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A Flexible Digital Musical Instrument

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THE SPRINGAMAJIG: A FLEXIBLE DIGITAL MUSICAL INSTRUMENT

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ABSTRACT

The Springamajig is a prototype gestural digital musical instrument based on the physical properties of a large helical extension spring suspended between two long handles. Equipped with a small collection of sensors which measure its physical orientation and manipulation, plus a microphone and speaker, the instrument is self-contained, and sonifies gestures by way of a bespoke, granular-type table-lookup synthesis engine running on an internal microcontroller.

The instrument has the potential to present an engaging and compelling experience for performer and audience, respectively; this is due in part to the resistance provided by the spring under deformation, and the physical effort required in order to perform with it. Its physical properties lend it to a variety of performance approaches, taking advantage of its weight and momentum.

1. INTRODUCTION

The physicality of digital musical instruments (DMI) is a topic that has been given serious consideration within the field of New Interfaces for Music Expression [1]. Arguably the physical *dialogue* that one enters into with a traditional musical instrument is a key aspect in making playing that instrument compelling.

The Springamajig seeks to incorporate the important sense of effortfulness in performance (and in observing that performance), while also emulating the *standalone* nature of traditional music instruments. In terms of DMI taxonomy it represents an *alternate controller*, but, given the inspiration drawn from embodied and gestural controllers such as the *T-Stick* [2] and *Accordiatron* [3], it is fair to ascribe a degree of instrument-like control [4].

2. DESIGN AND IMPLEMENTATION

2.1 Construction

The instrument is constructed around its central spring. The metal inner handle at each end of the spring is surrounded by a $40\,\mathrm{mm}$ diameter polypropylene tube, $1\,\mathrm{m}$ in length. One outer handle, designated *active*, terminates in a box containing a Teensy 4.0 microcontroller [1] to which sensor data is relayed, a small amplifier circuit, a 3" loudspeaker, and separate batteries to power the amplifier and microcontroller. A single power switch is installed on the outside of the box.

2.1.1 Sensors

A 4.5" flex sensor is installed within the hollow part of the spring, and effectively registers the amount of curvature in the spring. A force sensitive resistor (FSR) is situated between the inside of the active handle and the outside of the corresponding inner handle and detects changes in the squeezing force between the two. A 3-axis digital accelerometer (LIS3DHTR) is mounted to a foam plug inserted into the active handle and reports its spatial orientation along x, y and z axes.

An I2S MEMS microphone (SPH0645LM4H) on a breakout board is attached to the inner handle at the point at which the active handle terminates near the spring.The microphone picks up the sound of the spring creaking under manipulation where it joins the inner handles. It is also sensitive to ambient sound, and the performer can achieve interesting effects by singing or whistling into the microphone. A diagram of the construction of the instrument can be seen in Figure 1.

2.2 Sonification

Observing the *granular* nature of the creaking sounds produced by the spring at its mounting points, the development of a granular synthesis engine in the Faust [2] audio programming language was conducted. Inspiration was found in Mykle Hansen's *Weather Organ* [5], a system for generating soundscapes based on stochastically distributed "sparse noise". Weather Organ's `sparse_periodic_trigger` function was adapted to trigger the generation of a windowed grain from a sample lookup table. Faust code was compiled for the Teensy microcontroller and combined with a simple routing algorithm that combined a small proportion of the unprocessed microphone input with the output of the granular synthesis implementation [3].

[1] https://www.pjrc.com/store/teensy40.html
[2] https://faust.grame.fr/
[3] Code can be found at https://github.com/hatchjaw/springamajig

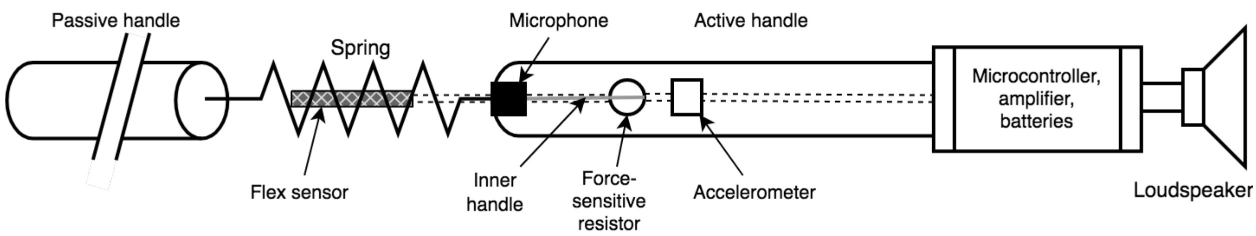
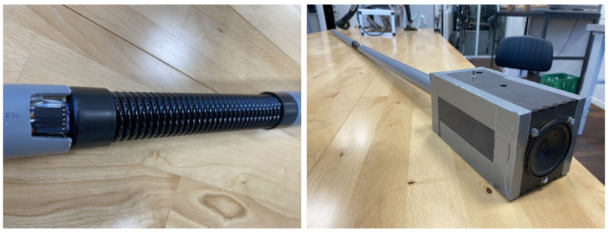


