WhammyPhone: Exploring Tangible Audio Manipulation Using Bend Input on a Flexible Smartphone

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ABSTRACT
We present WhammyPhone, a novel audio interface that supports physical manipulation of digital audio through bend gestures. WhammyPhone combines a high-resolution flexible display, bend sensors, and a set of intuitive interaction techniques that enable novice users to manipulate sound in a tangible fashion. With WhammyPhone, bend gestures can control both discrete (e.g. triggering a note) and continuous parameters (e.g. pitch bend). We showcase application scenarios that leverage the unique input modalities of WhammyPhone and discuss its potential for digital audio manipulation.

Author Keywords
Flexible Displays; Bend Input; Sound Mixing; Organic User Interfaces; Tangible Interaction; Music Interfaces.

ACM Classification Keywords
H.5.5. Information interfaces and presentation - Sound and Music Computing: Methodologies and Techniques.

INTRODUCTION
Digital technologies offer unprecedented opportunities for the creation and manipulation of sound. With the ubiquity of laptops and tablet computers, digital audio workstations (DAWs) geared towards touch screens and mobile form factors have become widespread and continue to grow in popularity. GarageBand [3] and Caustic [6] are just a few examples of desktop audio interfaces that have been made available on mobile platforms. While these tools have been simplified to overcome the lack of screen real estate in portable devices, they are limited in their audio control capabilities in comparison to their desktop counterparts. Furthermore, most of these tools rely on touch interaction to manipulate audio parameters, falling short in providing the haptic qualities otherwise offered by physical knobs, faders and keys. Research in new interfaces for musical expression [4,8,9,11,18,19] has explored how specialized digital audio workstations can be complemented with tangible artifacts thus providing musicians with the ability to physically manipulate and create sound in real-time performances. In recent years, OUIs [17] paved the way for a new generation of technologies and materials for computer input and display. Specifically, flexible display interactions are an increasingly popular field of study. While explorations like BendFlip [7], PaperPhone [5] and ReFlex [15] have effectively demonstrated the potential of bend gesturing as an input methodology to navigate and interact with digital content, to our knowledge, there has not been a systematic exploration of audio manipulation using flexible display devices.

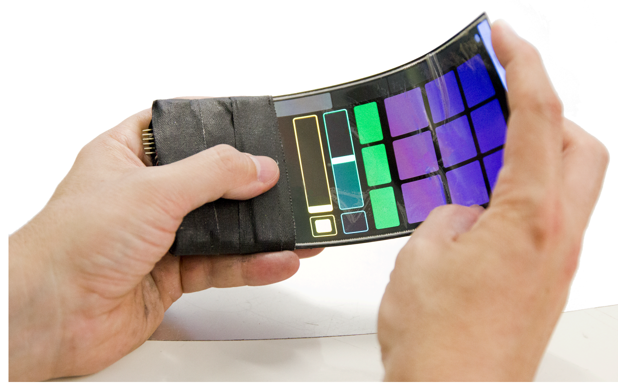

Figure 1. WammyPhone modulating electronic music loops.

WhammyPhone: A Tangible Flexible Musical Interface
We created WhammyPhone, a flexible smartphone featuring a high-resolution, touch-sensitive flexible display and a bend sensor array (Figure 1). WhammyPhone addresses some of the occlusion and fat-finger issues associated with small display devices, by allowing users to tangibly manipulate sound parameters (e.g., pitch, panning, delay) by means of physical deformation of the device in addition to traditional touch-based interactions. This creates possibilities for new multimodal interfaces that offer rich interaction techniques for expressive musical control.

RELATED WORK

Flexible Musical Interfaces
The need to add tangibility to computer music performance has motivated innovation in the field of user interfaces. Some

researchers have proposed that the elastic quality offered by tangible deformable devices improve the expressiveness in audio manipulation because of their haptic feedback properties [10,13]. Rowland and Freed [12] demonstrated different approaches to collocate surface interaction and sound with paper, fabric and printed conductors on malleable plastic. Dahl et al. [13] used a flexible metal strip to directly manipulate a wavetable. The interaction with high resolution flexible displays have only recently become a reality, thus has not been explored in musical interfaces. Troiano et al. [10] conducted a user-centered study evaluating several flexible and deformable interfaces for music performance. They found that deformation is effective for embodying control of musical parameters.

