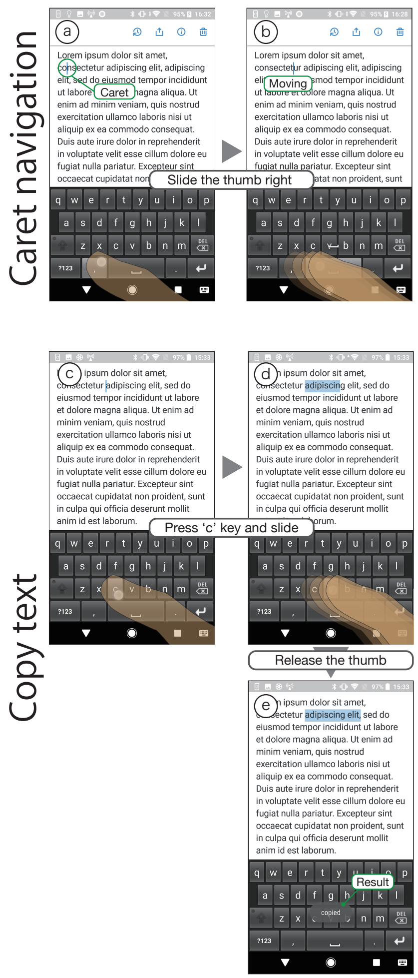

Figure 1: Usage of Press & Slide.

One-handed Rapid Text Selection and Command Execution Method for Smartphones

Toshiyuki Ando, Toshiya Isomoto, Buntarou Shizuki, and Shin Takahashi
University of Tsukuba
1-1-1, Tennodai, Tsukuba, Ibaraki, Japan
{ando,isomoto,shizuki,shin}@iplab.cs.tsukuba.ac.jp

ABSTRACT

We show a one-handed rapid text selection and command execution method for a smartphone; we term this Press & Slide. The user can perform caret navigation or text selection by sliding the finger on a software keyboard after pressing a key. Then, by releasing the key, a command such as “copy the selected text” is executed; the command is specified by the key that is pressed. Therefore, the user needs not touch the text, and thus the fat finger problem does not cause and the user needs not change his/her smartphone grip.

KEYWORDS

Software keyboard; caret navigation; single-handed; slide operation.

INTRODUCTION

A text control (e.g., selecting a text and activating a ‘copy’ command on the selected text) on a smartphone is associated with two problems when the users employ the thumb of the hand holding the device. First, the fat finger problem [7] tends to make precise selection difficult. A text selection is

CHI'19 Extended Abstracts, May 4–9, 2019, Glasgow, Scotland UK

ACM ISBN 978-1-4503-5971-9/19/05.
https://doi.org/10.1145/3290607.3312850

performed by pressing the text for few moments, moving adjusters to determine the selection range, and then releasing the finger. With this design, unwanted letters next to the text are unintentionally selected. Second, the user should change his/her smartphone grip if the thumb cannot reach the region of the touchscreen where the text is shown.

In this paper, we show Press & Slide (Figure 1), a one-handed rapid text selection and command execution method for a smartphone. In this method, the user performs a text control with the thumb of the hand holding the smartphone via the following steps: 1) Press a key on the software keyboard; this chooses a command; 2) Slide the thumb on the keyboard; the selection range changes depending on the extent of sliding; 3) Release the thumb from the touchscreen; the command specified is now executed on the selected text range. For example, to copy “adipiscing elit,” in Figure 1, the user presses any key of the fourth row (a) and slides the thumb to initiate carat navigation; the caret moves in the direction of sliding (b). Then, after terminating carat navigation by releasing the thumb from the touchscreen, the user presses the ‘c’ key (c) and slides the thumb to initiate text selection and to expand the selection range (d). Releasing the thumb copies the text (e). The command can be canceled by moving the caret back to its initial position. Using Press & Slide, the user can perform the text control (and caret navigation) by only pressing the software keyboard and then sliding the thumb on the keyboard. Therefore, the user needs not touch the text; the fat finger problem does not cause and there is no need to change the smartphone grip.

