SONIK SPRING

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Abstract - The Sonik Spring is an interface for real-time control of sound that directly links gestural motion and kinesthetic feedback to the resulting musical experience. The interface consists of a 15-inch spring with unique flexibility, which allows multiple degrees of variation in its shape and length. These are at the core of its expressive capabilities and wide range of functionality as a sound processor.

Keywords - Interface for Sound and Music, Kinesthetic and visual feedback. Gestural control of sound

I. INTRODUCTION

A spring is a universal symbol for oscillatory motion and vibration. Its power stems from being an object whose shape, length, motion, and vibrating kinetic energy, can be easily felt and modified. The Slinky® is a familiar example of such an object. As an interface, the Sonic Spring draws on the slinky's simplicity and appeal. It too can be compressed, expanded, twisted or bent in any direction, allowing the user to combine different types of intricate manipulation. The novelty of the Sonik Spring lies within the unique malleability of its coils. They provide well-balanced resistance, triggering a muscle feedback response that lends a strong sense of connectedness with the person who plays it. This powerful rapport mimics a quality found in acoustic instruments that enables the interface to become a truly responsive musical device, capable of delivering a wide range of expressive musical content [1].

Figure 1. The Sonik Spring

Holding and playing the Sonik Spring is meant to feel as if one is touching and sculpting sound in real time. The depth of the interaction attainable by the user of this new controller is thus quite intense. The continuous change in the interface's physicality, induced by arm/hand/wrist motions, overall gestures, and visual cues, are all directly translated into a strongly grounded sonic narrative.

II. RELATED WORK

The Harmonic Driving, part of the Brain Opera, was a pioneering music controller that explored force feedback using a spring-based device. It featured a large compression spring attached to a bike's handle bar. Changes in the spring's bending angles steered the alteration of various musical parameters. The amplitude of the bending angles was read with capacitive sensors that detected the relative displacement between the spring's coils [2]. More recent examples of controllers addressing the same issue are the Sonic Banana [3] and the G-Spring [4]. The former consists of a small flexible rubber tube with four bend sensors linearly attached to it. The G-Spring is a heavy, 25-inch close-coil expansion spring, housing light-dependent resistors to measure the amount of light that can slip through it. Both controllers, when respectively bent and extended, map the data from the sensors to sound synthesis parameters.

Figure 2. Expanding the spring's length

The Sonik Spring, unlike the controllers described above, uses accelerometers and gyroscopes to measure complex spatial motion, which have proven to be both highly efficient and very convenient given their lightweight and tiny dimensions. As an interface, it clearly offers greater physical flexibility, since the spring can be manipulated easily and freely to vary its length, overall shape, and orientation. Also, because the Sonik Spring is portable, wireless, and very comfortably played using both hands, it allows a higher degree of control. All of the above characteristics make it look and feel like a friendly, performable, "human-scaled" instrument.

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III. DESIGN

The Sonik Spring features a coil with an unstrained length of 15-inches and a diameter of 3-inches. The spring extends to a maximum length of 30-inches, and when fully compressed shrinks down to 7-inches. It therefore allows a length variation from roughly half its size to exactly twice the length. These proportions cover a 4:1 ratio and prove to be uniquely intuitive when applying mappings of the spring's varying length to simple linear changes in musical parameters. The spring attaches at both ends to hand controller units made of plexiglass. Each unit houses the orientation sensors and five multi-purpose push buttons. At their edge, the hand controllers connect to circular shaped plates. These are held on to while allowing the user's fingers to access the push buttons with ease.

IV. SENSNG MOTION

The Sonik Spring uses a combination of accelerometers and gyroscopes to detect spatial motion. Three groups of these sensors are housed within the interface: one in each hand unit, and one group at its middle. This set-up captures the extensive possibilities of changes in motion, especially those related to various types of torsion and bending. Each group of sensors consists of a 2-axis accelerometer to detect pitch and roll, and a 1-axis gyroscope to detect yaw.

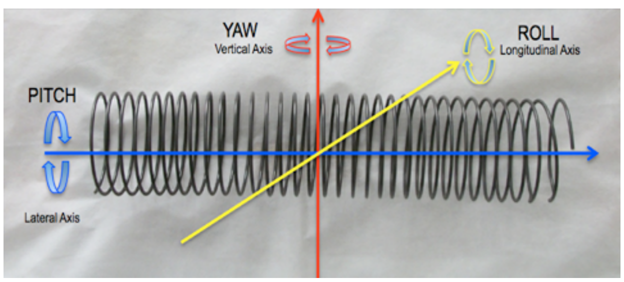

Figure 3. Spring's three axes of rotation

The amount of expansion or compression of the spring is measured using a small joystick built into the right-hand controller unit. The joystick's shaft was lengthened to allow it to reach and sit tightly against one of the spring's coils. Changing the spring's length forces the shaft of the joystick to move accordingly, giving an accurate measure of the overall length variation.

The five push buttons are symmetrically placed in each hand controller unit. Their position guides the fingers to comfortably hover over them, and assure that a specific finger triggers each button. The buttons perform multiple tasks, from tape-like transport functions, to routing the data from the sensors to be processed.

