

An Input Switching Interface Using Carbon Copy Metaphor

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ABSTRACT

This paper proposes a novel input technique that aims to switch between relative and absolute coordinates input methods seamlessly based on the “carbon copy” metaphor for track-pads.

Author Keywords

Input Techniques; Touch; Pointing; Gesture;

ACM Classification Keywords

H.5.2 User Interfaces: input devices and strategies

INTRODUCTION

Owing to the widespread use of touch surfaces, such as in smartphones, tablets, and trackpads, touch inputs can be seen in everyday life. At present, two input methods are used for touch surfaces, that is, relative coordinates and absolute coordinates pointing. Particular input equipment such as a pen tablet is required when a user performs absolute coordinates pointing. It allows a user to hand-draw or paint easily by providing absolute coordinates input to devices based on the relative coordinate input method. In a large screen environment, precise operation becomes difficult because of size difference between the screen and trackpad. By providing a small area that corresponds directly to a trackpad on the screen and allowing a user to input absolute coordinates only in this area, the problem can be resolved. However, a user interface for moving the small area and setting it on the screen is required. However, relative coordinate input method is suitable for common GUI operation. Even small finger movement can be used for large cursor movement, and precise operations can be performed, as mentioned before. In this study, we propose a new interface method based on the “carbon copy” metaphor for seamless mode switching between the following two modes: (a) input mode for the area enabling absolute coordinates input and (b) moving mode for this input area.

RELATED WORK

Various methods combine relative and absolute coordinate inputs. In [2], the switching of two coordinates input mode by

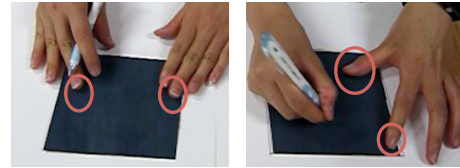


Figure 1. Fingertip Positions when Handling a Carbon Paper.

utilizing touch inputs on a smartphone is discussed. It focuses on rapid movement across large distances. In [1], a pen device is used, and [3] uses motion capture sensors. Our proposed method achieves this by using a widespread touchpad without any special hardware or sensor. Inklet is a utility that also allows a common trackpad to emulate virtual absolute coordinates input area by using predefined shortcut keys. Our technique provides intuitive and explicit operations based on the carbon copy metaphor. It will be more understandable than using pre-defined shortcut keys.

CARBON COPY METAPHOR

Our proposed method allows users to absolute input for the limited area, and the area can be moved to any optional place. A trackpad represents a carbon paper; it seems like an operation to create a carbon copy below a paper by using a small carbon paper and drawing paper. Aiming to achieve absolute-relative hybrid input, we adopted the “carbon copy” metaphor similarly to using a carbon paper. Our proposed method allows general trackpad operations for users in a conventional manner. Conversely, a virtual “carbon paper” appears on the display when the users touch the trackpad with their non dominant hand. The virtual carbon paper on the computer display is a metaphor of the actual carbon paper. Our proposed method is based on this hand motion: a user can manipulate the virtual “carbon paper” using similar actions, which they would apply to a physical carbon paper (Fig.1). The movement operation can be performed by touching the carbon paper with one finger of each hand (dominant and non dominant), and the writing operation (absolute coordinate inputs) can be performed by touching the carbon paper with two fingers of the non dominant hand for holding it and then pressing with a finger of the dominant hand or a pen held by dominant hand.

To design user actions on a touch surface of an interface based on the carbon copy metaphor, we conducted an observational study regarding the manipulation of a carbon paper in the real world. We assigned a drawing task to six participants (five right-handed, one left-handed, ages 21-24). We used a drawing paper (500mm × 400mm), small carbon pa-

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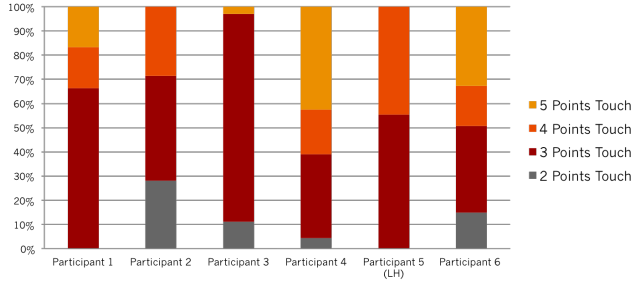


