Vector Keyboard for Touch Screen Devices

Martin Klima and Vaclav Slovacek

Czech Technical University in Prague, Czech Republic
{xklima,slovav1}@fel.cvut.cz

Abstract. Paper introduces a vector keyboard for touch screen devices. Characters are typed by drawing a vector starting from a dedicated area. The typing area is divided into three clusters, each containing 9 characters. Measurement of typing speed and of number of typos reveals that the keyboard is comparable to ABCDEF virtual keyboard.

Keywords: vector keyboard, virtual keyboard, touch screen, PDA, QWERT.

1 Motivation

The motivation of this work is to introduce a new, user friendly method for inserting text input on handheld devices. The widely spread insert methods are either using a limited hardware keyboard, graffiti, or a virtual QWERTY keyboard. Despite the fact that experienced users, who are well trained to use any of the named input methods, can be very efficient in typing text, each of the methods suffers with some limitations. The limited hardware keyboards are usually very small and difficult to press, graffiti is not intuitive and difficult to learn and finally the virtual QWERTY keyboard is, similarly to the hardware keyboard, small and often requires usage of stylus. The virtual QWERTY keyboard occupies a significant portion of the display that should be used for the application. We propose a method that was meant to solve most of the named weaknesses.

2 State of the Art

The current trend in mobile devices is to maximize the display area and to minimize the hardware buttons necessary to control the system. This aim leads to large touch screens with either virtual clickable keyboards or to vector, respectively gesture based text input. Palm Computing 5 introduced graffiti in Palm OS, a touch screen gesture input method, Microsoft implemented a similar system on its Pocket PC platform called Block Recognizer. The advantage of these methods is that the shapes to be drawn on the touch screen are similar to regular Greek alphabet. Nevertheless the shapes are quite complicated and the usage is not possible without an initial training.

Other approaches like 1, 2 use gestures either on a virtual keyboard or within a dedicated area for writing letters. In each case, the gesture made on the touch screen is a complicated shape, typically a polyline. An interesting approach is introduced in 3 where the virtual keyboard is split into several regions, each containing up to five

B.-T. Karsh (Ed.): Ergonomics and Health Aspects, HCII 2009, LNCS 5624, pp. 250–256, 2009.

characters. The user can draw a curve which will select one character. The above mentioned methods suffer with one or more significant drawbacks. Either the user has to learn a completely new set of gestures or the typing is extremely difficult on the handheld due to a reduced screen space. The first is true in case of 2 and the graffiti system. These (and similar) writing systems try to introduce gestures that are somewhat similar to the Latin alphabet nevertheless they are significantly different in many cases. The second is true in case of 6 or 7 where the individual letters are not typed directly but are passed over by a pen stroke. This method is vulnerable to errors on mobile devices when the user is in movement.

3 Our Approach

In our approach we introduce a method that enables for one stroke, simple non curved line character typing on a touch screen. The primary idea was to introduce an input method that would make it possible to use both hands simultaneously for typing on a touch screen devices. When holding a mobile device, typically a PDA (Personal Digital Assistant) or a Smart Phone in both hands, only the thumbs are available for typing on the touch screen, see Fig.1. In such a case, considering a small dimensions of the touch screen and relatively big dimension of the thumbs, it is difficult to use a standard QWERTY keyboard. The regular way of touching the keyboard becomes difficult in a mobile environment, users tend to mistype the proper area touch screen or touch them accidentally multiple times. Our approach uses typing gestures on the touch screen instead of typing. The gestures are extremely simple so that the users do not need to learn them or use some mnemonics. In our case the screen is divided into virtual keyboard area and the application area. The virtual keyboard requires less space than a QWERTY virtual keyboard.

The keyboard is divided into three major clusters, each containing an array of nine characters. There are four additional functional buttons that switch beween upper/lowercase letters, numbers and special characters, backspace key and enter key. See Fig. 4 for details.

Fig. 1. Typing letter

The usage of the keyboard is the following: The eight characters on the edge of each cluster are typed by drawing a vector starting wherever in the given area and pointing in parallel with a straight line from the middle of the box to the character typed. The method is displayed in Fig. 2.

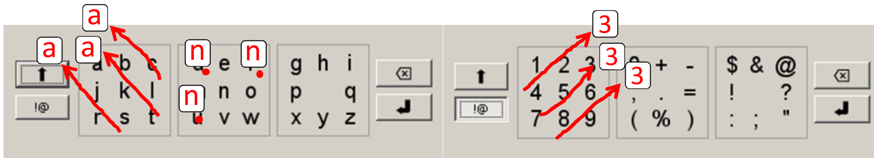

Fig. 2. Typing the character a, n, and 3

The character in middle of each cluster is typed by single tapping anywhere on the cluster area. For the user convenience the typing algorithm was enriched so that two spaces in a sequence are transformed into comma and a space followed by a capital letter.

For the sake of simplicity this keyboard is currently not enriched by special national characters, only the basic set of characters conforming the US QWERTY keyboard is present.

