Mobile Interaction Using Paperweight Metaphor

Itiro Siio
Faculty of Science,
Ochanomizu University
2-1-1 Otsuka, Bunkyo-ku, Tokyo
112-8610 Japan
siio@acm.org

Hitomi Tsujita
Faculty of Science,
Ochanomizu University
2-1-1 Otsuka, Bunkyo-ku, Tokyo
112-8610 Japan
g0220529@edu.is.ocha.ac.jp

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Abstract
Conventional scrolling methods for small sized display in PDAs or mobile phones are difficult to use when frequent switching of scrolling and editing operations are required, for example, browsing and operating large sized WWW pages.

In this paper, we have proposed a new user-interface method to provide seamless switching of scrolling / zooming mode and editing mode, based on a "Paperweight Metaphor". A sheet of paper that has been placed on a slippery table is difficult to draw on. Therefore, in order to write or draw something on the sheet of paper, a person must secure the paper with his/her palm to avoid the paper from moving. This will be a good metaphor to design switching operation of scroll and editing modes.

We have made a prototype system by placing a touch sensor under a PDA screen where user's palm will be hit. We also have developed an application program to switch scrolling / editing mode by the sensor output and assessed our method.

Keywords
Paperweight metaphor, mobile devices, small screen, touch sensor, scroll, zooming.

ACM Classification Keywords
H5. Information interfaces and presentation (e.g., HCI).

Introduction

In miniature handheld computing devices such as PDAs, mobile phones, display screens are small, and there are many limitations and difficulties to indicate over sized contents at once. In general, only a part of the contents is shown at once, and other part of the contents can only be shown by a scrolling operation. There are many user-interface techniques to display desired part of contents by scrolling and/or zooming.

One of the most common techniques is to place a scroll bar in the edge of the screen. Another popular method is a scroll mode that enables a user to scroll displayed contents by dragging it with a pen device. These conventional scrolling method, however, are difficult to use, especially when a user frequently wants to switch the mode from scrolling and to contents operating and editing. He/she has to access scroll bars or switch to scroll mode while operating (clicking buttons or anchor texts, and editing text fields) WWW contents or writing / drawing documents that were designed originally for large sized screens.

A new user-interface method to provide seamless switching of scrolling, zooming, and editing mode, has been desired for handheld computing devices.

Paperweight Metaphor

In this paper we have proposed a new user-interface method to provide seamless and intuitive switching of scrolling / zooming mode and editing mode, based on a "Paperweight Metaphor".

When we place a sheet of paper on a slippery tabletop as shown in figure 1, and try to write letters on the paper with one hand, we have to fix it by our palm (fig. 1 right), because it will be slipped following to the movement of the pen (fig. 1 left).

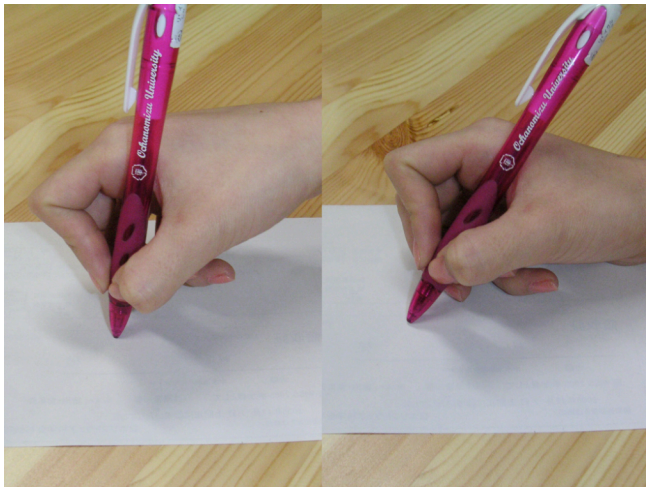

figure 1. Explanation of "Paperweight Metaphor." Since the paper on the desk moves when writing tool is moved (fig.1 left), we must hold it down by our hand to write letters on it. (fig.1 right). Making use of the familiar action as a metaphor, we could design intuitive switching operation for the scroll and edit modes.

