Utilizing Tactile Feedback to Guide Movements Between Sounds

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Abstract

Vibetone is a musical input device which was build to explore tactile feedback in gesture based interaction. It is a prototype aimed to allow the performer to play both continuously and discrete pitched sounds in the same space. Our primary focus is on tactile feedback to guide the artist's movements during his performance. Thus, also untrained users are enabled to musical expression through bodily actions and precisely arm movements, guided through tactile feedback signals.

Keywords: tactile feedback, intuitive interaction, gestural interaction, MIDI controller

1. Introduction

The goal of this work was to design a tangible musical instrument for gestural control of music that has specific qualities: good design and form factors, the ability to both play freely in space and *on* the instrument in a continuous fashion. Furthermore we wanted to display a method to segregate the continuous space into meaningful discrete segments to control the sound in a way that is easily accessible to the performer.

To enhance emotional, experimental and dynamic expression with a performing nature, the instrument allows users to create music not only via haptic gestures with extremities but also through semiotic gestures, integrating the motion of the user's body. Immersive control as one part of the design, offers a flexible interface with a large free space to move yet it handicaps the performer's estimation of movement-effect mapping.

To offer additional functionality, artificial boundaries are introduced in mid-air. But without physical reference points the utilization of gestures may imply ambiguity for the user. A visual feedback is not an appropriate medium to give this kind of information for many reasons, including dependence on lighting conditions and the need of the visual channel to be available for performance cues.

As the artist's creative process should not be disturbed, an audible feedback in the form of an informative or warning signal seems unsuitable for a musical application. Hence we emphasize the tactile sense as a channel for meaningful and unintrusive feedback for this purpose.

1.1 Related Work

There is extensive literature on gesture based control - in fact musical gesture is a primary aspect of much of the research undertaken into new and existing instruments for musical expression. The Moog Ribbon Controller [1] and the Percussion Ribbon Controller [2] are instruments with similar interaction principles that use linear position sensors to control the pitch. By analogy with conduction this work is very much related to prior art in conducting interfaces, for example the work of Lee, Marin-Nakra and Borchers [3]. The importance of tactile feedback in musical performance has often been highlighted for instance by M. Wanderley and M. Marshall [4]. O'Modhrain's thesis showed that tactile feedback can drastically improve continuous performance [5]. For a review see Miranda and Wanderley [1].

2. Designing Vibetone

Vibetone is modelled on the perspective of a conductor facing an orchestra. An orchestra is naturally organized in angular segments with different instruments and hence it creates discrete sections. For gestural performance this analogy causes segments in a way that is body-centric and ergonomically easy to perform. The boundaries between the segments are, however, arbitrary and invisible. Hence a further design concern was to make these boundaries accessible in a way that does not hamper continuous play or limit the user's actions. We chose the tactile channel due to its non-intrusive character and because it is a visceral channel for feedback.

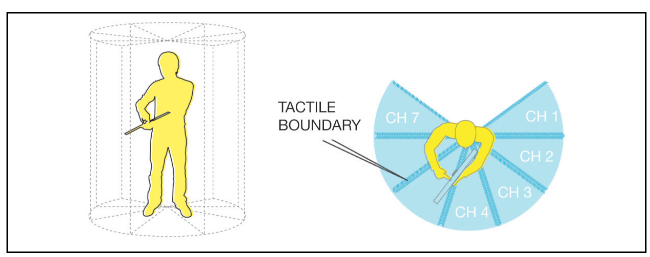

Figure 1: Virtual segments and boundaries

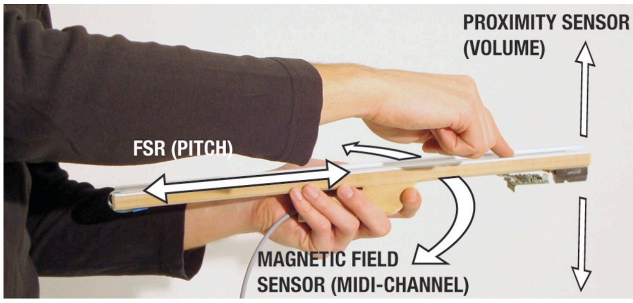

Figure 2: Prototype Vibetone

2.1 Sensors and system details

The current prototype's body is made of medium density fiberboard and includes following parts:

