Caret Manipulation using Deformable Input in Mobile Devices

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Abstract

Caret movement is difficult with touch input because of finger occlusion and the imprecision of interacting with a small display using fingers. We hypothesize that bend might provide a better text manipulation solution. We propose bend gestures to move a single caret or dual carets without requiring hand repositioning. We create a deformable prototype and implement the gestures. We present our bend interactions for caret manipulation and discuss our prototype.

Author Keywords

Deformable User Interface; Flexible Display; Bend Gesture; Caret; Mobile Device

ACM Classification Keywords

H.5.2. Information interfaces and presentation: *User Interfaces – Interaction styles, user-centered design*.

Introduction

Text selection and manipulation can be difficult on mobile devices. These actions require a detailed positioning of the caret on the screen, but thumb and finger occlusion makes this task particularly difficult [7]. Users find it hard to interpret where the caret will be positioned based on the touch event, and misread touches can cause the point of focus to jump or trigger word selection. Researchers and developers have created software solutions such as magnifying tools [7], but they create text occlusion.

We propose that bend gestures offer an opportunity to overcome this weakness of touch interactions for caret manipulation. While Schwesig et al. [6] have found bend interactions not to be suitable for complex tasks such as text entry, Ahmaniemi et al. [1] illustrated that they are best for continuous bipolar parameters, such as the directional movement of a text caret. Bend gestures have the advantage of eliminating finger occlusion on the task. Hence, we believe that they can be useful for micro-interactions such as caret placement by providing precise, occlusion-free, interactions.

In this work in progress, we present our bend interactions techniques for caret and text manipulation, as well as the deformable prototype we designed for single or dual caret manipulation that does not require hand repositioning. We discuss initial observations and future work.

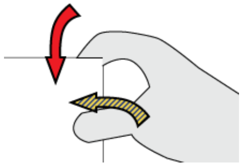

Figure 1. Detectable edges of corner bends (vertical in red, and horizontal in shaded yellow), bi-directionally.

Related Works

Schwesig et al. [6] developed a bendable device called Gummi. They used this prototype to demonstrate that users can quickly discover and learn bend interactions when they apply real-world metaphors to the mapping of gestures. The authors developed two text input systems, one layered and one using a nested grid. Both proved to be ineffective to enter any substantial amount of text.

PaperPhone [4] found that bend interactions are useful in user interface where directionality is involved: directionality links the direction of the bend (up/down) with the action that happens on the display (moving left or right). FlexView [2] corroborated this result. BendFlip [9] demonstrated that bend gestures can replace simple interactions, like button clicks. Finally, Kildal et al. [3] discussed the concept of discrete and continuous gestures applied to deformation gestures. They propose that continuous gestures are suited for the control of the magnitude of a parameter. This was confirmed by a follow up study [1].

Much of the work on deformable user interaction focusses on addressing the shortcomings, imprecision and screen occlusion of touch interactions. However, complex tasks, like text entry, have either been avoided or found inappropriate for deformable interactions. Other than Gummi [6], no other prior work that we could find explored text input or manipulation using deformable input.

Text Manipulation Interaction Techniques

We believe that bend gestures can be useful in text interactions in mobile devices. They can offer interactions techniques similar to the keyboard's directional arrows, to augment text manipulation.

For our text manipulation interaction techniques, we created an intuitive interaction language which makes use of the location, direction, and the edge of the device's corner, as described by Warren et al. [8]. The edge component of our language allows us to manipulate each top corner in four ways, more than the typical corner (Figure 1). This offers the advantage of not having to frequently reposition the hands during text manipulation.

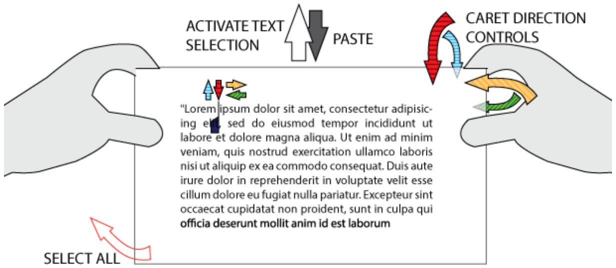

Figure 2. Gestures for single caret control.

Caret Placement: Single Caret

The gestural affordances of the prototype let us control the movement of the text caret through the manipulation of a single upper corner (Figure 2). Bending the right upper corner horizontally upwards moves the caret left and a horizontal downwards bend moves it right (yellow and green respectively in Figure 2). A vertical upwards bend moves the caret downwards, whereas a vertical downwards bend moves the caret up (red/blue). The gestures design follows a push-pull model: an up bend pushes the caret and a down bend pulls the caret. By controlling caret placement from the device's corner, no screen occlusion occurs, allowing unimpaired interaction.

Text Selection: Dual Caret

The true strength of granting caret control through the manipulation of a single corner comes when more complex text manipulation tasks are required. Text selection requires marking a range of text. Delimiting the selected text on a mobile device requires two carets, one starting and one ending, both of which require control. When controlling dual carets (Figure 3), the left upper corner controls the starting caret and the right upper corner controls the end caret. This mapping follows the left to right progression of reading in Western languages.

