Augmenting Braille Input through Multitouch Feedback

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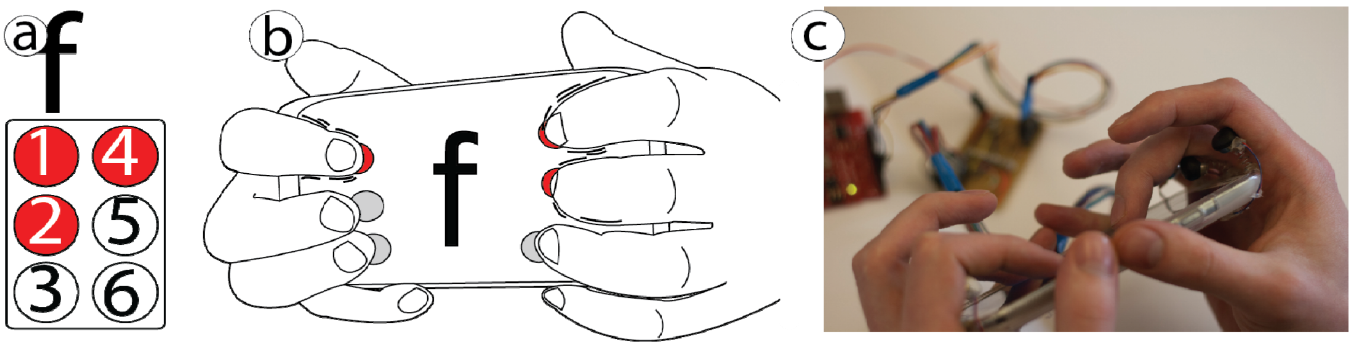

Figure 1. HoliBraille, a multi-point vibrotactile feedback prototype to improve Braille input. (a) Representation of 'f' using the Braille code: dots 1, 2, and 4. (b) The user types the letter 'f' and immediately receives feedback of the recognized fingers. (c) The prototype consists of six vibrotactile motors attached to springs and a silicone case. The springs mold to users' hands and dampen vibrations through the device, preventing propagation between fingers and allowing better stimuli discrimination.

ABSTRACT

Current touch interfaces lack the rich tactile feedback that allows blind users to detect and correct errors. This is especially relevant for multitouch interactions, such as Braille input. We propose HoliBraille, a system that combines touch input and multi-point vibrotactile output on mobile devices. We believe this technology can offer several benefits to blind users; namely, convey feedback for complex multitouch gestures, improve input performance, and support inconspicuous interactions. In this paper, we present the design of our unique prototype, which allows users to receive multitouch localized vibrotactile feedback. Preliminary results on perceptual discrimination show an average of 100% and 82% accuracy for single-point and chord discrimination, respectively. Finally, we discuss a text-entry application with rich tactile feedback.

Author Keywords

Braille; Input; Output; Multitouch; Vibrotactile; Feedback

ACM Classification Keywords

H.5.2 [User Interfaces]: Input devices and strategies; Haptic I/O, Prototyping.

General Terms

Human Factors; Design

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INTRODUCTION

Touchscreen devices offer interaction designers greater input flexibility, enabling a more engaging and natural user experience. Although touch interfaces are inherently visually demanding, previous research, including our own [4], has taken advantage of this technology to provide new input methods for blind people. Particularly, Braille-based text-entry techniques [4, 5] allow users to input chords or Braille characters and receive auditory feedback about the transcribed letters. However, these methods fail to address an important question: how do users know that the input is being correctly detected by the system? Simple auditory feedback (e.g. "beeps") or single vibrations that signify that a touch occurred are inadequate to convey multitouch actions, resulting in error rates up to 50% [5]. We believe that proper localized feedback is crucial to allow users to immediately detect and correct touch input errors.

We present HoliBraille, a holistic prototype that features Braille input and output using vibrotactile feedback. While tactile feedback has previously been shown to improve input accuracy during text-entry tasks [2], it has not been widely explored with chord or multitouch input methods.

HOLIBRAILLE DESIGN AND IMPLEMENTATION

HoliBraille draws inspiration from the standard writing system of a traditional Perkins Brailler. The Braille input system combines BrailleTouch's [5] usage setup (Figure 1-b), having the screen facing away from the user, and finger recognition/tracking techniques. In addition to input, HoliBraille includes six vibration motors on top and bottom of the device (Figure 1) allowing multi-point and localized feedback on individual fingers.

Localized Vibrotactile Feedback

Prior research has attempted to deliver localized feedback on touch devices. TeslaTouch [1] uses an instrumented touch surface to provide tactile sensations on users' fingers tips through electrostatic friction. However, feedback is restricted to a single point of contact. Others [6] take advantage of multiple motors attached to a mobile device producing single-point vibrations on specific locations. Nonetheless, this approach has a well-known side effect: vibrations go through the device, making it challenging to pinpoint the source of feedback. This is especially relevant when motors are close to each other. HoliBraille addresses these issues by independently dampening each motor, reducing the vibrations through the device and allowing users to identify single- and multiple-point feedback.

In order to dampen vibrations, we considered a number of different materials: cork, sorbothane[1], and springs. Acceleration readings were collected to measure the amount of vibration that went through the device. Preliminary results showed that springs yielded the best results. Our final design consisted of six small vibration motors[2] strategically secured to springs and a silicon case, thus allowing users to receive localized feedback whilst typing (Figure 1-c). Ergonomic factors were also taken into account in the design. Springs mould themselves to different hand shapes and allow users to rest their hands in a comfortable position. Moreover, they guarantee direct contact between fingers and vibrotactile motors.

In order to assess the viability of our approach, we conducted a preliminary user study with 8 sighted participants (ages between 24-30, 2 female) and asked them to provide an answer about the fingers they felt vibrating. Two major results emerged: first, single finger vibrations are 100% accurate, suggesting that little noise is transmitted between fingers. Second, most confusions are between ring-index chord and all three fingers. Reported results are promising, with 82% accuracy, however further research is needed to improve chord discrimination.

Leveraging Multitouch Feedback

In this section, we describe three scenarios that leverage multitouch feedback in the context of Braille input.

Typing feedback. In this interaction mode vibrotactile feedback can be used to improve typing performance. When the system recognizes a finger or chord, it provides tactile feedback corresponding to the users' actions. This informs blind users whether the device correctly recognized the intended chord input.

[1] http://www.amazon.com/gp/product/B006YJ82W4/ref=oh_o00_s00_i01_details

[2] https://www.sparkfun.com/products/8449

Multitouch gestures. It is often necessary to move a cursor while typing in order to edit text. Two-finger gestures can be used to navigate through characters. Moreover, text selection can be done combining cursor movement and non-dominant hand gestures. While speech is typically used to communicate cursor position, multitouch feedback can still aid users in these complex-editing operations by providing rich tactile confirmation about their actions.

Inconspicuous reading. In addition to Braille input, HoliBraille also allows for vibrotactile reading by vibrating the fingers that correspond to a specific character. This reading approach has been validated with wearable devices [3]. Through touch gestures users can control the amount of information they receive and read short notifications when auditory feedback is impossible or inappropriate (e.g. noise environments, password reading).

CONCLUSION AND FUTURE WORK

In this paper, we proposed a vibrotactile prototype to support discrete multitouch feedback on mobile devices. Particularly, we applied our solution to Braille input allowing users to receive feedback of their actions whilst chord-typing. Currently, we are exploring novel approaches to improve multi-point discrimination. For this next stage of research, it will be crucial to test the system with blind users to determine the extent to which HoliBraille provides relevant feedback.

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