4 Evaluation and Testing

The evaluation of the usability of the vector keyboard was based on a combination of a subjective evaluation of the evaluators and an objective performance measurement. The test conditions were following:

4.1 Test Setup

Each tests consisted of an introduction of the device, several types of keyboards, pre-test interview, test of different keyboards and a post-test interview.

Number of users: 9

Device used: Mivvy UM-400 with stylus

Input methods: external QWERTY keyboard, internal sliding keyboard, QWERTY touch screen, ABCDEF touch screen and vector keyboard touch screen.

Each user was to use five different keyboards for typing texts. The keyboards were:

1. Regular 105 keys PC keyboard attached via USB. Typing on such a keyboard reveals the experience of the user with work on a PC.
2. Sliding keyboard of the ultra mobile PC Mivvy UM-400. This keyboard has a limited size and 65 keys, see Fig. 4. This keyboard has principally a QWERTY layout but should be operated by thumbs only. Typing on this keyboard reveals the user's capability to use thumbs only on a quasi normal keyboard.
3. QWERTY keyboard on the touch screen operated by stylus. The dimension of the keyboard does not allow for using fingers (thumbs). Similar to the previous case, this keyboard reveals the user's capability to use stylus.

Table 1. User overview

Nr.	Age	Gender	PC Exp.	Handheld Exp.	Touchscreen Exp.	Type Style	Layout
1	24	Male	Yes	Occasional	Occasional	8	QWERTY
2	31	Female	Yes	No	No	10	QWERTZ
3	12	Female	Yes	No	No	8	QWERTY
4	47	Male	Yes	No	No	2	QWERTZ
5	27	Male	Yes	Yes	Yes	8	QWERTY
6	33	Female	Yes	No	No	2	QWERTZ
7	44	Female	No	None	No	2	none
8	63	Male	Yes	No	No	2	QWERTZ
9	35	Male	Yes	Yes	Yes	10	QWERTY

Fig. 3. Mivvy UM-400 sliding keyboard

4. ABCDEF keyboard on the touch screen operated by stylus. This keyboard has physically the same geometrical layout of keys but the keys are ordered in an alphabetical order. Typing on this keyboard shows the contrast between the layout the user is used to from the PC and a new layout which is easy to understand but not fully adopted by the user.
5. Vector keyboard, which is the primary subject of testing. Due to the sensitivity of the touch screen used, stylus was used for operating it.

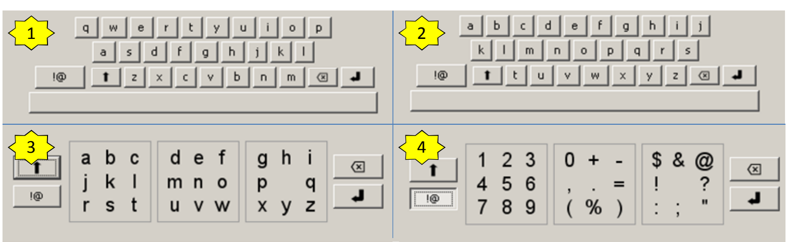

Fig. 4. 1- QWERTY touch screen keyboard, 2 – ABCDEF touch screen keyboard, 3 – vector keyboard, 4- vector keyboard numeric set

Texts: We used texts of equal complexity, thematic and size that were dictated to the user so that the attention was not disrupted. Each text was approximately 100 words in length. All eventual foreign words or grammatical structures were dictated phonetically in order to minimize the cognitive load dedicated to text structure.

Recording: Every letter typed was automatically logged with exact time and order. The evaluation was done by measuring various aspects of typing.

4.2 Evaluation

The evaluation has taken into account two aspects. The first one was the actual performance of each user. The collected typing data were filtered so that all pauses between two characters longer than 3 seconds were removed. The reason for this was that such long pauses were always caused by influences different from typing difficulties, for example by not understanding the dictated text or by interruption by external sources.

By our observations the pauses between individual words were significantly longer than pauses between individual characters. Therefore we measured only times between characters within a single word, not between words. Number of typos was measured and number of deletes was measured. A multiple delete in a row was suggested as a single delete operation due to the fact that some users deleted a series of characters after recognizing a typo instead of moving the cursor to the typo first.

5 Results

Experienced users showed very good performance in typing with QWERTY layout both hardware and virtual keyboard, see Fig. 5. This is an expected result since the layout is well memorized from previous experience.

The most relevant comparison can be made between the ABCDEF keyboard and the vector keyboard, since the ABCDEF partly eliminates the user's experience.

The typing speed was comparable to the ABCDEF, see Fig. 5, which is considered a good result considering a new way of interaction (draw instead of tap). The drawing itself takes longer.

Writing on vector keyboard caused significantly higher number of typos for most users (6 of 9). Fig. 6 shows sum of typos that were corrected by user during the test and typos that were not corrected at all.