Flexible Display Interfaces
Recent research on flexible displays for mobile computing have successfully demonstrated the potential of bend input to interact with digital content. BendFlip [7] investigated form factors and input techniques for flexible devices, with a focus on document navigation tasks. PaperPhone [5] evaluated the effectiveness of bend gestures to execute common computing actions on a flexible e-ink display. More recently, ReFlex [15] showcased a flexible smartphone with passive and active haptic feedback, introducing sensations such as friction and resistance. We borrow from the aforementioned explorations when designing a tangible musical interface deployed on a flexible smartphone. This allows the use of physical deformation as a means to manipulate sound.

IMPLEMENTATION
WhammyPhone is a flexible smartphone prototype with integrated bend sensors. Our prototype can be used as a stand-alone device running Android 4.2 or as a peripheral input device for controlling any music software.

Display
WhammyPhone uses a 6.0” Flexible OLED (FOLED) display with a resolution of 1280 x 720 pixels and a refresh rate of 60 Hz. The display is mounted on a flexible substrate that extends 5 cm to one of it sides. This allows mounting of a rigid Android circuit board.

Input
WhammyPhone measures bend gestures applied to the corners and body of the device via 3 Flexpoint 2” bi-directional bend sensors. An Arduino Pro Micro microcontroller samples the bend sensors at a sample rate of 76.8KHz and transmits data over a Bluetooth link to a host computer. WhammyPhone’s display is also equipped with a high resolution multi-touch sensor, which we use for triggering notes or samples. We use the TouchOSC [20] application on WhammyPhone to customize the touch-based controls.

Software
Our prototype employs Ableton’s Connection Kit [2] to receive data from the microcontroller and to translate them into musical parameters. Data from TouchOSC is translated from OSC [14] to MIDI using TouchOSC MIDI Bridge.

Sound generation
Our current implementation uses custom Ableton Live [1] and Reaktor [16] patches for sound synthesis. It is possible, however, to control any digital audio software via OSC. It would also be possible to run a sound synthesizer app on the device, effectively turning it into a completely self-contained musical instrument.

APPLICATION EXAMPLES
We present three musical application scenarios for WhammyPhone. Each application utilizes bend input and touch to control audio operation and sound effects.

Guitar Effects Demo
In the Guitar Effects demonstration, users control the effects and pitch of an electric guitar with a virtual tube amplifier. Strings are played by touching the display. Users can then apply a full screen bend to control pitch bend of the string up and down, as if they were bending the string or using a Whammy Bar. Dog earing is used to control the amount of pre-gain of the virtual tube amp, and the amount of *Overdrive* distortion applied. It provides a highly effective example of how bend input helps gain expressiveness through haptic, elastic control in artistic applications.

EDM Loop Control
The Electronic Dance Music (EDM) Loop demonstration showcases how users can control effects and loops of pre-recorded audio samples in Ableton Live using screen bends. Users activate or deactivate sample plays in Ableton Live using touch buttons. Full screen bends can then, e.g., be used to increase or decrease the loop speed of the sequence, while corner bends are used to control the application of audio effects, e.g., a low pass filter’s cutoff frequency.

Bowed Violin Control
In *Bowed Violin* we present a bowing interface for a software physical model of a violin (Chet Singer’s ‘Serenade’ ensemble in Reaktor). Users use touch input to play a string. Here, a full screen bend controls the position and force of the bow on the string: the bow is moved back and forth by bending and flattening the display. The speed of this gesture controls the speed and pressure of the bow. Bending the left corner of the display in this demonstration controls the amplitude of a vibrato applied to the tone.

CONCLUSION
We presented WhammyPhone, a tangible audio manipulation interface that uses bend gestures to create and manipulate audio on a flexible smartphone. We describe application examples that use bend+touch input to manipulate sound parameters. Our prototype is a first step towards flexible mobile audio manipulation platforms that are able to effectively mimic some of the tactile affordances associated with traditional and digital audio workstations.

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