimensions. The gloves are wired to an AVRmini development board equipped with an Atmel AT-Mega16 microprocessor, which in turn is connected via a serial cable to a personal computer running Pd.

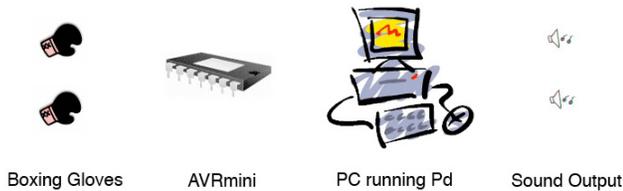


Figure 2: Hardware Layout

3.2 Software

The Atmel microprocessor converts force and acceleration data received from the gloves into Open Sound Control (OSC) messages. All data is sent to Pd as a single 30-bit stream of OSC messages running at 115200 bits per second, which are divided by Pd into three 10-bit directional components (x, y and z) and filtered to remove DC offset.

3.2.1 Hit Detection

Hit detection is carried out by a custom Pd patch using accelerometer data from each glove. “Hits” are triggered when the instantaneous change in acceleration crosses pre-set thresholds, corresponding to a percussive snap of the glove. Between each hit, data such as maximum acceleration and length of continuous acceleration in a given plane are tracked, allowing Pd to recognize characteristic gestures. This allows, for example, Pd to differentiate between a short “jabbing” snap of the wrist as would be used on a djembe, and a sweeping “roundhouse” swing as might be used on a cajon.

3.2.2 Custom Applications

A variety of custom applications have been written to take advantage of the Beat Boxing interface. Among these are:

- A drum machine used to trigger sound clips, play Pd instruments or control external MIDI applications;
- A looping instrument allowing users to create, modify and control an arbitrary number of tracks for compositions with greater rhythmic complexity; and
- A guitar string model that allows the user to “pluck” or “strum” an air guitar.

3.2.3 Commercial Software

The Beat Boxing gloves can also be used to control commercial software applications. Sensor data can be sent to applications directly via a multi-platform Java interface, or Pd can output control messages using OSC or MIDI. A separate Java interface allows these messages to be converted to keystrokes or joystick commands for easy software

integration. A wide range of programs can be effectively controlled in this manner, ranging from virtual synth studios like Propellerhead Software’s Reason to music education software aimed at children. We have optimized this feature to map to a 6-button or 8-button controller, allowing us to take advantage of such existing commercial software as Sony Computer Entertainment’s PaRappa the Rapper - a popular music-based video game - and Capcom’s Street Fighter series.

4. FUTURE WORK

At present, the primary limitation of Beat Boxing is its reliance on a hard-wired serial connection with a computer. Work is underway to allow wireless operation using a small Bluetooth module housed at the wrist of each glove. Further work can also be done to refine the gestural modeling, and it may prove worthwhile to move the modeling functions from Pd to a more flexible language such as C or Java. This would enable more effective hit detection, and allow us to connect the AVRmini development board directly to console gaming systems such as Sony’s Playstation. Optimization for specific commercial applications offers the opportunity for significant further expansion.

5. ACKNOWLEDGMENTS

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