The Midi-AirGuitar, A serious Musical Controller with a Funny Name

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Abstract

The MIDI-Airguitar is a hand held musical controller based on Force Sensing Resister (FSR) and Accelerometer technology. The hardware and software implementation of the MIDI-Airguitars are described below. Current practices of the authors in performance are discussed.

1. Introduction

The MIDI-Airguitar was invented to allow the authors to perform their electronics works with gestures similar to those of one mimicking an aggressive rock guitar player. We had explored other technologies such as video tracking in SoftVNS2.0 and capacitance sensing using Theremins, which provided gestural control of sound. But these technologies did not allow accessible yet precise control of musical parameters, such as pitch. We sought to develop an interface that provided a low threshold for making sound but also a high ceiling for virtuosic musical improvisation [1]. In addition to our lofty musical goals we had several practical goals for the instrument: portability (it must fit in a carry-on-sized bag and setup time must be fast); flexibility (it must be easy to change mappings via software without hardware or firmware modifications); rock-ability (it must allow experienced players to perform [ideally engaging the audience] without the need to focus on feedback from the computer screen); robustness (it must be able to be dropped often).

Inspired by others who have developed portable precision input devices such as The Hands [2] The Lady's Glove [3], and systems designed for Airgutarists [4], we developed a controller that could be held in the hand like some of Steve Mann's keyers [5] but did not wrap around the back of the hand. During development and in performance we needed to put down the devices to operate the laptop, or stage mixer. Data gloves could be worn while typing, but not while using track pads or mixers.

Figure 1. **The MIDI-Airguitar prototype**

2. Hardware and Firmware

The device consists of two 12 oz soda can sized units (2.5" PVC pipe fittings with fibreglass and epoxy-resin additions) covered with Force Sensing Resistors (FSRs) and wires. Four of the FSRs are configured such that the fingers rest on or just over them when holding the devices in ones hands. Four additional FSRs rest under the thumb. Dual axis accelerometers, ADC circuitry and 9v batteries are stuffed in side each pipe. The accelerometers are mounted such that one reaches the minimum/maximum tilt of the x-axis by turning his palms toward the floor or ceiling (depending which hand). One reaches the minimum/maximum tilt of the y-axis by flexing/fully extending the elbow.

The ADC circuitry is based on the MidiTron™[6]. The pic-chip firmware reads the 10 ADCs of the 18F2550 [7], takes a running average of each of the 10 readings, and sends each reading as a MIDI Continuous Control message, if the new reading is different than the average. This firmware reduces noisy readings as well as excessive redundant continuous control messages.

3. Software and Mapping

The MIDI-Airguitars are mapped similarly to a guitar such that the left hand controls the pitch and the right hand articulates and modifies timbre. Sounds generated are

based on an extended Karplus-Strong string model [8] [9], utilizing the right hand to dynamically excite and/or dampen the string. The pitch mapping system uses the left hand's finger FSRs to form a 4-bit word and thus select pitch class [10].

pitch	value	Pinky	Ring	Middle	Index
C	0	0	0	0	0
C#/Db	1	0	0	0	1
D	2	0	0	1	0
D#/Eb	3	0	0	1	1
E	4	0	1	0	0
F	5	0	1	0	1
F#/Gb	6	0	1	1	0
G	7	0	1	1	1
G#/Ab	8	1	0	0	0
A	9	1	0	0	1
A#/Bb	10	1	0	1	0
B	11	1	0	1	1
C	12	1	1	0	0
C#/Db	13	1	1	0	1
D	14	1	1	1	0
D#/Eb	15	1	1	1	1

Table 1. chord key tuning system (4 bit word layout)

The thumb FSRs on the left hand can be used individually or in combinations of two to select the octave transposition (up to 6 octaves in current models). The y-axis raw acceleration on the left hand controls vibrato while its x-axis tilt controls the cut-off frequency of a resonant low pass filter. The right hand finger FSRs gate different exciters: the index finger gates the output of an acceleration to a triggered impulse patch, the middle finger gates and fades in/out (coupled with y-axis tilt) a lookup oscillator; the ring finger gates the microphone or line input allowing acoustic feedback into the string model; and the pinky finger fades in an experimental exciter based on bowing or scratching. The x-axis raw acceleration controls a pulse train where more motion causes more excitation of the string model. Two of the right-hand thumb FSRs control dampening and slew time on the pitch controls. The other two FSRs, are remapped depending on the type of performance. Distortion presets are selected for a rock show, while effect cross-fades/gates are employed for an ambient show.

4. Practice Makes Perfect

In developmental stages, composing for the MIDI-Airguitar required continuous programming. For each new piece, new software presets were needed to deal with items such as tonicity, timbre, tempo, and quantization. This combined with continuous changes in instrument shape and FSR mapping, rendered practicing ineffective and perpetuated a dependency on visual feedback during performance. Over time, as development steadied and the software became more robust, the MIDI-Airguitar became more manageable. It evolved into an instrument that can be practiced methodically much like any acoustic instrument where rehearsing skills, such as scales and patterns, increases dexterity and musical prowess. In turn, the dependency on visual feedback is eliminated allowing performers to actively engage each other, the music, and the audience rather than the laptop. Composition no longer requires (p)re-programming, thus enormously widening the MIDI-Airguitar's musical and improvisational scope.

5. Conclusion

The MIDI-Airguitar is an exceptional controller that can be used in a wide range of musical contexts. With rehearsal one can master its tuning system and timbre controls, potentially focusing on performance and improvisation.

References

[1] D. Wessel and M. Wright. Problems and Prospects for Intimate Musical Control of Computers. In *New Interfaces for Musical Expression - NIME Workshop*, 2001.

[2] M. Waiswisz, "The hands, a set of remote MIDI-controllers," in Proc. 1985 Int. Computer Music Conf., pp. 313–318.

[3] L. Sonami., Lady's Glove, http://www.sonami.net/lady_glove2.htm

[4] Karjalainen, M., Mäki-Patola, T., Kanerva, A., Huovilainen, A. and Jänis, P. Virtual Air Guitar. Proc. AES 117th Convention, San Francisco, CA, October 28--31, 2004

[5] S. Mann. Wearable computing: A first step toward personal imaging. *IEEE Computer*, 30(2), February 1997.

[6] E. Signer, MidiTron™ http://eroktronix.com/

[7] Pic Chip ww1.microchip.com/downloads/en/DeviceDoc/39632D.pdf

[8] K. Karplus and A. Strong, "Digital Synthesis of Plucked-String and Drum Timbres," Computer Music Journal, vol. 7 no. 2, pp. 43–55, 1983.

[9] C. S. Sullivan, "Extending the Karplus–Strong Algorithm to Synthesize Electric Guitar Timbres with Distortion and Feedback," Computer Music Journal, vol. 14 no. 3, pp. 26–37, 1990.

[10] L. Crawford, *How to Write Music for The Airband; An Electronic Music Performance Ensemble*, Masters Thesis, NYU. December 2006