Part	Function
Linear Force-Sensing Resistor (FSR)	Measuring finger position
Optical Sensor	Height recognition
Magnetic Field/Compass Sensor	Direction recognition
Vibration Motor	Tactile actuation

Table 1: Parts and Function of the Vibetone

The signals transmitted from the sensors are sent to a microcontroller on a nearby Arduino board. The signals are mapped to MIDI data and then sent to a music software with a synthesizer.

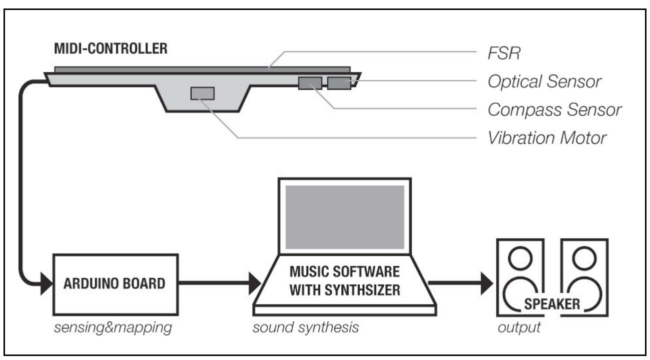

Figure 3: Organization and signal flow of Vibetone

2.2 Interaction Methods

The artist holds the instrument with one hand. One essential component of Vibetone is the linear FSR. By running on it with a finger the melody is played. According to a metaphorical translation of *low height* to *piano* (soft volume) and *great height* to *forte* (loud volume) the volume control depends on the position of the Vibetone over the ground: Standing tall is loud and crouching is soft.

In the design of our prototype multiple virtual segments are mapped around the user. Each of these segments defines a sound (a MIDI channel): If the artist holds the Vibetone within a segment, its sound is set (see Figure 1). Once he changes the segment, the sound changes accordingly.

In order to avoid an accidental overlap into a proximate segment, vibrotactile feedback occurs as the performer approaches a boundary between virtual segments. The intensity of the vibrational feedback increases with a greater proximity to the boundary. This feedback gets activated only in the marginal area of a particular action-latitude: So the user becomes aware of the imminent change-over before it happens.

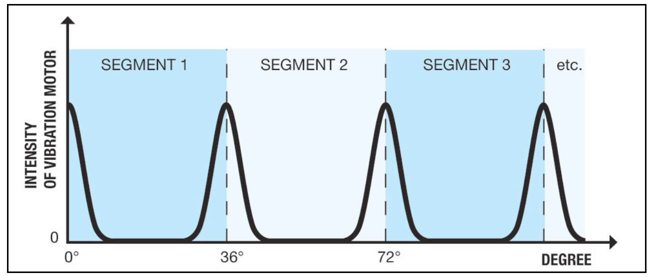

Figure 4: Tactile Actuation

3. Conclusion and Future Work

For the control of musical interfaces with gestural interaction, it is helpful to inform the artist about boundaries between virtual segments via tactile feedback.

The user's cognitive abilities during a musical performance seem to be more effective with the utilization of a sensible vibrotactile information signal than with a visual or an auditive cue.

We plan to conduct a study exploring the effectiveness of vibrotactile feedback using this device to guide performers in invisible discretizations of space. If viable this could be explored to give feedback in instrument play that is naturally continuous but usually played mostly discrete such as fretless string instruments like violins. Furthermore we would like to explore body-centered gestures such as the body-posture height control of volume.

4. References

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