Leyboard: A Software Keyboard that Places Keys at Positions of Fingers and their Surroundings

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ABSTRACT
In this paper, we present a software keyboard called Leyboard that provides users easy touch-typing. Traditional software keyboards are difficult for users to touch-type because users cannot sense the places of keys by touching them. Thus, we make touch-typing easier by placing keys at the positions of fingers and their surroundings. Even if keys are unperceivable, adjusting the places of keys to users' hands enables them faster and more accurate input than using ordinary software keyboards. We have implemented a prototype and have performed a user study for evaluation. The input rate of Leyboard has risen up to 31 wpm.

Author Keywords
Touch screen; text input; software keyboard; touch-typing.

ACM Classification Keywords
H.5.2. [Information interfaces and presentation]: User Interfaces—*Input devices and strategies*

General Terms
Design; Experimentation; Human Factors.

INTRODUCTION
A software keyboard is a software system for text entry. Specifically, it is the dominant text entry system for a touch-screen computer. In contrast to physical keyboards with which users can use touch-type for fast text entry, however, conventional software keyboards are difficult to touch-type on. The reason is that users cannot feel the places of keys by touching them, since no key of a software keyboard is substantial.

In this research, our goal is to develop a software keyboard for touch screens, which enables users to touch-type easily. The key idea is to place keys at the position of each finger and their surroundings and to use the QWERTY layout. Our system adjusts the places of keys to users' hands by identifying fingers. This enables users to input text faster and more accurately than ordinary software keyboards, even if keys are unperceivable. We implemented a prototype called Leyboard. We named it "L"eyboard by replacing "K" with "L" since we expect this will be a more advanced system than ordinary "K"eyboard.

LiquidKeyboard [4], BLT-Adaptive Keyboard [1], the study of Gunawardana and et al. [3], which adjusts shapes and places of keys to the user's hands, have adopted a similar approach to our research. We furthermore focus on how to use thumbs while typing to increase variations for text entry and make their input comfortable.

DESIGN OF LEYBOARD
In this section, we describe the essential features of Leyboard. When users place 10 fingers on the touch screen, Leyboard places home position keys responding to touched points by recognizing the touched points. Leyboard places non-home position keys around home position keys. Those positions are con-cyclic, and the home position key is at the center. Leyboard inputs the closest key from the touch point. We have made Leyboard draw Voronoi diagrams to show the area of keys. We used Fortune's algorithm [2] to draw Voronoi diagrams.

Key Layouts around Thumbs and Thumb Based Sliding
To input text, several other keys besides alphanumerics keys like Shift or Ctrl are required. The problem is that we cannot place those keys at the same places as on ordinary QWERTY keyboards. Areas around fingers except thumbs do not have enough space to place extra keys, because they may reach the edge of the screen or keys for other fingers. In the touch-typing method for physical keyboards, thumbs are used to press the Space bar. We placed some keys around thumbs on Leyboard because there are large spaces for just placing the Space bar.

We also developed a technique called "thumb based sliding". Pressing two keys is required to input some characters (e.g. "f" key and Shift to input capital "F"). The thumb based sliding technique makes such simultaneous input easy with our key layout. Figure 1 shows an example of thumb based sliding. Assume that the left thumb presses Shift. Then, Leyboard moves all the keys for the left hand like Figure 1. This design allows users to press keys while pressing another key without breaking the posture of the hand, which enables users to input comfortably.

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Key Set

To enable users to input characters other than letters, Leyboard provides three key sets: alphabet set (Figure 2), numbers and symbols set (Figure 3), and functions and numerical keypad set (Figure 4). The default key set is the alphabet set. Leyboard places keys that switch key sets and modifier keys such as Shift and Ctrl around thumbs. Users also can press keys around thumbs by sliding their fingers from one key to the next. With this design, users can switch the key set and press modifier keys in a single action.

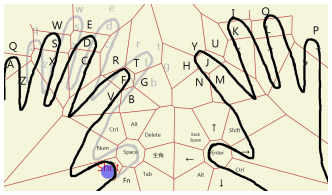

Figure 1. Example of thumb based sliding.

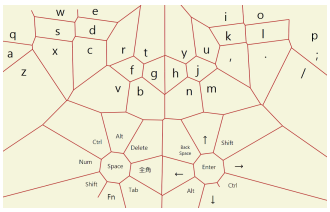

Figure 2. Layout of alphabet set.

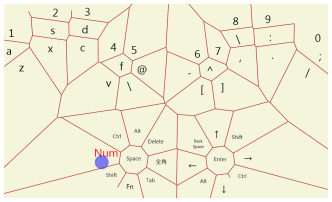

Figure 3. Layout of numbers and symbols set.

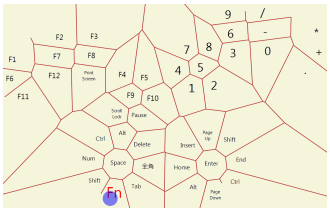

Figure 4. Layout of functions and numerical keypad set.

USER STUDY

We conducted a user study to compare an ordinary software keyboard and Leyboard. We chose the software keyboard regularly installed in Windows 7. Hereafter, we call this software keyboard the Windows 7 keyboard. Figure 5 shows our experiment environment where we used Acer's ICONIA-F54E. The participant was one of the authors. We chose tasks of inputting English pangrams. The pangrams contained capital letters and some also included symbols. Hereafter, we call inputting 10 different pangrams a set. The participant had three sets of tasks for each software keyboard on each day. We conducted this evaluation for 14 consecutive days. For the first seven days, the participant performed tasks first with the Windows 7 keyboard and then Leyboard. For the last seven days, the participant performed tasks in the opposite order. The aim of this was to avoid order effects in accordance with the counter balance method.

Results

Figure 6 shows the input rate in words per minute (wpm) on each software keyboard, with fitted curves, which are approximated to logarithmic curves. The maximum wpm of the Windows 7 keyboard was 31, which is almost the same as Leyboard. Although the input rate is only slightly improved, Leyboard still has the potential to outperform ordinary software keyboards according to the fitted curve.

Figure 5. Experiment environment.

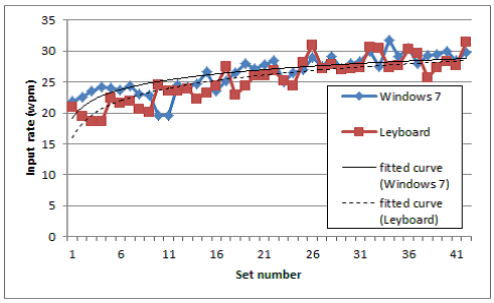

Figure 6. The input rate on each software keyboard.

CONCLUSION

In this paper, we have presented Leyboard, a software keyboard that enables easier touch-typing than ordinary software keyboards. Leyboard places home position keys of the QWERTY layout at the touch point of each finger and non-home position keys at their surroundings. Leyboard enables many keys to be pressed with a small amount of hand movement by placing several keys around the points of thumbs. A user study found that Leyboard has almost the same input rate with a slight improvement compared with the regularly installed Windows 7 software keyboard.

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