

A New Beatbug: Revisions, Simplifications, and New Directions

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Abstract

In this paper we present recent changes to the original design of the Beatbug, an electronic percussion controller for capturing and manipulating struck rhythm patterns. We discuss the context of this interface, the evolution of its form and function, and recent developments in the design. In our description of this work we highlight key issues, such as the motivation to create a controller more suitable for impromptu, improvisational solo performance, new mappings, and the benefit of a compact performance system.

1 Introduction

The Beatbug is a bug-shaped percussion controller that lets players make simple rhythms. It has gone through several design iterations, from a simple two-player demo system to a more complicated 8-player performance system that was used in a series of workshops, open houses, and concerts by and for children. We have revisited the Beatbug outside the constraints of a touring performance system, this time focusing on simplifying the hardware, mapping and interface for a single player.

2 A Brief Beatbug History

Below we discuss the evolution of the Beatbug from the first prototype designed for interaction between two players, through the 8-player system to the present work on the solo wireless Beatbug.

2.1 Blue Bugs

The first prototype of the Beatbugs was a two-player system, which we will refer to as the Blue Bugs (figure 1). The Blue Bugs were egg-shaped percussion controllers that featured two piezo disc sensors, two bend-sensor “antennas”, a stop button, and a speaker. Mapping of the sensor data was done in MAX, and sounds were triggered on a Clavia Nord rack synthesizer and played through the speaker in each bug (Aimi, 2002).



Figure 1. The Blue Bug design.

A PIC microcontroller encoded the bend sensor and button output as MIDI, and a single multi-conductor cable connected each Blue Bug to a breakout box that connected to a computer running MAX, a drum trigger unit (Yamaha TMX), amplified synthesizer output, and power (figure 2).

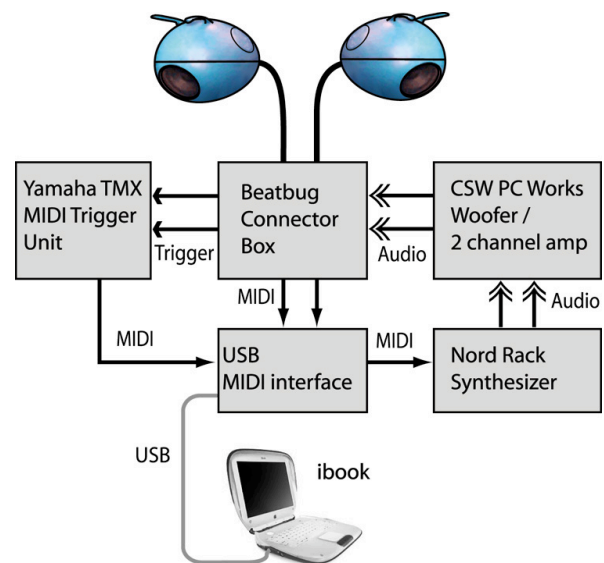


Figure 2. The Blue Bug system.

The Blue Bugs allowed two players to enter sequences of accented and unaccented notes by hitting two piezo discs mounted to the outside of each bug. The patterns would play

back in a loop, and manipulation of the left antenna provided discrete control over tempo (normal and double speed) and continuous control of filter cutoff, while the right antenna provided continuous control of reverb mix, volume, and the resonance of the same filter.

New sounds could be played over the loop by hitting the piezos. The looping pattern could be stopped at any time by pressing a stop button, and a new pattern could be entered. In multi-player mode, the antennas of one Blue Bug could control the sound of another Blue Bug, while each player could still play his or her own real-time sounds over the pattern, providing a limited degree of interdependence between players.

2.2 Toy Symphony Beatbugs

The Blue Bugs led through several iterations to what we will call the Toy Symphony Beatbugs, (or TS Beatbugs). Toy Symphony is a large project by Tod Machover that brings together kids, orchestras, and music technology toys and instruments in a series of open houses, workshops, and concerts (see www.toysymphony.org). In Toy Symphony, we wanted to give children access to technological tools to make music, much like the FMOL workshops (Jorda 2002), but with a larger rehearsal and performance component. Inspired by research into interconnected musical instruments such as Jam-O-drum (Blaine, Perkis, 2000), we also decided to extend the Blue Bug to a larger number of players.

