Beyond the Constraints of QWERTY Keyboard: Challenges to Provide Alternative Input Methods for Japanese Older Adults

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Abstract. Standard QWERTY keyboards are considered as a major source of reluctance towards computer usage by Japanese elderly, because of their limited experience with Western typewriters and the high cognitive demand involved in typing Japanese characters with them. This paper discusses the difficulty in typing Japanese characters using QWERTY keyboards, and then introduces two alternative approaches. The first approach makes use of touchscreen and software keyboards. Touchscreen enables users to enter Japanese characters more directly and is expected to moderate their resistance. As the second approach, a trial to develop a mechanical keyboard that is able to change its key layout dynamically is introduced. The proposed keyboard is also capable to change colors of keys, to flash keys to attract users' attention, and to hide unnecessary keys to avoid errors.

Keywords: interface, keyboard, touchscreen, elderly, gerontechnology.

1 Introduction

For elderly Japanese users, one of the major sources of resistance towards computers is thought to be the use of keyboards [1]. Two major reasons can be assumed. First, because the number of Japanese elderly people who have experience with Western typewriters is limited, they have to get accustomed to QWERTY keyboards as a totally new interaction paradigm before they start learning about computers. Second, although handling Japanese characters is essential in Japanese daily life, the process of inputting Japanese characters requires a relatively high cognitive demand. Thus, alternative ways to use computers without using standard QWERTY keyboards need to be considered in order to lower the resistance of elderly Japanese users towards computers so that they would have more opportunities to take their first steps.

This paper discusses the problems that Japanese older users might face when they handle Japanese characters with conventional QWERTY keyboards. Then two alternative approaches for character input are introduced. The first approach makes use of touchscreen and software keyboards. Touchscreen enables users to enter Japanese characters more directly and is expected to moderate their resistance. As the

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second approach, a trial to develop a mechanical keyboard that is able to change its key layout dynamically is introduced.

2 Problems in Japanese Input with QWERTY Keyboards

One of the major problems specific for Japanese older users is handling Japanese characters on computers [1]. Japanese populations who have experiences with Western typewriters is limited in number, especially among older generations. Besides, because of that huge number of characters used in the language, it is almost impossible to input all characters directly from "keyboards" with ordinal number of keys. These together make input of Japanese characters with QWERTY keyboards quite demanding, especially for elderly people.

Japanese language can be expressed in three different forms of expressions. The first and most fundamental expression is using Chinese ("Kanji") characters along with phonetic ("Kana") characters. Japanese language is usually written in this form. The total number of Chinese characters is said to be about fifty thousand, six thousand of which are frequently used [2]. Every Chinese character has its own meanings and pronunciations, while a number of Chinese characters may share the same pronunciation. Thus, it is often difficult to identify a Chinese character uniquely based only on its phonetic characteristics.

The second form of Japanese expression uses only phonetic characters. Each character is associated to a unique phoneme; these characters are phonetic symbols and have no meanings themselves. Although it is possible, it is not usual to write in Japanese using only phonetic characters, because most of the semantic information held by the Chinese characters would be lost. Basically there are only 48 phonetic characters with some extensions, systematically organized in the standard table form. This standard table is popular among all generations of Japanese; all Japanese elementary schools teach the table.

Finally, the third type of written representation uses a Roman character transliteration that has been developed to represent Japanese language phonemes with the Roman alphabet. Any sound in Japanese can be represented by one vowel or a combination of a consonant and a vowel. This expression, called Roman characters expression, has one-to-one mapping to phonetic characters.

Among methods to input Japanese using computer keyboards, most of popular and widely accepted methods make use of the conversion between these three expressions of Japanese. Fig. 1 shows a comparison of input processes of English and Japanese languages using QWERTY keyboard. Typing an English word is straightforward; users can type keys along with the actual spell of the word. On the other hand, in order to input Japanese characters, it requires users to convert their intended Japanese sentences first into sound (phonetic) characters, and then into Roman characters expression. As shown in Fig. 1, this conversion demands users a certain amount of cognitive processing, comparing with typing Western languages using Roman alphabets. Although Japanese younger generations are well accustomed with this type of methods, the cognitive demand can be significant for older users.