This familiar writing action of using our hand as paperweight to fix a sheet of paper is a good metaphor to design switching operation of scroll and editing modes. We can design new interaction methods using the Paperweight Metaphor.

For example, the action of sliding a sheet of paper can be used to scroll contents in a computer display, and the action of writing letters by fixing it can be used to edit the contents. Sliding a paper is responded as a scroll mode, while the act of pressing a paper down is responded as a edit mode.

Paperweight Metaphor can also be applied to other operations, i.e. rotation and zooming operations. When a user moves the pen from left to right, while he/she is softly pressing the sheet of paper with his/her palm, it may be rotated clockwise around the place where his/her palm is attaching. This action can be mapped to rotation operations. Assume that the sheet of paper is made of elastic material such as a thin rubber-sheet, pressing against the sheet by one's palm and moving the pen upward may stretch the sheet. Conversely, moving the pen downward may cause the sheet to shrink. This action can be mapped to zooming in and zooming out operations.

Prototype Applications

To realize the interaction using Paperweight Metaphor, we have made a prototype system by placing a touch sensor[1] under a PDA[2] screen where user's palm will be hit. The silver electrode under the palm is the sensing area as shown in figure 2. The output of the touch sensor is connected to the PDA via USB. By detecting whether a user's palm is touching the sensor or not, the mode of pen operation changes.

Paperweight Metaphor can be applied to various possible applications. In order to assess our interaction method, we have developed JAVA application programs, which will allow the sensor output to smoothly switch modes between scrolling, zooming, rotating and editing.

Most promising interaction technique using our metaphor is to switch editing and scrolling modes by touching and not touching the sensor. This is a basic action of writing on a sheet of paper on a slippery tabletop. We can make a word processor application that will switch text-editing and scrolling mode by touching and not touching the sensor. We can also make a drawing application that handles large drawing sheet with intuitive scrolling. There could be many business PDA applications that provide scrolling and editing mode switch by Paperweight Metaphor, such as medical records viewer and annotator, and on-site inventory system. Scrolling and editing switcher will benefit WWW browser for PDAs and mobile phones, too. A user can browse WWW contents originally designed for large sized screens (i.e. PC) easily and seamlessly, by scrolling the contents, clicking buttons or anchoring texts, and editing text entry fields.

[1] Quantum Research Group: QTouch QT240.

[2] SHARP: Zaurus SL-C720, running Linux OS.

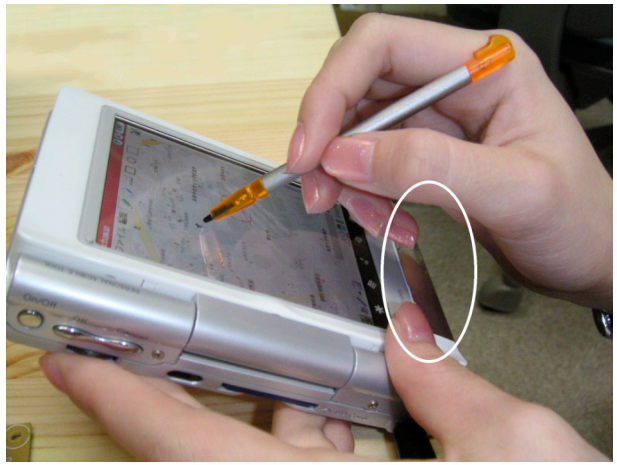

figure 2. A user scrolls the map while not touching the sensor (at the oval mark) and drugging.

figure 3. A user draws handwritten memo while touching the sensor.

Figure 2 and 3 shows a map browser and annotator application that we have developed for demonstration purposes. When a user does not touch his/her palm from the touch sensor, and drags the map by using the pen device, the map scrolls according to the movement of the pen (figure 2). When a user touches the sensor by his/her palm, the map does not scroll and a user can draw handwritten annotations while dragging the pen on the map.