The TS Beatbugs presented several improvements to the Blue Bug design. The number of players was increased from two to eight. A software synthesizer allowed greater timbral control. The two discrete piezo sensors were replaced with one velocity-sensitive piezo, and an array of white and colored LEDs were used to illuminate the top of the Beatbug to provide feedback to the player when it was hit or repeating sounds. (Aimi, 2002)

Several modes of interaction were devised for the Beatbug. In its primary mode, which was used in performances and in the piece *Nerve* by Gil Weinberg, a player would hit a simple rhythm, and it would be sent to a second player's Beatbug. The second player could either use the antennas to modify the timbre and ornament the rhythm using a delay before passing it on to another player for further development (a bit like the game of telephone), or he could choose to hit a new rhythm. If the second player hit a new rhythm, it would also jump to a third player, who would be given the same choice of either manipulating the pattern or creating a new one, but the original rhythm (from player one) would be captured in player two's Beatbug, and still controllable via the antennas. (Weinberg, 2002).

The TS Beatbug system was substantially more complex than the Blue bug system, adding a mixer, audio interface, 8-channel amplifier and connecting to the Beatbugs via a custom patch bay (figure 3). A mixer was added to increase the flexibility of sending eight discrete channels or a stereo

mix depending on the venue. The entire system was placed in a mixer rack flight case on heavy-duty casters to make it easier to move from venue to venue, while keeping it safe in trucks and shipping containers.

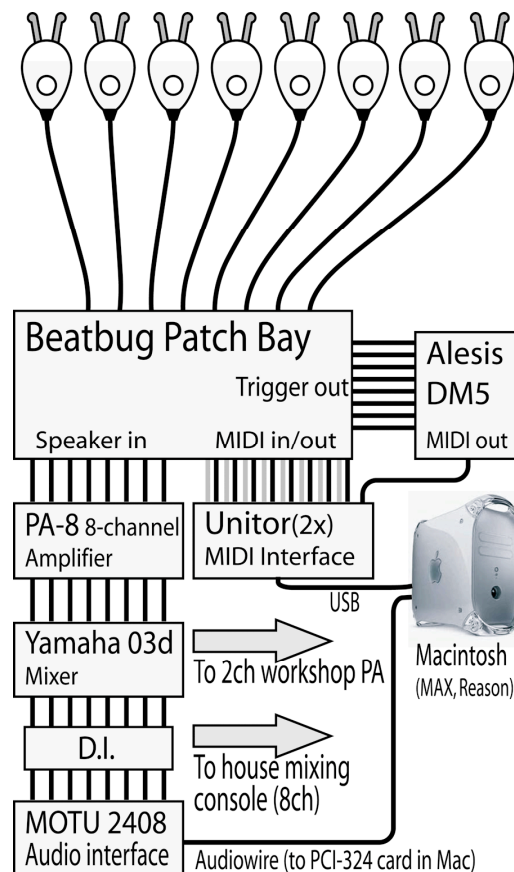


Figure 3. Toy Symphony Beatbug System

The Toy Symphony project imposed strict design requirements for Beatbug system. Though the Beatbugs were originally intended to produce their own sound from on-board speakers, they needed to be supplemented with larger speakers next to each player for performances (figure 4). The system needed to be intelligible to both the players and an audience, which led to the flashing LEDs on the top of the Beatbug.



Figure 4. Toy Symphony Beatbugs in performance of *Nerve* by Gil Weinberg.

There was value in making the Beatbugs physically identical to each other to allow for quick replacement if anything broke. This was especially important because the bend sensors proved to be quite delicate, and some children showed great interest in yanking on the cables until the strain relief broke.

Given the concern that batteries always die at a bad time (Cook, 2001), we decided to hardwire the Beatbugs. Similarly, once we ran one wire, there was little reason not to run as many conductors as was convenient, so we directly connected the piezo trigger through the cable to a commercial trigger unit. A wireless Beatbug would have to wait until we were in a less hostile environment.