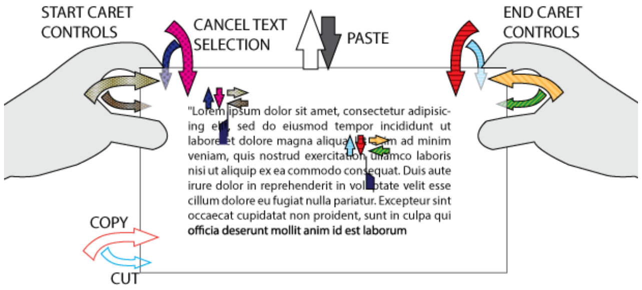

Figure 3. Gestures for dual caret control.

Additional Controls

However, text manipulation requires further functionality; we mapped additional controls to the upper edge of the device and the bottom left corner (Figure 2 and Figure 3). Bending the upper edge requires that both upper corners be activated simultaneously. Bending the edge upwards activates and deactivates text selection. A downwards bend of the same edge allows copied text to be pasted. While text selection is active, an upwards bend of the bottom left corner copies the selected text and a downwards bend cuts it. When text selection is not active, bending the bottom corner selects all the text in the document.

The gesture design allows the caret manipulation to occur without re-gripping. However, other text manipulations (copy, cut, or select all) require the left hand to re-grip. Likewise, transitioning in and out of text selection or pasting text require a coordinated bend of both corners in the same direction. These gestures reduce the likelihood of accidental activation.

Our Deformable Prototype

We designed our prototype to allow the recording of fine corner deformations. Our prototype involves a fully deformable silicon body with an embedded flexible circuit that incorporates bi-directional bend sensors located in each corner. We followed the design process outlined by Lo and Girouard [5] and modified their fabrication technique.

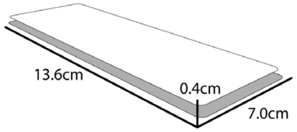

Figure 4. Device dimensions.

Our prototype is 13.6 cm x 7.0 cm x 0.4 cm, approximating the size of the average smartphone (Figure 4). We use six bidirectional 1-inch Flexpoint sensors in the device: two sensors are nested in each of the top corners, each parallel to a side, and one sensor in each of the bottom corners (Figure 5).

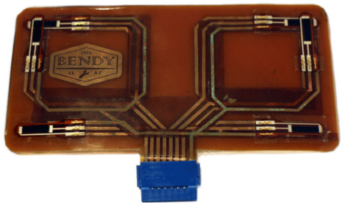

Figure 5. Prototype circuit with six bi-directional sensors.

The flexible circuit was etched into copper clad laminate sheeting, with the circuit marked using a solid ink printer. The bi-directional bend sensors were attached using crimp connectors, with a layer of flexible conductive tape between the circuit and the sensor ensuring an uninterrupted connection even under large deformations of the device. The small connection point created by the crimp connectors allows the entire device to be bent freely in any direction.

We applied a 2mm layer of 60A silicon to the reverse side of the flexible circuit, and another separate 2mm layer of silicon serves to cover the circuit and sensors. The silicon serves as a surface for display, we use a micro projector to cast an image on the prototype to mimic a flexible display.

An 8-pin connector located on the edge of the device allows it to connect to an Arduino Uno, which interprets the sensor data as discrete gestures. The Arduino recognizes any individual sensor activation beyond a certain threshold as a discrete activation. The directionality of the deformation allows each individual sensor to be mapped to two gestures, for a total of 12 gestures. The device also allows deformations that activate multiple sensors, such as bends that affect an entire edge of the device, allowing 14 additional gestures using sensor pairs, for a total of 26. The gestures are used to control the caret in a simple text editor program that allows the basic text manipulations that can be found on mobile devices.

While our current prototype does not include a display, we plan on projecting our user interface on the prototype.

Discussion

Though text entry is better handled by touch than by bend input [6], the ability of deformable interactions address the weaknesses of touch interactions in text manipulation has not been fully explored. In this work in progress, we proposed bend gestures to manipulate the caret in text editors. Our interaction techniques offer no occlusion of the display, minimal hand repositioning, and both intuitive single and dual caret manipulation. The gestures described follow an intuitive push-pull model and allow for the control of a text caret with a single hand.

Our prototype allows for the implementation of deformable interactions as a medium for text manipulation. In addition, there remains room to further expand the interactions explored, with only 14 of a possible 26 single and paired sensor combinations currently mapped to gestures. We are planning a full scale user study using the prototype to evaluate the benefits of text manipulation using bend gestures. We plan on comparing the performance of bend gestures with touch input in single and dual caret manipulation.

One consideration is that current touch applications for mobile devices allow single-handed text entry and manipulation, our current design is formulated around a two-handed interaction with the device. The feasibility of such interactions remains unexplored. The configuration of this device may allow for such inquiry.

Overall, we believe that deformable interactions show promise as a means of overcoming the limitations of touch on mobile devices and can offer a simpler, more intuitive means performing tasks that require precise control.

Acknowledgments

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