RELATED WORK

Several one-handed text control methods allowing the user to access the entire touchscreen without changing the smartphone grip, have been proposed. Some change UIs [3, 5, 8]. For example, iPhone Reachability [3] allows the user to perform the text control by moving the top half of the content to the bottom of the touchscreen. Some use tilt gestures [1, 6, 9]. Using Press & Tilt [1], the command is executed by pressing a key specifies the command on a software keyboard, tilting the smartphone, and releasing the key. In contrast to these methods, we use sliding a thumb of the hand with which the user holds the smartphone to resolve the abovementioned problems.

Sliding a finger on a keyboard has often been used to perform a text control. For example, iPhone 3DTouch [4] allows the user to navigate a caret by strongly pressing the keyboard and sliding the finger; then, a text selection is performed by changing the pressure. Gestures and Widgets [2] is a method using a swipe gesture or a circle drawing on the keyboard; a caret navigation, a text selection, and a command execution can be performed. Press & Slide also employs finger sliding, however Press & Slide allows the user to execute different commands specified by various keys; the maximum number of commands is the number of keys on the keyboard.

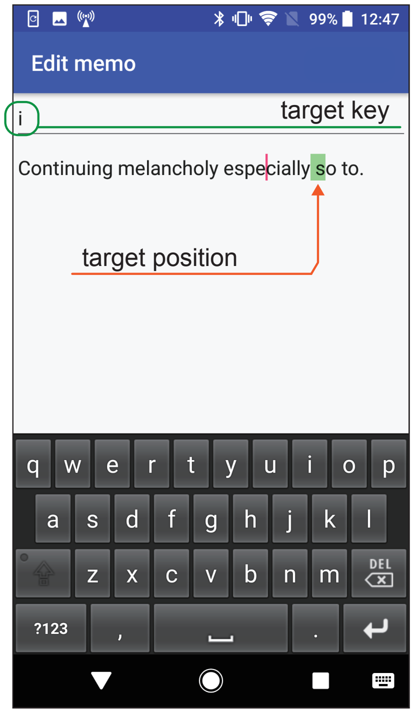

Figure 2: Application used in Exp. 1.

EXPERIMENT 1: DETERMINING PARAMETER

We conducted an experiment (Exp. 1) to determine the control-display (CD) ratio that is the amount of the caret movement with respect the amount of finger sliding.

Methods

12 volunteers (11 males, including students in our laboratory) aged 22–25 years ($M = 22.8$, $SD = 1.0$) participated in Exp. 1. We used an Xperia XZ (dimensions: 46 × 72 × 8.1 mm, touchscreen size: 5.2 inches, OS: Android 8.0.0) as a smartphone. Figure 2 shows the application used in Exp. 1.

The task was to move the caret using 3 CD ratios (0.05, 0.1, and 0.2), of which 0.1 was the ratio that the authors felt the most comfortable. The task was completed with the right hand which is the hand the participants always use for manipulating a smartphone.

In a trial, we first asked the participants to press a target key specified by the application (*i* in Figure 2). Then, the participants moved the caret by sliding the thumb to the target position which is shown as a green region (the target position was between the *space* and *s* in Figure 2). If participants could not move the caret to the target position because the thumb reached the edge of the touchscreen, they could release the thumb, press the target key, and slide the thumb again. After moving the caret to the target position and releasing the thumb from the keyboard, the trial was finished. Each participant performed 100 trials for each CD ratio. Therefore, data on 1,200 trials (12 participants × 100 trials) were collected. To eliminate the effects of particular target keys, each of the 33 keys on the keyboard were used three times and space once in the 100 trials; the key order was randomized. The order of CD ratios was also randomized. Moreover, the initial position of the caret was randomly determined.

