Swing Set: Musical Controllers with Inherent Physical Dynamics

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ABSTRACT
The Swing Set is a simple idea: a set of pendulums which control musical parameters. The dynamics of the pendulums, with their inherent rhythms and a tendency to conserve energy efficiently, allow musician to play them in several modes; the player can respect the dynamics, or alter them according to his will. When controlled with a computer, this allows for a surprisingly playable musical instrument.

Keywords
tangible interface, pendulum, interaction design, inherent dynamics, musical instrument, installation, swing

1.INTRODUCTION
Many digital interfaces choose power and flexibility over ease-of-use and intelligibility. Moreover, many of them are overwhelmed by metaphors from the computing world. Our goal with the Swing Set was to produce a set of controllers which are immediately intuitive and break away from this pattern. Furthermore, we wanted to present something that had its own tangible physical dynamics; with a pendulum, we were able to capitalize not only on natural resonance and decay, but also the fringe benefits of physical devices, like inherent haptic feedback and visual intelligibility.

In order to create compelling musical experiences with the devices, we decided not to limit ourselves to using only the pendulums as controllers: our installation also includes a computer interface where an operator chooses samples, volume levels, and melodic patterns.

2.OUR PENDULUMS AND THEIR USES
Our Swing Set consists of two main devices: the Swing Set proper, which consists of three pendulums, each with a dedicated purpose, and then the Transfer Pendulum, which is a set of two loosely-coupled pendulums dedicated for use as a tangible mixer.

The three pendulums of the Swing Set proper are as follows:

1) A short one-piece pendulum, the position of which directs a pointer within a sample. This can be used for a simple scratching technique, similar to a turntablist with a vinyl record.
2) A longer one-piece pendulum which operates by a similar principle, however, instead of a simple pointer within a file, it controls the position of several “grains” for a basic granular synthesis.
3) A copper, two-piece pendulum, the position of which is recorded to create a waveform, then played back at audio rates and frequencies, for a “scanning” synthesis.

The Transfer Pendulum works as an audio mixer, based on a simple physical principle: if one pendulum is excited, its energy will slowly transfer to the other, and then back, through the loose coupling. The energy on each side of the device controls the amplitude envelope of an audio channel.

3.SENSORS AND IMPLEMENTATION
3.1Overview
The system was implemented using hall sensors, an Atmega-based sensor interface board, and Miller Puckette's Pure Data.

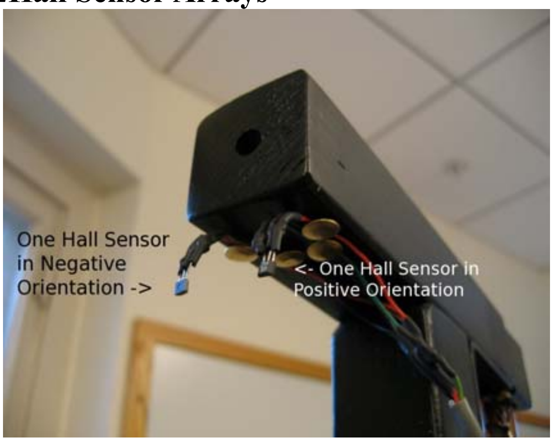
3.2Hall Sensor Arrays


Figure 1. Hall Sensor Array

We quickly decided that Hall sensors were our preferred sensing technology for several reasons: they are fast, cheap, sensitive, and most importantly, allow for sensing without touching the objects in motion. This avoids a major source of energy damping via friction, and allows our pendulums to swing unhindered. The range of hall sensors is limited to a few centimeters, so we first extended it by choosing very powerful rare-earth magnets. Second, we built arrays with two Hall sensors side by side in opposite physical polarity; summing these two signals (in software) allowed us to view each of the pendulums as a single oscillator, and provided a quality signal with a expanded range of motion.

3.3Sensor Data Processing

This data was then fed into several tables in Pure Data, where it was processed to provide the control data we required. For pendulums 1 and 2, no further processing was necessary after the summation; the data was suitable for our control needs, straightforwardly mapping the motion of the pendulums to our the pointers in our wavefiles. Pendulm 3, the two-part pendulum used for scanning synthesis, was straightforward as well; the data was simply windowed, then played back at an audio rate set in an external file. For the Transfer Pendulum, however, position data was squared to produce an energy level, then normalized by its maximum to set gain levels.

3.4Mappings

Ultimately, the data from our interface is abstract, and can be used in multiple ways. It is simply a set of low-frequency sinusoidal oscillations which decay over time. We could have used created an interface with dynamically changing modal mappings for greater flexibility, but doing so would have detracted from our overall goal of immediate intuitive understanding. We chose to create static mappings in order to underline the primacy of the interface's physical dynamics; the Swing Set is about learning how simple gestures map to musical sound. For this reason, the gestures must be repeatable.

3.5Computer Interfaces

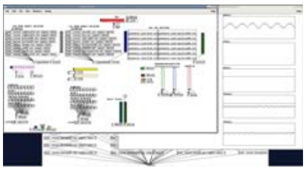


Figure 2. Computer Interface.

A small computer interface was also used, mainly to turn the different pendulums on and off, to set volume levels and to choose the audio samples to be played. In its current state, playing the Swing Set is a collaboration between the player manipulating the pendulums and the player manipulating the computer interface.

4.FUTURE WORK

A version of the Swing Set for installation is highly desirable. For this purpose, we would make only minimal changes to the physical design and setup for sturdiness. A simplified interface for volume control and sample choice would be required, however, and it would be highly desirable to map this onto sturdy physical controllers. Ultimately, it would be beneficial to substantially re-engineer the design for unsupervised interaction.

5.ACKNOWLEDGMENTS

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