Can Haptics make New Music? - Fader and Plank Demos

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ABSTRACT
Haptic interfaces using active force-feedback have mostly been used for emulating existing instruments and making conventional music. With the right speed, force, precision and software they can also be used to make new sounds and perhaps new music.

The requirements are local microprocessors (for low-latency and high update rates), strategic sensors (for force as well as position), and non-linear dynamics (that make for rich overtones and chaotic music).

Keywords
NIME, Haptics, Music Controllers, Microprocessors.

1. INTRODUCTION
For more than fifteen years, we have been exploring the use of haptics (active force feedback) in music controllers. Recently, an experienced composer spent a morning exploring the latest "Plank". He was surprised: *"the instrument is not only responsive, it's also assertive; and I don't know of another situation like that."* What are the qualities that excited this composer? What was required?

2. EARLY HAPTICS FOR MUSIC
Our most common experience of haptics is in mobile phones - early pagers had vibration for a silent alert. Video games have "rumble packs" for excitement. An inexpensive motor simply spins an eccentric weight. These "tactors" have also been used as simple musical feedback for controlling performance [1]. Beyond vibration, d-c motors can provide constant forces - call it "active force-feedback".

We have attempted to make electronic instruments feel like their physical ancestors. For example, springs and weights were added to electric keyboards - i.e. "passive haptics". Active force-feedback keyboards have been attempted by Cadoz [2] and Gillespie [3]. A four-degree-of-freedom haptic violin was built by Charles Nichols in 2000 [4]. None of these have made it into musical performance.

Two recent examples are notable because with inexpensive components, and modern electronics they achieve surprising results. They are "high-performance haptics".

3. HIGH PERFORMANCE HAPTICS

3.1 Haptic Drum
When you hit Ed Berdahl's haptic drum[5] with a stick, it kicks back using a speaker coil (woofer). Depending on which target you hit with the stick, the drum will make a different sound. By varying the way you hold the stick, the Haptic Drum enables you to play drum rolls that would otherwise be difficult or impossible. For instance, drum rolls can be played at speeds of up to 70Hz. It's superhuman but still a drum.

3.2 Cellomobo
In Collin Oldham's Cellomobo [6], the "bow" is a wooden dowel, the "string" is the blade of a painter's palette knife with a piezo pickup attached. The signal goes via Arduino to Pd where it is delayed by an amount determined by his left hand on a "string" sensor acting as a linear potentiometer. Finally, the delayed signal is amplified and a shaker vibrates the palette knife orthogonal to the motion of the bow, making it stick and slip. This is a (surprising) emulation of an ancient instument.

4 NEW MUSIC

4.1 FM Fader Synth
At Stanford's CCRMA, in Music 250A Wendy Ju and Ed Berdahl attached an Arduino to a BeagleBoard [7] As a student exercise, Francesco Georg programmed a haptic landscape in Pd. With the fader, he "throws" the fader knob as it "bounces" over a landscape of FM synthesis parameters.

When people tried it, there were a variety of surprised expressions: "It's fighting me" or "we're dancing". A German offered the word "widerspenstig" which has something to do with a spirit working against you. A rough translation is "unruly" or "assertive".

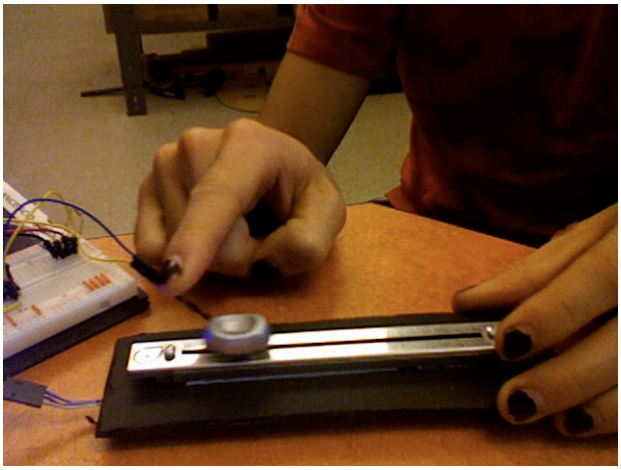

Figure 1. Francesco Georg "throwing" a motorized fader.

