Reflective Haptics: Resistive Force Feedback for Musical Performances with Stylus-Controlled Instruments

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ABSTRACT

In this paper we present a novel system for tactile actuation in stylus-based musical interactions. The proposed controller aims to support rhythmical musical performance. The system builds on resistive force feedback, which is achieved through a brake-augmented ball pen stylus on a sticky touch-sensitive surface.
Along the device itself, we present musical interaction principles that are enabled through the aforementioned tactile response. Further variations of the device and perspectives of the friction-based feedback are outlined.

Keywords

Haptic Feedback, Force Feedback, Pen Controller, Interactive Music Control.

1. INTRODUCTION

The utilization of force feedback in HCI is an active field of research; its results often recur in the design of musical controllers. Existing technologies, e.g. the *PHANTOM® Desktop™ Haptic Device*, are used to conceptualize new principles that enrich musical interaction with haptic feedback [2]. At the same time, new technologies are developed through prototyping, hacking and in the manner of DIY culture [7,8]. These endeavors share the effort to examine the theory that tactile feedback could improve continuous performance, as proposed by O'Modhrain [6]. Mounting-based force feedback in musical interfaces is often worthwhile, but such devices are bound to constrain the interaction. Vibrotactile actuation, on the other hand, is often perceived as limited and imprecise. Finding new feedback mechanisms appears therefore to be an important activity.

In addition to key-based and motion-based music controllers, the use of touch screens and interactive surfaces like the *WACOM®* tablet seems to be a viable input method. Zbyszynski et al. stated: *"cost, availability, the degree and fineness of control […] suggested that these devices would be useful for expressive control in a variety of musical contexts."* [9]. Moreover, the stylus is often considered as an intuitive means for musical performances [1, 4].

2. BACKGROUND

Originally, the success of pens and stylus-controlled interactions seems not only to be based on its ergonomic shape. As Katz observed, the pressure sense can be excorporated through various kinds of graspable media that afford sufficient stiffness: surface properties can be made sensible mediatedly [3]. For instance, the haptic pen by Lee [5] takes advantage of this circumstance, simulating surface properties through solenoid actuation. Stylus-based interfaces for digital sound control are promising [1,4]. Regarding their feedback, they basically address the visual and aural channels of musicians.

This paper proposes to assess the following research question: How can stylus-based musical interactions be enriched through reflective force feedback?

3. THE GUI///RO

We present the GUI///RO, a stylus controlled instrument, augmented with resistive force feedback. It explores a new way in which the tactile sense can be addressed for meaningful and unintrusive feedback. The instrument, which contains a looping mode, is suitable for live performance. Furthermore, we want to display a method to segregate continuous areas on a screen into meaningful discrete segments. By the design we intended to provide an easily accessible way for the performer's sound control.

3.1 System Design

In the proposed system, feedback is provided by increasing the friction and thereby the required force to drag the stylus across the screen surface. In order to display such forces, we developed a low-cost pen setup that is similar to a conventional ball pen. It consists of the following components: a steel ball, an electromagnetic coil, and a pen housing, to which a pressure sensor (FSR) is attached (Figure 1). When the pen is moved over the touch screen surface, the steel ball is rolled. At this point, the electromagnetic coil does not affect the steel ball. When voltage is applied to the coil, it magnetically attracts the steel ball and the friction between them increases dynamically. The operating strength of the electromagnetic coil is controlled by a nearby Arduino board. The generation of haptic effects and the generation of sound depend on the stylus' position on an Eee PC's touch-sensitive screen. The signals of the stylus' position are sent to the Arduino through an instance of PureData, which also handles the audio processing and sampling.

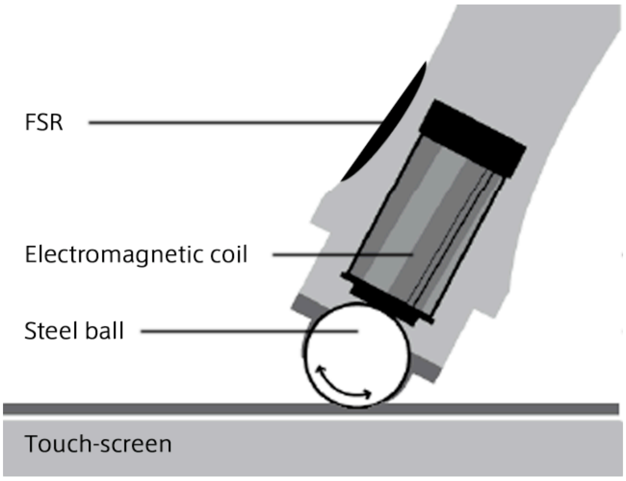

Figure 1. Setup of screen, stylus and FSR

3.2 Interaction Method

The artist holds the stylus with one hand, while touching the pressure sensor with the forefinger. By running the stylus over the screen, sound can be played. Similar to the stroking gesture of playing a traditional guiro instrument, a sound is played when certain segments on the GUI are passed. Each segment is mapped to a specific sample. The rhythm of the played samples consequently depends on the rate at which the segments of the, in this case equispaced, pattern are struck. Whenever a segment is passed, the artist can sense a gradually increasing feedback, as the electromagnetic coil is activated.

By holding the button (FSR), the musician's play is recorded and added to a continuous loop. The force that is exerted onto the button thereby affects the volume of the recording.

Figure 2. The GUI///RO Prototype

3.3 Simulating Surface Textures

The proposed interface can generate dynamic resistive force feedback. By increasing the intensity of the brake activation, the user has to apply more force to move the stylus. Hence, through a dynamically controllable actuation, the magnetic line of force used to simulate different surface textures. Exemplary textures are shown in Figure 3.

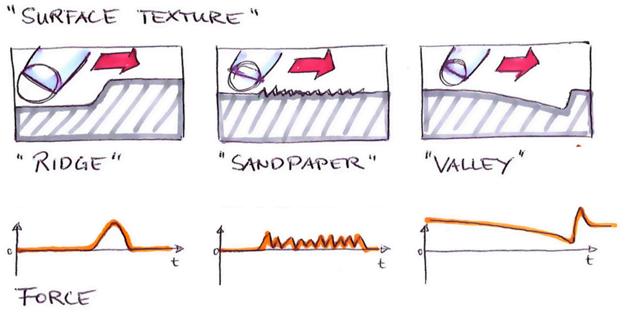

Figure 3. Surface Textures

4. CONCLUSION AND FUTURE WORK

It appears helpful to augment musical interaction with styli on touch screens through resistive force feedback. Musical performances could successfully be supported through the utilization of a sensible haptic signal, rather than with solely visual or auditive cues. We plan to conduct a study exploring the effectiveness of resistive force feedback, using this device to guide performers on screens and plane surfaces. For further prototypes, motion tracking could be integrated into the stylus. Any plane surface could be augmented with the input functions and so become a musical instrument. In order to converge to the demands of mobile applications, we intend to miniaturize the existing setup and plan a wireless version of the GUI///RO. Also, the most favorable ratio between the stylus' weight and the intensity of the force feedback should be explored. We encourage further research in this area.

5. REFERENCES

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