As a major problem of the tested setup of the vector keyboard were reported:

1. The fact that the current design of the vector keyboard combines vector gestures with tapping. The tapping caused significant amount of typos and was also reported as a subjective problem by the users.
2. The angle dedicated for writing each letter in a cluster is 45 degrees that caused accidental write of a neighboring letter.
3. The quality of the touch screen of the Mivvy UM-400 made it sometimes difficult to draw the vector in a satisfactory level.

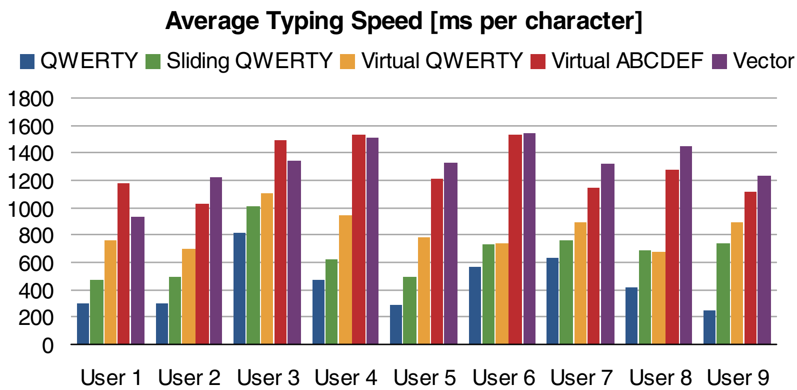

Fig. 5. Average typing speed of one character on various keyboards

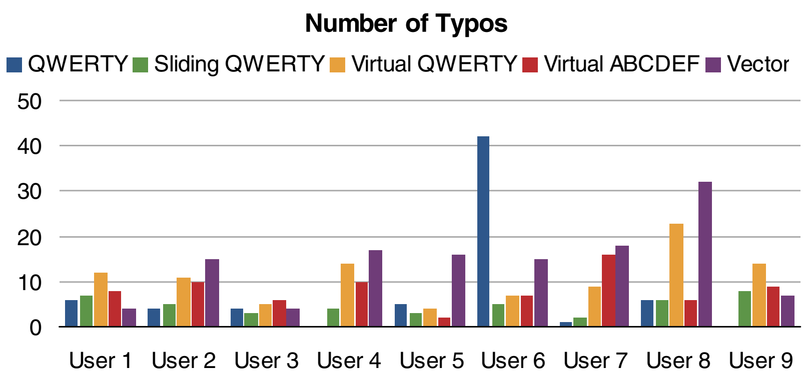

Fig. 6. Number of typos on various keyboards

As a future improvement we recommend to introduce a layout with one more cluster, each having eight characters only (with no letter in the middle) and thus omitting the tapping at all.

Implementing an error correction based on a dictionary may also lead to reducing number of typos. The correction of typo of two neighboring characters can be done in case the direction of a stroke is close to a threshold between the two characters.

We recommend developing and testing of a new prototype for capacitive touch screen device. Capacitive touch screen enables higher level of precision when recognizing strokes and also makes it possible to control the vector keyboard by thumbs that may lead to different results.

As a result we state that the vector keyboard as it was implemented does not compete to the virtual QWERTY keyboard due to the generic experience with this keyboard. On the other hand, the vector keyboard was performing almost equally to the ABCDEF keyboard which shows that the method itself is as good as the tapping. We believe that further development of the vector keyboard, as it is suggested above, will lead to significant improvement of typing performance.

References

1. Kristensson, P.O., Zhai, S.: Command Strokes with and without Preview: Using Pen Gestures on Keyboard for Command Selection. In: Proc. CHI 2007: ACM Conference on Human Factors in Computing Systems, San Jose, California (2007)
2. Wobbrock, J.O., Myers, B.A., Kembel, J.A.: EdgeWrite: A stylus-based text entry method designed for high accuracy and stability of motion. In: Proceedings of the ACM Symposium on User Interface Software and Technology (UIST 2003), Vancouver, British Columbia, pp. 61–70. ACM Press, New York (2003)
3. Perlin, K.: Quikwriting: continuous stylus-based text entry. In: UIST 1998: Proceedings of the 11th annual ACM symposium on User interface software and technology, pp. 215–216 (1998)
4. Yatani, K., Truong, K.N.: An Evaluation of Stylus-Based Text Entry Methods on Handheld Devices in Stationary & Mobile Settings. In: The Proceedings of MobileHCI 2007: The 9th International Conference on Human-Computer Interaction with Mobile Devices and Services, Singapore, September 11-14, pp. 145–152 (2007)
5. Shoemaker, P.B.: Designing interfaces for handheld computers. In: Conference on Human Factors in Computing Systems, pp. 127–127. ACM, New York (1999)
6. Kristensson, P.O., Zhai, S.: Command Strokes with and without Preview: Using Pen Gestures on Keyboard for Command Selection. In: Proc. ACM CHI 2007, New York, NY, USA, pp. 1137–1146 (2007)
7. Kristensson, P.-O., Zhai, S.: SHARK2: a large vocabulary shorthand writing system for pen-based computers. In: Proc. the 17th annual ACM Symposium on User Interface Software and Technology, pp. 43–52 (2004)