TedStick: a Tangible Electrophonic Drumstick

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ABSTRACT

TedStick is a new wireless musical instrument that processes acoustic sounds resonating within its wooden body and manipulates them via gestural movements. The sounds are transduced by a piezoelectric sensor inside the wooden body, so any tactile contact with TedStick is transmitted as audio and further processed by a computer. The main method for performing with TedStick focuses on extracting diverse sounds from within the resonant properties of TedStick itself. This is done by holding TedStick in one hand and a standard drumstick in the opposite hand while tapping, rubbing, or scraping the two against each other. Gestural movements of TedStick are then mapped to parameters for several sound effects including pitch shift, delay, reverb and low/high pass filters. Using this technique the hand holding the drumstick can control the acoustic sounds/interaction between the sticks while the hand holding TedStick can focus purely on controlling the sound manipulation and effects parameters.

Keywords

tangible user interface, piezoelectric sensors, gestural performance, digital sound manipulation

1. INTRODUCTION

In the past there have been many implementations of both gestural performance[2] and digital manipulation of acoustically resonant sounds when it comes to instrument design. David Merrill's The Sound of Touch[4] is a great example of the latter. His instrument consisted of a wand with a button that records and stores audio samples. The wand could be scraped and rubbed against different kinds of surfaces to manipulate and convolute the recorded sample.

For gestural instrument design, popular electronics such as the Wiimote and iPhone have made accelerometer data incredibly accessible. Tim Soo's Invisible Instruments[5] project has gained a lot of press both online and through Music Hack Day conferences, using a Wiimote to detect performance gestures of traditional instruments. Accelerometer data is then sent to a computer to replicate the sound of these traditional instruments.

TedStick attempts to take gestural instruments a step further by using the resonant acoustic properties of the instrument itself as the source audio for gestural sound manipulation in a way more akin to The Sound of Touch. However, The Sound of Touch lacks a certain live performative aspect of the acoustic sounds which TedStick overcomes by keeping acoustically resonant interactions completely independent from the gestures necessary for sonic manipulation.

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Figure 1: TedStick

2. PERFORMING

The basic performative technique of TedStick involves holding the instrument in one hand and a standard drumstick in the other. The handle of TedStick has four buttons (functioning as momentary switches) for the performer to control each of four different sound effects: pitch shift, delay, filter and reverb (see Figure 2).

When a button is pressed, the vertical tilt and rolling tilt of TedStick each control a different parameter of the corresponding effect. When the button is released, the effect's parameters are frozen at those settings set by the tilt of TedStick. Holding down multiple buttons at the same time adds another dimension of playability, enabling the vertical tilt and roll of the instrument to control multiple effects simultaneously. By exploring clever patterns of when to press and release each button, the performer has a plethora of sounds and settings to choose from.

3. TECHNICAL OVERVIEW

3.1 Hardware

The wood used for TedStick originally came from a truncated stair banister. This shape was ideal, as the short rectangular handle could be used for storing electronics, and the longer rounded pole-like extension is great for tactile interaction. A 3cm X 3cm X 17cm cavity was drilled into the

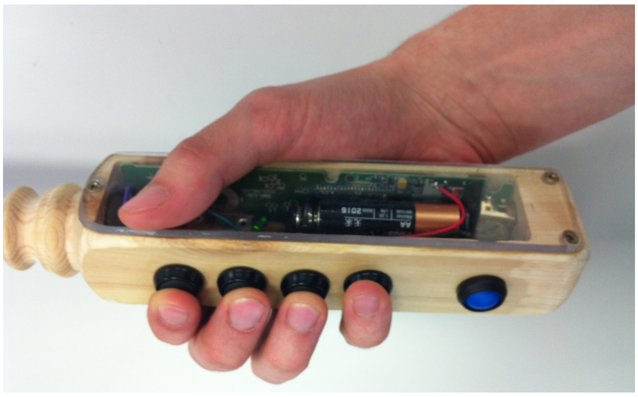

Figure 2: Holding TedStick

handle as is seen in Figure 3. The circuit board from a Nintendo Wiimote rests inside the cavity, transmitting the accelerometer data and button on/off messages via Bluetooth.