4.2 Granular synthesis with the PLANK.

"The PLANK" [8] is made from an old hard-disk drive by removing the disks and using the head-positioning voice-coil actuator to move a cylindrical surface. A force-sensitive resistor senses the force of the user's fingers on the surface. With a simple program on the AVR controller, if you push "into" the surface, it "sides down" a virtual profile - e.g. the envelope of a wave or sample.

In a recent workshop [9] with Bill Verplank and David Zicarelli, Roger Reynolds used the PLANK with Hans Tutschku's granular synthesis (running in MAX/MSP). As Roger bounced the PLANK around the envelope of the sample, he remarked that "it's' a situation in which the instrument is not only responsive, it's also assertive".

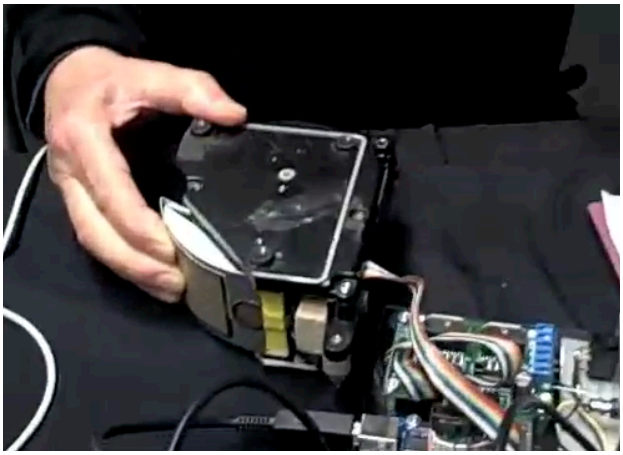

Figure 2. The PLANK with Arduino and Motorboard

Figure 3 shows the display in MaxMSP of the sample which is granularized, the computed envelope and the "slope" smoothed and stored on the Arduino for force feedback.

5. SUMMARY

The combination of inexpensive actuators (motorized fader, disk head-positioner), high-performance hardware, and open software make "high-performance haptics" accessible to musicians. Rather than emulating traditional instruments, we can explore new forms of expressive and lively music.

6. ACKNOWLEDGMENTS

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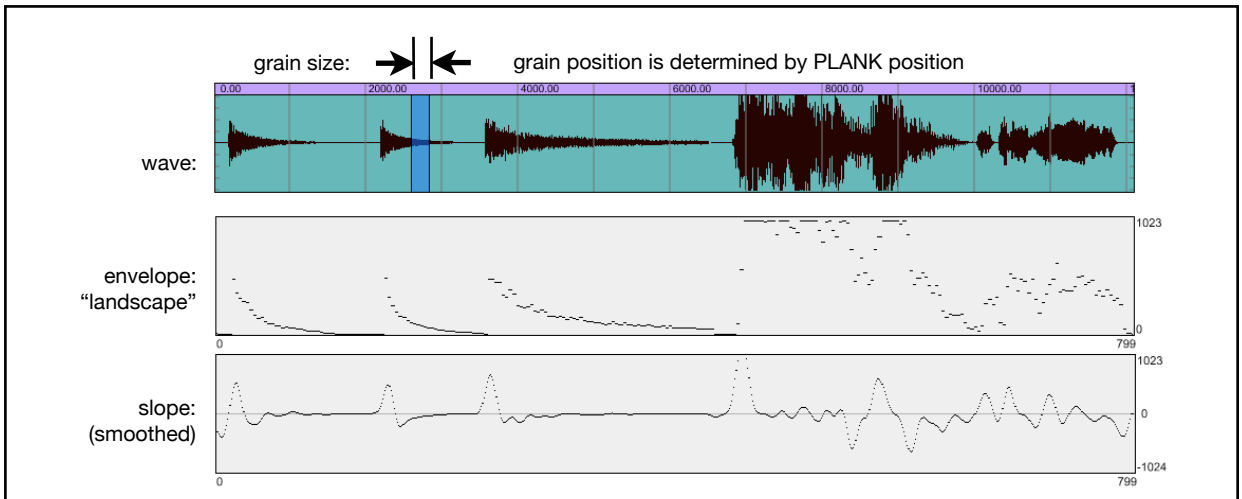

Figure 3. MaxMSP display of "landscape" for granular synthesis with the Plank.