Results

The results are shown in Figure 3. The time taken for 100 trials (Figure 3, top) was the longest in CD ratio 0.2 and the shortest in CD ratio 0.05. As the data were not normally distributed, we used Friedman's tests to reveal significant differences among the CD ratios ($p = 0.001 < 0.05$). Moreover, Dunn's multiple comparisons tests showed that there were significant differences between 0.05–0.2 ($p = 0.003 < 0.05$) and between 0.1–0.2 ($p = 0.002 < 0.05$). The number of overshoots in 100 trials, which were counted when the caret moved beyond the target position (Figure 3, center), was the largest for CD ratio 0.2 and the smallest for CD ratio 0.05. As the data were not normally distributed, we used Friedman's tests to examine significant differences among the CD ratios ($p = 0.000 < 0.05$). Moreover, Dunn's multiple comparisons tests showed that there were significant differences between 0.05–0.2 ($p = 0.000 < 0.05$) and between 0.1–0.2 ($p = 0.007 < 0.05$). We also collected a number of a touchdown in 100 trials, which was counted when a user presses a software keyboard (Figure 3, bottom). As the data were normally distributed, we performed a repeated-measures ANOVA; there

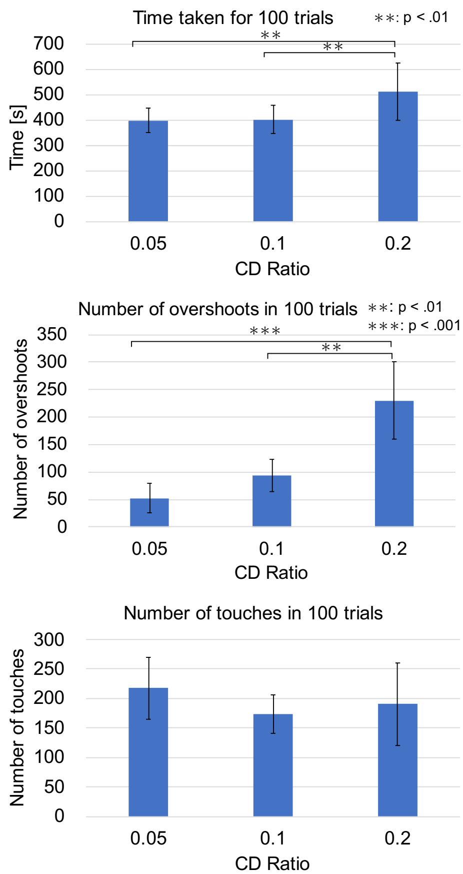

Figure 3: Results of Exp. 1.

were no significant difference among CD ratios ($p = 0.10 > 0.05$). Note that each number was at least 100 because 100 trials were completed at each CD ratio.

We obtained negative comments such as “I felt frustrated when moving the caret over a long distance” for CD ratio of 0.05, “The caret tended to move over the target position.” for CD ratio of 0.2, and “When I released the thumb from the touchscreen, the caret moved” for all CD ratios (especially for 0.2). Moreover, some participants commented that “to press a key positioned at the left edge and slide the thumb was difficult due to the movable range of the thumb” regardless of the CD ratios.

Because of lower performance of 0.2 and the negative comments received when CD ratio of 0.05 and 0.2 were used, we chose 0.1 as the CD ratio.

IMPLEMENTATION

In our current implementation, the amount m by which a caret moves or a selection range is expanded is: $m = s\ [\text{pixel}] \times 0.1$, where s is the amount of finger sliding and 0.1 is the CD ratio determined in Exp. 1. More specifically, if m becomes larger or equal to 1, the caret moves or the selection range expands by FLOOR(m) letters from the current position.

The key used for the text control should be assigned according to manners that the user can intuitively perform the text control (e.g., ‘v’ for ‘paste’, ‘shift’ for capitalization). Moreover, participants commented that keys near the bezels were difficult to press; thus, a text control which is frequently used should be assigned to a key that is easy to press or multiple keys. For example, we assigned all keys of the fourth row to caret navigation because this is frequently required.

EXPERIMENT 2: COMPARISON WITH OTHER METHODS

We conducted an experiment (Exp. 2) to compare the performance and usability of Press & Slide to the built-in method of smartphones and Press & Tilt [1].

