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Virtual Sliding QWERTY: A new text entry method for smartwatches using Tap-N-Drag

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ABSTRACT

A smaller screen of smartwatches compare to conventional mobile devices such as PDAs and smartphones is one of the main factors that makes users to input texts difficult. However, several studies have only proposed a concept for entering texts for smartwatches without usability tests while other studies showed low text input performance. In this study, we proposed a new text entry method called Virtual Sliding QWERTY (VSQ) which utilizes a virtual qwerty-layout keyboard and a 'Tap-N-Drag' method to move the keyboard to the desired position. In addition, to verify VSQ we conducted a usability test with 20 participants for a combination of 5 key sizes and 4 CD-gains. As a result, VSQ achieved an average of 11.9 Words per Minute which was higher than previous studies. In particular, VSQ at 5 × 5 key size and 2×, or 3× CD-gain had the highest performance in terms of the quantitative and qualitative usability test.

1. Introduction

Since the1880s a wristwatch, a wearable device, has played a role in conveniently showing the time. Recently, with the development in IT technology, in addition to telling the time a smartwatch with similar functions to a smartphone has been developed. This wearable device is multi-functional in that it has the capability of being used as a wrist watch and also as a smartphone.

One of the key design considerations of the wearable device such as a smartwatch is the size of the device (Narayanaswami and Raghunath, 2000). The small size of the device restricts the screen size, and restricts the information space and also it makes it difficult to input text. The difficulty of inputting text on a small screen size is a widely known problem (Haseloff, 2001), and various methods of resolving the limitation have been developed (Colle and Hiszem, 2004; Gündüz and Pathan, 2013; Kwon et al., 2009, 2011; Park and Han, 2010; Parhi et al., 2006; Schedlbauer, 2007). However, the target devices of the previous studies were PDAs or smartphones which have a significantly larger screen than a smartwatch which has an ultra-small touchscreen. Thus, there is a limitation in the utilization of the current input method for the smartwatch.

Studies in the development of a method of enhancing text input for a smartwatch remain at a developmental stage. Although several studies have provided new methods of inputting text which may be feasible for the smartwatch, only a few studies have conducted usability tests to verify the input methods which currently have limitations (Table 1). Partridge et al. (2002) provided TiltType that inputs text using slope attained by an accelerometer. TiltType shows 9 letters sequentially on the 9 regions including 8 azimuth (NW, N, NE, E, SE, S, SW, W) and a center point. A user can move the next page with the other 9 letters by pushing a button and to select one of the alphabets they have to change the angle of the watch by tilting the arm. Raghunath and Narayanaswami (2002) developed Alphabet selector which selects one of 24 alphabets, A to Z, in a two-line circle with the use of a physical button. TiltType and Alphabet selector are currently only concepts, and usability tests to validate the concepts have not been conducted. Also, the two concept methods did not consider a touchscreen interface which is widely used on the mobile device.

Instead of the physical button recent studies have developed text input methods based on touchscreen interface (Oney et al., 2013; Komninos and Dunlop, 2014; Cho et al., 2014). Oney et al. (2013) proposed ZoomBoard based on a qwerty keyboard layout

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Table 1
Summary of major related researches.

Name (Author, Year)	Interface layout	Used interface type	Size information	Validation
TiltType (Partridge et al., 2002)	• 9 alphabets in each layout which can be changed to next layout with buttons and tilting sensors	• 4 physical buttons and • Accelerometer based tilting sensor (9 directions)	• Device: 40 × 37 mm	• Participants: 50 children between 8 and 16 ages • Method: Simple informal observations • Result: Slow (No quantitative results)
Alphabet selector (Raghunath and Narayanaswami, 2002)	• Alphabets are circularly located in 2 circular rows	• 4 physical buttons	• Device: 34.7 × 27.5 mm	• N.A.

ZoomBoard (Oney et al., 2013)	• Non-zooming/zoomable full QWERTY keyboard
	• 3 swipe gestures such as left, upward, right for backspace, changing to secondary keyboard, space
		• Touch screen	• Screen: Any display above 1 inch size
			• Keyboard: 16.5 × 6.1 mm
			• A key: 1.5 × 1.5~4.4 × 4.4 mm
				• Participants: 6 (4 female, 2 male)
				• Method: Controlled experiment with 4 sessions
				  • Session 1: 4 trials including 3 min typing
				  • 1) proficiency test on a standard physical keyboard, 2) 3 min small non-zooming touchscreen keyboard test on an iPad3, 3—4) two 3 min trials with ZoomBoard
				  • Session 2—3: two 3 min trials with ZoomBoard
				  • Session 4: Short qualitative survey
				• Test set: Phrases set by MacKenzie and Soukoreff (2003)
				• Result: 4.5/9.3 WPM in non-zooming keyboard and zoomable keyboard

6 key layout (Komninos and Dunlop, 2014)	• 6 groups of alphabet
	• 4 swipe gestures such as left, right, upward, downward for backspace, word completion, toggle capitalization, numeric punctuation mode
		• Touch screen	• Screen: 30 × 25 mm (Sony SmartWatch2)
			• A key: Over 7 mm
				• Participants: 20 (9 female, 11 male)
				• Method: Controlled experiment with 4 phases
				  • Session 1: Introduce and complete a brief prior-experience form
				  • Session 2: Demonstrate how to enter text using the system
				  • Session 3 & 4: Conduct formal tasks and subjective survey
				• Test set: 44 phrases divided by 2 sets of 22 phrases randomly selected from Enron email set (Vertanen and Kristensson, 2011). Each set contains 2 practice phrases followed by 4 groups of 5 phrases.
				• Result: 8.1 WPM

DragKeys (Cho et al., 2014)	• 8 groups of alphabet • Key groups are circularly arranged around the text cursor	• Touch screen	• Screen: 1.54 inch diagonal length (Google Smart Watch)	• N.A.

Touch-sensitive wristband (Funk et al., 2014)	• 26 alphabets, delete, enter, and space buttons are located serially in Linear layout and grouped in Multitap layout	• Touch-sensitive wristband using Spectrasymbol SoftPot potentiometer	• Wristband: 7.2 × 52 mm
			• A button: 10 mm width and 5.5 mm/1.8 mm height in each multitap and linear layout
				• Participants: 10 (4 female, 6 male)
				• Method: Controlled experiment
				  • 5 phrases are asked with multitap and linear layout
				  • 2 questionnaire survey for qualitative results
				• Test set:: Phrases set by Soukoreff and MacKenzie (2001)
				• Result: 3.45/2.91 WPM and 1.54/1.83 Key KSPCs Per Character (KSPC) in each multitap and linear layout