V. GATHERING SENSOR DATA

A MIDItron™ wireless transmitter placed within the right hand controller collects the information from the ten analog sensors and ten digital buttons [5]. The analog sensor data is formatted as MIDI continuous controller messages, and the on-off states of the buttons, as MIDI note-on and note-off messages. This information is sent to a computer running the MaxMSP software, which does all the data processing.

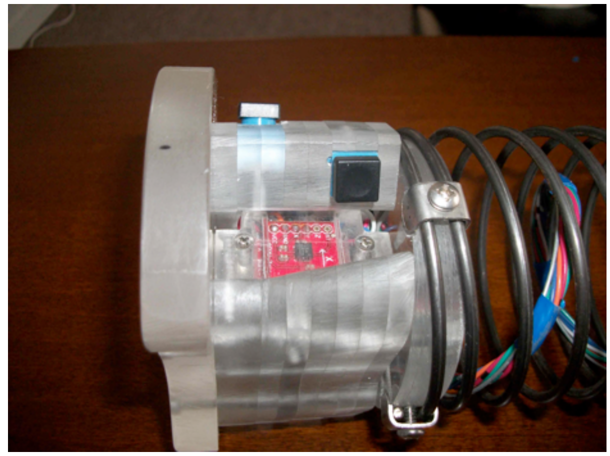
Figure 4. Accelerometer and two of the five buttons

VI. PLAYING THE SONIK SPRING

The Sonik Spring can be used in three different 'performance modes', these are: Instrument Mode, Sound Processing Mode and Cognitive Mode.

6.1 *Instrument Mode*

In "Instrument mode" the Sonik-Spring is played as a virtual concertina, using the gestural motions commonly associated with playing this instrument while adding new performance nuances unique to the physical characteristics of the spring.

The sensors of the left hand unit trigger the generation of chords while those of the right hand generate melodic material. The motion of pulling and pushing the spring emulates the presses and draws of virtual bellows using the tone generation technique of an English concertina. The loudness of the tones produced by the instrument is a function of both the absolute length of the spring as well as the amount of acceleration force exerted to make that length change from its previous position. The rate (speed and acceleration) at which the length changes is given by the joystick's displacement and by the combined data from the three accelerometers, being assigned to changes in loudness using different mapping strategies.

The accelerometer and the five push buttons of the right hand unit are combined to generate the melodic material. This is accomplished using fingers index through pinky, to access 4 buttons that borrow the pitch generating method of a 4-valve brass instrument, allowing the production of the 12 chromatic tones within an octave. Chords are generated using the five push buttons, the accelerometer and the gyroscope of the left hand controller. The software that generates the chords is largely based on the author's previous work implemented in the wind controller META-EVI [6].

6.2 *Sound Processing Mode*

In its current implementation the software uses a granular synthesis engine to playback and process sounds stored in memory [7].

Mapping the variation of the length of the spring to different parameters, switchable using push button presses on the right hand controller, achieve the best results as far as the correspondence between the auditory and visual domains. The most striking use of the length variation is to map it to classic pitch transposition where both pitch and tempo are simultaneously altered. Holding the sound playback and performing scrubbing effects, forward or backwards, on a short section of a sound, by extending and compressing the spring, is also perceptually rewarding. Mappings of the left hand accelerometer include the control of a sound's pitch and playback speed by respectively varying the spring's lateral and longitudinal axial rotations, that is, its 'pitch' and its roll. The gyroscope of the left hand controller, detecting the spring's yaw, is used to perform panning changes on the sound being processed.

Figure 5. Twisting the interface in a complex way

The switches of the right hand are use to perform tape-like "transport functions". Therefore sounds can be triggered forward or backwards, stopped, paused, muted and can be looped. It is also possible to choose variable loop points and isolate a chunk of an audio file anywhere within its length, with the capability to trigger the loop start point at will thus creating rhythmic effects.

The sensors of the right hand are used to perform additional functions such as control grain duration and randomize playback position.

For this performance mode a vocabulary of a small group of gestures has been implemented. This was done to obtain a simple but effective way to correlate visual to auditory information [8] [9]. These gestures are as follows:

a) Twisting the hand units symmetrically in opposite directions and with the same force to map changes to Filter Cutoff frequency
b) Twisting the hand units symmetrically in opposite directions while bending the spring down to map both filter cutoff *and* resonance
c) Bending the spring so that it defines a "U" shape mapping that shape to LFO rate, acting on the pitch being played
d) Bending the spring so that it defines an inverted "U" shape, mapping it to LFO amplitude
e) Shaking the interface along its lateral axis to map oscillation of the center mass to the frequency of an oscillator doing amplitude modulation

6.3 *Cognitive Mode*

An interesting use of the Sonik Spring is as a tool to test different sensorial stimuli. At an immediate and simple level, it can be used to gauge an individual's upper limbs muscle and force responsiveness by directly linking variations in a sound's parameter such as pitch or loudness, to variations of the spring's length. A more complex approach to study an individual's level of cognitive perception can be done by simultaneously linking auditory, visual, spatial and force feedback. This last scenario is especially promising to medically assess people with neurological challenges [10].

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