TouchBand: A Pressure-Sensitive Wristband as Input for Smartwatch Scrolling and Selection

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ABSTRACT
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INTRODUCTION
The main input methods for traditional smartwatches on the market are display touch screens and physical buttons. However, it is difficult to carry out complex tasks on smartwatches due to the limited number of physical buttons and the inadequate size of the touch surface. The small screen can be partially or completely blocked by the user's finger when they interact with the device. Furthermore, selecting objects on the screen, especially small ones, can be inaccurate due to the size of the user's finger in relation to the size of the touchscreen. Our research aims to enhance users' experience with smartwatches and increase efficiency and accuracy of scrolling and selection through extending the touch surface to the wristband.

We propose placing arduino touch sensors around the whole smartwatch wristband and using these sensors to identify scrolling and selection input. To scroll up and down, a user can move their finger along the long edge of the band. For long scrolls, a user can do multiple strokes, as they would on a normal touchscreen. We will not make the wristband identify horizontal scrolls because while the touch interaction space is bigger vertically (i.e. along the wristband), usually it is not bigger horizontally, since a lot of wristbands are more narrow than the touchscreen. To select an object on the screen, a user can move their finger on the wristband and this movement will be mapped on the smartwatch by highlighting the different objects on the screen. Once the desired item is highlighted, the user can tap his/her finger anywhere on the band to select it. Our research question is: Is placing touch input on the whole smartwatch wristband, including the back of the band, more convenient to users and will it lead to faster and more accurate selection compared to normal touch interaction? We argue that our input method can deliver more selection accuracy and freedom because the finger will be moving along bigger interaction area. Moreover, moving the touch interaction off the screen will allow the user to not block the display screen while interacting with the device.

While no other input methods beyond smartwatch touchscreens and physical buttons have been implemented commercially, there are several studies that researched the possibility of extending the interaction surfaces beyond these two methods (such as using an air-magnet-pen or hand gestures). There are a few studies that used the wristband as an input method, but they either focused on developing the strap only for text entry or the wristband was only sensitive on the edges where the wristband touches the watch. We are studying the possibility of making the entire wristband sensitive so we can use the whole wristband as an input surface. This will give the user the potential to perform more complex tasks with higher accuracy.

RELATED WORK
Knibbe et al. [4] proposed extending the interaction area of smartwatches to include the back of the wearer's hand. They also used gesture interaction as an input method. The proposed device supports a range of bimanual gestures that translate into commands for the smartwatch. The prototype built for this experiment had infrared proximity sensors on the sides of the watch and wristband. These sensors were used to identify different dynamic gestures from the watch hand, and to recognize bimanual gestures that were made by the other hand on the back of the watch hand. There were also piezoelectric sensors positioned underneath the watch to detect taps when the watch hand moved, and if there were actions at the back of the watch hand by the other hand. By adapting parts of this approach in our research, namely sensors used along the wristband, we can identify taps and finger movement.

By using a magnetically driven input technique, Abracadabra [3] provided an unpowered wireless method for its users to interact with small mobile devices. It made use of magnetic sensing to expand the input area above the device and detect the finger's movement along a one-dimensional polar and a 2D positional plane. In doing this, Abracadabra achieved high accuracy and low error rates for input selection. However, this technique required the user to wear a magnet on their finger which is an additional component the user must manage.

Perrault et al. [6] presented WatchIt, a device extending interaction techniques for command selection and execution beyond the watch surface to the wristband. Their device uses two simple gestures for interaction: a pointing gesture for selecting an item in a list and sliding gesture consisting of sliding the fingertip along a half-band. Their prototype was also evaluated on the usability for eyes-free interactions, such as silencing a vibrating ringer in a meeting. In their user study they found all the interaction techniques to be more effective in the eyes-free usage scenario.

Lyons et al. [5] presented Facet, a multi-display wrist-worn system consisting of independent touch-sensitive segments joined into a bracelet. Two common forms of interaction used on the multi-segment touchscreen were pinch and rotate. Using each segment's accelerometer and magnetometer, they extracted orientation like pitch, roll, and yaw for each screen with respect to a common coordinate system. Since they did not conduct a user study, there is no proof of the device's effectiveness.

Ahn et al. [1] explored pressure-sensitive multi-touch interactions with a smartwatch wristband. Their device had pressure-sensitive touch sensors on the wristband on either side of the smartwatch screen (but not the back). The sensors could detect tapping and flicking motions, as well as pressure input on part of the band that could be used as directional input. The device could also interpret flicking up and down motions as commands for copying and pasting. They demonstrated that this kind of device could be useful for many different tasks, although they did not conduct a user study to test the effectiveness of this device.

Funk et al. [2] experimented with two text entry methods on a touch-sensitive smartwatch wristband: sliding and multi-tapping. Both text entry layouts were a vertical arrangement of letters positioned to the sides of the watch display (again, nothing on the back of the wristband). The first had a narrow key for each character, and the user could slide their finger until the correct character was selected. The second had 3 letters per key, which were selected by multi-tap. They concluded that the multi-tap layout was faster in terms of words per minute, and also preferred by the study participants.

CONCLUSION

We suggest making a touch interface on the entire smartwatch wristband, including the back, to define interactions that can provide alternate methods of input selection and scrolling. While previous works have attempted to solve similar issues, we believe that our approach addresses some of the pitfalls associated with previous works. By providing a touch interface at the back of wristbands, we expect that we will be able to define an input technique that does not occlude the screen while still providing an intuitive, integrated, and accurate method of navigating smartwatch interfaces.

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