Below the four effect triggering buttons is a fifth button (a latch switch), acting as a power switch for all of the electronics inside TedStick. This includes both the Wiimote circuit board and a wireless microphone transmitter from a karaoke microphone, not pictured in Figure 3. The leads of the transmitter were soldered to the raw piezo element so that the piezo could use the transmitter's internal op amp as well. With all of the electronics fitting securely inside TedStick, a plexiglass lid was screwed on to enclose the cavity, while still allowing the electronics to be visible to the performer and the audience.

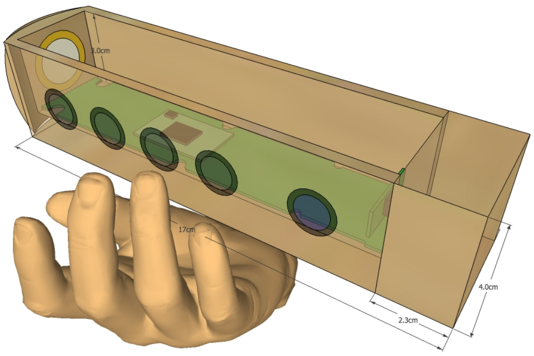

Figure 3: a preliminary design for the handle

3.2 Software

Accelerometer and button information are sent via Bluetooth to a computer running OSCulator and Max/MSP. The audio is sent directly to the computer's audio interface via a wireless receiver corresponding to the transmitter inside TedStick. All of the effects parameters are calibrated so that TedStick has a 'rest' position. When held horizontally with the buttons facing down the effects are neutral/dry. The one exception is reverb, which is at a 50-50 wet/dry ratio when TedStick is held in in the rest position. This calibration allows for an easy reset if the performer wants to return to a dry and unprocessed sound. When pressing the first button, vertical tilt is mapped to pitch bend, and the left-right roll is mapped to an equal power stereo panning algorithm. The second button has vertical tilt mapped to feedback of a delay, and roll controls delay time. The third button corresponds to a low pass and high pass filter. When there is no left-right tilt at all, the filter is all pass. As TedStick is rolled to the left, the cutoff frequency of the LPF sweeps down, and when TedStick is rolled to the right of its rest position, the cutoff of the HPF sweeps up. Vertical tilt then corresponds to the Q or resonance of the filters. Lastly, the fourth button controls reverb with left-right tilt mapping to wet/dry ratio, and vertical tilt controlling the reverb time.

4. OBSERVATIONS AND FEEDBACK

When initially testing the software there appeared to be a considerable amount of Bluetooth interference being picked up by the wireless microphone signal. After analyzing the audio signal, it was found that interference was occurring primarily at 800, 1600 and 3200 hz. An equalizer was applied to filter out these frequencies within the initial incoming audio signal, reducing the interference to a negligible level.

Once fully operational, a series of user tests were undertaken. People were asked to give feedback on the playability of the instrument, the calibration of the software and the comfortableness of the handle. After these tests, certain areas of the wooden handle were smoothed out for more comfortable playing, but there were no major changes made to the software.

5. CONCLUSIONS AND FUTURE WORKS

Overall, TedStick has shown to be a versatile instrument with capabilities for incredible control of sonic texture. Users are drawn in to its simplicity and wide ranging sounds. Once familiar with TedStick's button function, beginners can easily explore different sound manipulations in a controlled way, crafting their own preferred technique and playing patterns.

The real power of TedStick lies within its methods for gestural sound manipulation. A next step for this instrument may be to try applying this method of sonic manipulation to external sources of audio. This could be implemented through an interactive microphone/effects controller, or any other instrument that has a playability completely independent of the instrument's gestural movements.

6. ACKNOWLEDGMENTS

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7. REFERENCES

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