Figure 2. Frequency of the number of fingers used to hold the carbon paper

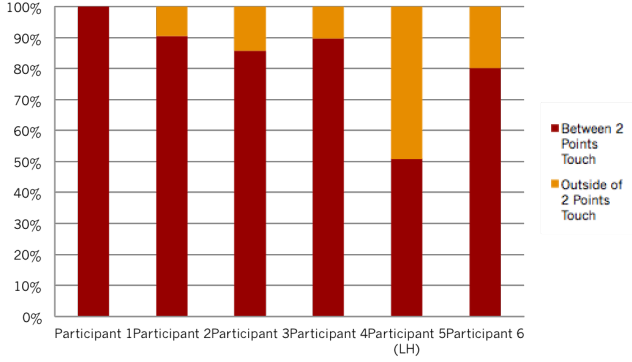


Figure 3. Frequency of drawing posture: drawing between or outside the fingers used for holding the paper

per ($130\text{mm} \times 130\text{mm}$), and ballpoint pen that ran out of ink. Participants sign their own name on the left half of the drawing paper and paint freely on the right half.

We recorded this experiment and looked for patterns in which the fingers were used for handling a carbon paper. When participants carried out the task, to write or draw on the paper, they pressed the edge of the carbon paper with their non dominant hand. This indicates that the participants utilized a wide drawing area and prevented the carbon paper from floating or peeling off. Fig. 2 shows the ratio of the time the fingers touched the carbon paper to that taken for the execution of the entire task. There are significant differences in frequencies of pairs of three fingers and other touches.

The t-test calculation showed that there are significant differences in frequencies of pairs of three fingers and other touches, such as between a three-finger touch and two-finger touch ($t(5) = 4.028, p < 0.001$), three-finger touch and four-finger touch ($t(5) = 3.007, p < 0.005$) and three-finger touch and five-finger touch ($t(5) = 3.466, p < 0.005$). All the other pairs are not considered significant. As shown in Fig. 3, we found that the participants tended to open certain two fingers widely, which means the participants decisively used two fingers for holding a carbon paper. Conversely, various finger movements were observed when the participants moved the carbon copy paper.

INTERFACE DESIGN

We designed the interface based on the preliminary experiment as follows. Focusing on the writing behavior of the par-

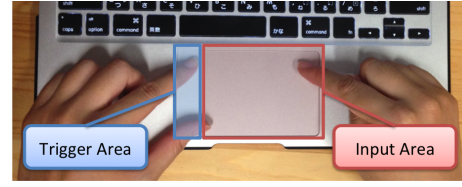


Figure 4. Trackpad divided into two areasA case for a right-handed person

ticipants on a carbon paper, we adopted “Pressing the edge of a carbon paper with two spreading fingers of the non dominant hand” as a condition for the writing operation. When a user uses two spreading fingers of the non dominant hand to press the edge of a trackpad while moving the cursor with one finger, a small working area with the same aspect ratio as a trackpad appears at the cursor location on the screen. This small working area (carbon copy area) is enabling absolute coordinates inputs. The absolute coordinates input mode is called the “carbon copy mode.” When the user removes the two non dominant fingers, the carbon copy area disappears, and the input mode switches to the conventional relative coordinates input mode. It provides seamless switching between the moving carbon copy area and carbon copy mode operations.

IMPLEMENTATION

To test the efficiency of our proposed method, we implemented a prototype, a painting application, in Objective-C for use on a Mac OS X 10.9 operating system. Touching the trigger area with one finger activates the carbon copy area (the black-edged area on the screen). When compared with the preliminary experiment, in the prototype, the entire desktop area corresponds to the drawing paper and the black-framed carbon copy area corresponds to the carbon paper. As Fig.4 shows, we divided a trackpad into two parts (non dominant hand side: trigger area, dominant hand side: input area). Our prototype allows a user to display/fix the screen using two fingers of the non dominant hand touching the trigger area of the trackpad. The user can draw in the carbon copy area with one finger of the dominant hand touching the input area of the trackpad. The position coordinate of the carbon copy area corresponds directly to that of a trackpad and allows a user to input by absolute coordinates. When the user puts one finger on the trigger area and one finger on the input area, the location of the carbon copy area can be changed by manipulating relative coordinates inputs.

CONCLUSION AND FUTURE WORK

In this paper, we proposed novel mode switching technique based on the carbon copy metaphor. It provides relative and absolute coordinates inputs by using a touch pad embedded in a laptop or a consumer trackpad. Based on the experiment, we implemented a desktop application available in a real GUI environment. We are planning to add a new function for virtual carbon paper, such as taking snapshots in the carbon copy area and sharing them to a smartphone. Furthermore, users can edit these snapshots in the smartphone. We will release our application as a GUI widget to allow the system to be used by a larger number of users.

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