Figure 4 shows a photograph browser application. In this application, when a user's hand is not touching the sensor, the user can scroll the photograph using the pen device, on the other hand, when a user's hand is touching the sensor, the user can zoom and rotate the photograph using the pen device. This is another phenomenon that may occur in Paperweight Metaphor as mentioned in the previous section. That is, dragging the pen upward, allows the photograph to stretch and zoom-in operation is invoked, and dragging the pen downward invokes zoom-out operation. Dragging the pen left to right invokes clockwise rotation, and right to left invokes counter clockwise rotation. By using these operations, a user can browse the photograph easily by scrolling, zooming in/out, and rotating seamlessly.

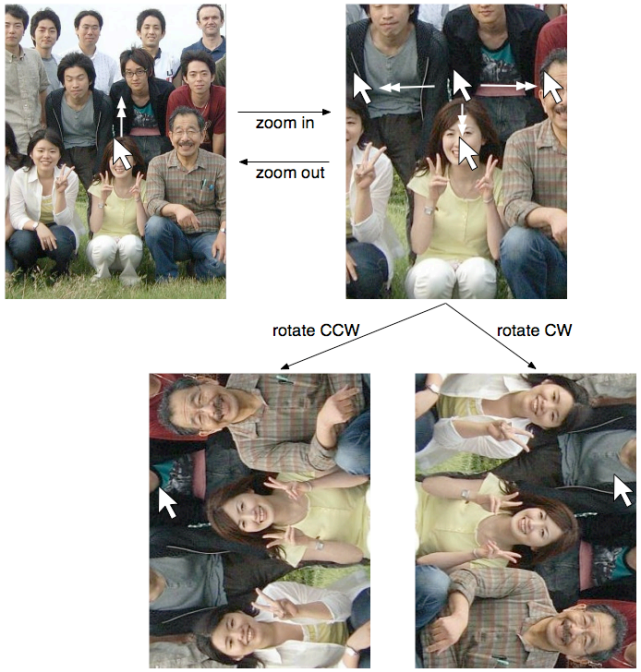

figure 4. Zooming in/out and rotating a photograph by pen dragging while touching the sensor.

Apart from Paperweight Metaphor, the touch sensor under the screen provides many interesting interaction method for mobile and tablet computers.

As mobile computers are often used in a public environment, it is necessary to keep private personal information such as address, telephone number, and password from prying eyes. We can operate the workings of the PDA so that the backlight of the screen dims when a user is touching the touch sensor by his/her palm.

Many laptops have tablet like input devices named touch-pads to detect position of user's fingertip. Normally it operates as a relative coordinate input device like mouse. If we install our touch sensor in front of the touch-pad, it can be designed to operate as an absolute coordinate input device like a pen tablet only when the user's hand is touching the sensor. This device will be an excellent input device for hand-written annotation, hand-written text, and character recognition.

Related Works

Making use of the user's fingertip to touch the pad device of laptop computers, the ThumSense system has provided additional mouse-button-functions to some of the keys in the QWERTY keyboard [5]. In our research, we have also focused on designing seamless mode switching with the contact of the human body.

Various approaches for incorporating our natural body movements into portable handheld devices have been proposed. Interaction techniques are proposed by arranging fingertip contact position sensors around the screen of the portable computer [3]. A user can turn pages by stroking one of the sensors. Rekimoto [6] and Fitzmaurice [1] used tilt sensor for navigating maps and menus. Harrison [2] used pressure and tilt sensors for scrolling documents and lists. RodDirect [4] used interaction technique for handheld computers by rotating and sliding a pen device in a pen holder of the computer body. We have focused on smooth switching of scroll mode based on our Paperweight Metaphor and realized it by using a simple touch sensor.

Summary and Future Works

In this paper, we have proposed new interaction techniques for handheld mobile computers based on Paperweight Metaphor. We have developed a prototype program to show that this metaphor will provide smooth operation for handling large contents by scrolling, zooming, rotating, and annotating. We are planning further experiment and evaluation of our methods in comparison with scrolling and zooming methods used in conventional PDAs and mobile phones.

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