Methods

We recruited 6 participants (5 males) aged 23–25 years ($M = 24.2$, $SD = 0.8$) in Exp. 2. We used the same smartphone and application as Exp. 1. All tasks were completed with the right hand which is the hand the participants always use for manipulating a smartphone. We asked the participants to sit on a chair during the tasks. Specifically, the tasks were performed using three methods as follows:

Press & Slide To determine the start position of the selection, the participants moved the caret before the target text by sliding the thumb on the keyboard while pressing any key of the fourth row of the keyboard. Next, text selection was performed by sliding the thumb on the keyboard while pressing a key of a row other than the fourth row. Then, the command (*Next* in Exp. 2) was executed on the target text by releasing the touchscreen.

Built-in method The participants initiated text selection by pressing the text for a few moments and then moved adjusters to adjust the selection range. They then executed the text command

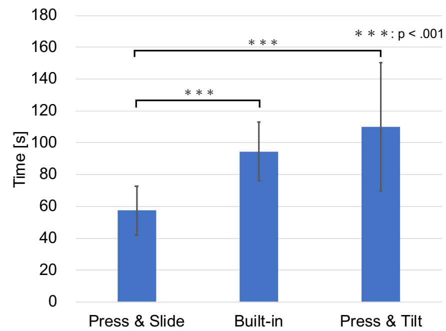

Figure 4: Average time taken for all sessions evaluating each method. Error bars indicate standard deviations.

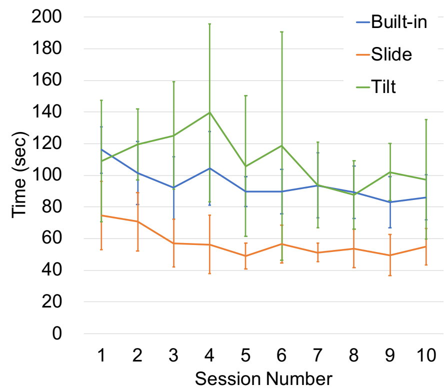

Figure 5: Average time taken per session for each method. Error bars indicate standard deviations.

[1]http://randomtextgenerator.com

on the target text by tapping *Next* on the menu that appeared near the text (*Next* was the only item on the menu).

Press & Tilt To determine the start position of the selection, the participants moved the caret before the target text by tilting the smartphone while pressing any key of the fourth row. Next, they performed text selection by tilting the smartphone while pressing a key of any row other than the fourth row. Then, the command (*Next* in Exp. 2) was executed on the target text by releasing the key.

For the same reason that we assigned caret navigation to an entire row of the keyboard (described in IMPLEMENTATION), we assigned text selection to any key of the fourth row of the keyboard.

A trial was to perform one text control correctly; if the command was correctly performed, the target text was updated; otherwise, the participant adjusted the selection range and executed the command again. Each session consisted of 11 trials. After completing a session, all participants rested for at least one minute. We did not use data from the first trial in analysis; the times required for trials 2–11 (10 trials) were recorded. All participants completed 10 sessions using each method. In total, data on 600 (6 participants × 10 trials × 10 sessions) trials of each method were collected. To counterbalance any order effect, the order of methods was changed for each participant. We used randomly generated English sentences[1]. To record participants impressions, we asked them to complete the System Usability Scale (SUS) after each method.

Results

Figures 4 and 5 show the average times taken for all session in each method and the average time taken per session in each method, respectively. The average time of all session was the shortest in Press & Slide and the longest in Press & Tilt. As the data were not normally distributed, we used Friedman's tests to reveal significant differences among the methods ($p = 0.000 < 0.05$). Moreover, Dunn's multiple comparisons tests also revealed significant differences between Press & Slide and the built-in method ($p = 0.000 < 0.05$) and between Press & Slide and Press & Tilt ($p = 0.000 < 0.05$).

In terms of participant impressions, the SUS score was the highest in Press & Slide and lowest in Press & Tilt. Since there was normality, we compared the methods with a repeated-measures ANOVA test; a significant difference was shown among the methods ($p = 0.00 < 0.05$). Moreover, the Bonferroni multiple comparison test revealed a significant difference between Press & Slide and Press & Tilt ($p = 0.02 < 0.05$). In the built-in method, two participants commented that "my thumb hid the target text."; about Press & Tilt, one commented that "expanding the selection range one letter next to the current position was difficult."; by contrast, Press & Slide got no negative comment.