Figure 1: Diagram of the instrument: Dashed lines represent internal wiring, connecting sensors to the microcontroller. The force-sensitive resistor lies between the outer face of the right-hand inner handle and the inner face of the active handle. The microphone is situated atop the inner handle, accommodated by a notch cut into the end of the left extremity of the active handle; the microphone is oriented with its port facing the inner handle.



(a) Detail of spring and embedded microphone

(b) Detail of box enclosure and speaker

Figure 2: Images of completed prototype of *The Springamajig*.

2.3 Mapping

The primary mapping relates to the flex sensor embedded within the spring. The value of this sensor is mapped to three distinct aspects of the granular synthesis engine: 1) Grain density is proportional to the amount of flex. 2) Flex is also mapped proportionally to grain duration, within the range $0.005\,\mathrm{s} < t_{\mathrm{grain}} < 0.5\,\mathrm{s}$. 3) Above an arbitrary threshold (62.5% of the maximum), further samples are no longer written to the grain lookup table. Performers can thereby flex and *hold*, then change the orientation of the instrument to alter, for example, the grain playback rate.

The gesture required to change the amount of pressure on the FSR is quite subtle, therefore it is mapped to a relatively subtle parameter, that of *grain regularity*. Low FSR values result in irregular grain distribution; high values result in regular distributions that can give rise to periodic, rhythmic effects.

The z-axis of the accelerometer is mapped to the grain playback rate. Inclining the active handle will cause the grain playback rate to increase, gradually, to maximum of 200%; declining it will result in the rate slowing and eventually reversing, to a 'minimum' of -200%.

The x- and y-axes of the accelerometer correspond to rotations along the roll axis of the instrument. For y, the absolute sensor value is taken, and used to scale the 'room size' and gain of a reverberation algorithm applied to the output of the granular synthesis engine. If the absolute value of x undercuts the normalised flex sensor value, x will override the grain duration. x can be used to affect output texture by modulating the grain duration during performed gestures incorporating high levels of flex.

3. CONCLUSION & PERFORMANCE METHODS

The Springamajig represents a novel DMI exhibiting a potentially compelling experience for both performer and audience. The 'standard' way to wield *The Springamajig* is by its handles, somewhat like grasping a pair of garden shears. As the performer brings their hands together, the spring bends and the microphone detects its creaking (in addition to sampling any other sounds the performer makes), which are fed into the granular synthesis engine. The performer may now raise or lower the spring to change the grain density and playback rate, perhaps hooking the handles under their arms for greater control. A particularly enjoyable technique involves holding the instrument vertically by the passive end, and allowing the active end to drop under its own weight, then guiding it around as it bounces and spins overhead. The performer has less direct control in this scenario, but can *encourage* the instrument into variations in grain texture. Initial feedback from test performers is promising, but it should be subjected to evaluation by a variety of performers in differing conditions. Finally, the instrument's sonic fidelity could be improved with better speakers (and/or sending the audio wirelessly).

4. REFERENCES

[1] P. Bennett, N. Ward, S. O'Modhrain, and P. Rebelo, "Damper: a platform for effortful interface development," in *Proceedings of the 7th international conference on New interfaces for musical expression*, 2007, pp. 273–276.

[2] J. Malloch and M. M. Wanderley, "The t-stick: From musical interface to musical instrument," in *Proceedings of the 7th international conference on New interfaces for musical expression*, 2007, pp. 66–70.

[3] M. Gurevich and S. von Muehlen, "The accordiatron: A midi controller for interactive music," *arXiv preprint arXiv:2010.01574*, 2020.

[4] D. Overholt, "Musical interface technology: Multimodal control of multidimensional parameter spaces for electroacoustic music performance," 2007.

[5] M. Hansen, "Weather organ: A sparse stochastic synthesizer in faust," in *Proceedings of the 1st International Faust Conference (IFC-18)*, 2018.

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