3 Solo Beatbug

After the main tour of Toy Symphony was over, we began to consider new design possibilities for the Beatbugs. This time, we decided to prioritize simplicity in the system to create a more compact, portable, personal system for play. This Beatbug design (figure 5) is primarily intended for solo, improvisational use.



Figure 5. New Beatbug design.

3.1 Hardware Changes: a simplified system

Our goal for this project was to create a controller that would require no external hardware (figure 6). A new board assembly was designed, based on the hardware used in the Hyperbow measurement system (Young, 2003), to receive and transmit the sensor data directly to the computer by means of Bluetooth technology (using the chipset from Blueradios, inc). This allows for easy, wireless connection to the computer that ideally has Bluetooth technology built-in (otherwise all that is needed is a small Bluetooth USB dongle).



Figure 6. New Beatbug system.

Rather than connect the piezo element to a trigger interface, a new sensor circuit was designed to capture the strikes made by the player on the Beatbug and send this data to the computer directly for peak detection and analysis.

The final alteration was to replace the problematic (and apparently discontinued) bend sensors with magnets and Hall effect sensors (Allegro A3515EUA). A small magnet were placed under each of the antennas, while the sensors themselves were attached to the inside wall of the Beatbug. The signals produced by this method are improved from the previous design, as they do not exhibit the hysteresis shown by the bend sensors; and the sensor is not damaged by repeated bending of the antennas.

This Beatbug is currently powered by 3 AA batteries, which have a lifetime of about 10 hours. We hope to switch to an internal rechargeable system soon.

3.2 New Mappings

The mapping for the Bluetooth Beatbug is an attempt to simplify and readdress the interaction of a single Beatbug. The sound is synthesized in MAX/MSP by sending a noise envelope into a pair of re-circulating delay lines (figure 7) which corresponds to the intensity of a hit. Bending the left antenna raises the cutoff of a variable low-pass filter in the feedback loop, effectively increasing the feedback and yielding a more sustained sound. The right antenna adds echoed notes, providing a linear cross fade between quarter note and triplet delays. The children who played the TS Beatbug often wiggled and pointed the Beatbug in different directions and angles while moving the antennas, a gesture that was ignored by the TS Beatbug. To measure these gestures, we added a pair of accelerometers (Analog Devices ADXL202E) to measure pitch and roll of the Beatbug. Aiming the nose of the Beatbug downward increases the length of the delay lines and drops the pitch, while rolling side-to-side controls left and right panning.

When a simple rhythmic pattern is played on the Beatbug, it is quantized and played back in a loop that can be manipulated by the antennas and pitch and roll of the Beatbug. New hits can be added to the loop by hitting, and any new sound within a particular quantization replaces the old one, letting the player add and remove accents by hitting hard and soft at the particular beat of interest. Pointing the

Beatbug upwards clears the loop and the player can start fresh with a new rhythm.

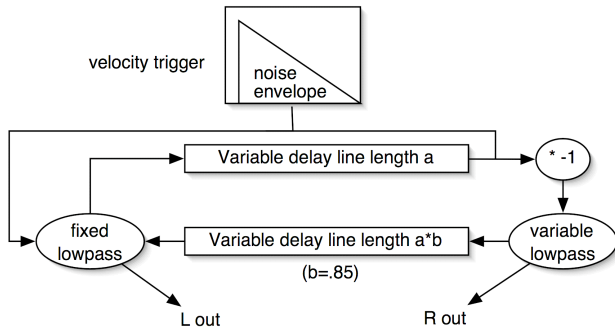


Figure 7. Simple drum sound.

4 Summary

We have described the history of the Beatbug controller, from its beginnings with the Blue Bug design, through the Toy Symphony version, to the current design revision. This new Beatbug is intended primarily for use as a solo instrument for improvisational applications.

Perhaps the most compelling aspect of this project is the simplicity in the Beatbug system, which has been reduced from an entire rack of equipment to a laptop and a Beatbug.

In future, we plan to investigate the potential of this work to extend to small ensembles in which the bugs might communicate with each other directly (not through the main computer) using Bluetooth.

5 Acknowledgments

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