CONCLUSIONS AND FUTURE WORK

We showed Press & Slide, a one-handed rapid text selection and command execution method for a smartphone by sliding. The user can perform caret navigation or text selection by sliding the finger on the software keyboard after pressing a key. Then, by releasing the keyboard, commands such as copy for the selected text is executed; the command is specified by the key. The results of Exp. 2 showed that its performance and usability were higher than two prior methods. Moreover, the comments obtained in Exp. 2 suggested that both occlusion and the fat finger problem were not of concern.

Our immediate future work to improve Press & Slide is adding a vertical caret movement with another CD ratio that must be determined by additional user studies. This addition would allow the user to perform the command execution more rapidly with better usability. Moreover, we need to improve memorization of key assignment. One idea for such improvement is placing a balloon help above a key when the key is touched down, helping the user memorize the assignment to the key. With respect to Exp. 1 and 2, we need to conduct the experiments with more participants of greater diversity (e.g., gender, age, and hand size), explore various user postures (e.g., sitting, standing, and walking), and evaluate device parameters (e.g., touchscreen and font size).

REFERENCES

[1] Toshiyuki Ando, Toshiya Isomoto, Buntarou Shizuki, and Shin Takahashi. 2018. Press & Tilt: One-handed Text Selection and Command Execution on Smartphone. In *Proceedings of the 30th Australian Computer-Human Interaction Conference (OzCHI '18)*. ACM, New York, NY, USA, 401–405. https://doi.org/10.1145/3292147.3292178

[2] Vittorio Fuccella, Poika Isokoski, and Benoit Martin. 2013. Gestures and Widgets: Performance in Text Editing on Multi-touch Capable Mobile Devices. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '13)*. ACM, New York, NY, USA, 2785–2794. https://doi.org/10.1145/2470654.2481385

[3] Apple Inc. 2014. iPhone User Guide - Reachability. https://help.apple.com/iphone/11/?lang=en#/iph66e10a71c (accessed 2019-1-7).

[4] Apple Inc. 2015. 3D Touch - iOS - Apple Developer. https://developer.apple.com/ios/3d-touch/ (accessed 2019-1-7).

[5] Sunjun Kim, Jihyun Yu, and Geehyuk Lee. 2012. Interaction Techniques for Unreachable Objects on the Touchscreen. In *Proceedings of the 24th Australian Computer-Human Interaction Conference (OzCHI '12)*. ACM, New York, NY, USA, 295–298. https://doi.org/10.1145/2414536.2414585

[6] Keigo Shima, Kazusa Onishi, Ryosuke Takada, Takuya Adachi, Buntarou Shizuki, and Jiro Tanaka. 2016. Investigating Accuracy of Tilting Operation on Wrist-worn Devices with Touchscreens. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '16)*. ACM, New York, NY, USA, 2705–2711. https://doi.org/10.1145/2851581.2892377

[7] Katie A. Siek, Yvonne Rogers, and Kay H. Connelly. 2005. Fat Finger Worries: How Older and Younger Users Physically Interact with PDAs. In *Proceedings of IFIP Conference on Human-Computer Interaction (INTERACT '05)*. 267–280.

[8] Kenji Suzuki, Kazumasa Okabe, Ryuuki Sakamoto, and Daisuke Sakamoto. 2016. Fix and Slide: Caret Navigation with Movable Background. In *Proceedings of the 18th International Conference on Human-Computer Interaction with Mobile Devices and Services (MobileHCI '16)*. ACM, New York, NY, USA, 478–482. https://doi.org/10.1145/2935334.2935357

[9] Hui-Shyong Yeo, Xiao-Shen Phang, Steven J. Castellucci, Per Ola Kristensson, and Aaron Quigley. 2017. Investigating Tilt-based Gesture Keyboard Entry for Single-Handed Text Entry on Large Devices. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM, New York, NY, USA, 4194–4202. https://doi.org/10.1145/3025453.3025520