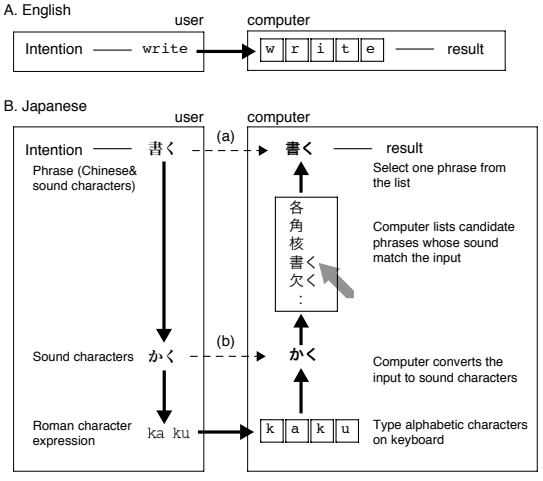

Fig. 1. Comparison of input of English and Japanese characters using QWERTY keyboard [1]

One possible intervention could be direct input of characters (dashed arrow (a) in Fig. 1). However, the large number of Chinese characters is making it very difficult to implement such direct input of all Japanese characters. (There have been, though, a few implementations of this idea using "table-size" keyboards. See [2] and [3] for detail.)

Another possibility for intervention would be using phonetic (sound) characters set (dashed arrow (b) in Fig. 1). Because the number of phonetic characters is limited, it is feasible to lay them out on a standard-sized keyboard or on a screen. Furthermore, if the standard table of phonetic characters is used as the key layout, users should be able to look up characters easily. The following two sections will introduce two alternative methods that have utilized this idea.

3 Intervention 1: Touchscreen and Software Keyboards

The first alternative input method for older Japanese users introduced in this paper is the direct input of phonetic characters using touchscreen and software keyboards, as discussed in the previous section. The most important characteristic of touchscreen is the ease of learning and operation [4]. When used with a software keyboard, the touchscreen enables direct input of characters, and is free from the constraints of traditional keyboards, such as layouts and sets of characters [5]. Tobias [6] suggested that a touchscreen is a suitable input device for elderly users.

Umemuro [7] designed an e-mail terminal with touchscreen technology and examined its effectiveness to lower elderly Japanese users' resistance toward computers. Apple Computer's iMac personal computer (OS ver. 9) was customized so that it offers e-mail handling as its principal function when users logged in. Fig. 2 shows an example of screen layouts of the customized terminal. Fig. 3 illustrates actual operation by older Japanese users.

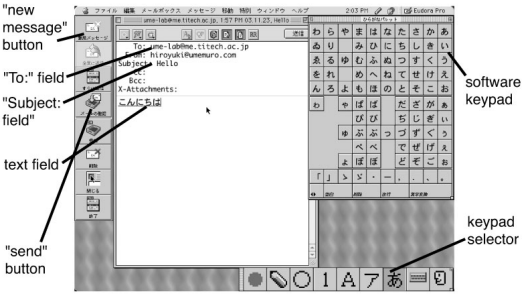

Fig. 2. E-mail software with software keyboard input for Japanese characters [7]

Fig. 3. Touchscreen operation by older user

The developed terminal was compared with another terminal that had the same design except that it had a standard keyboard and a mouse instead of a touchscreen and software keyboards. Older Japanese adults' computer attitudes and subjective evaluation were assessed for each of these terminals and compared. In the study, it was shown that elderly users' anxiety toward computers diminished after the training session with the touchscreen-based terminal, while users who experienced the keyboard-based terminal did not show a significant decline in computer anxiety. In addition, all touchscreen condition participants were not only able to send and receive e-mails on the developed terminal after a short training, but also expressed higher evaluation in terms of overall impressions of the terminal and a stronger willingness towards future use.

The developed terminal was also evaluated through a long term test by 16 older participants for twelve months, and the effectiveness as an intervention for older users was confirmed [8].

4 Intervention 2: Keyboard with Dynamic Key Layout Change

Although touchscreen and software keyboards enables changes in key layout, it is also reported that reduced tactical feedback to fingers may lead to low usability, especially

for older users, and that users may prefer to use mechanical keyboard rather than touchscreen for the tasks that require a number of inputs [9].

The second alternative approach introduced in this paper is a development of a mechanical keyboard that is able to change its key layout dynamically [10]. Semi-opaque material was used for key-tops, and letters or symbols were projected from below. By changing the patterns projected onto the key-tops and accordingly changing the mapping between keys and input data, the proposed keyboard was able to change its key layouts freely. It may use the standard table for Japanese phonetic characters, while standard QWERTY layout may be used for Roman alphabets. The proposed keyboard was also capable to change colors of keys, to flash keys to attract users' attention, and to hide unnecessary keys to avoid errors.

The proposed keyboard was evaluated in both performance and subjective evaluation in comparison with standard QWERTY keyboard and touchscreen conditions. Results with older subjects showed that error rate was smaller with the proposed keyboard and touchscreen than standard QWERTY keyboard. Older subjects evaluated the proposed keyboard as comparable to the touchscreen condition and higher than the standard keyboard in dimensions of satisfaction, learnability and efficiency.

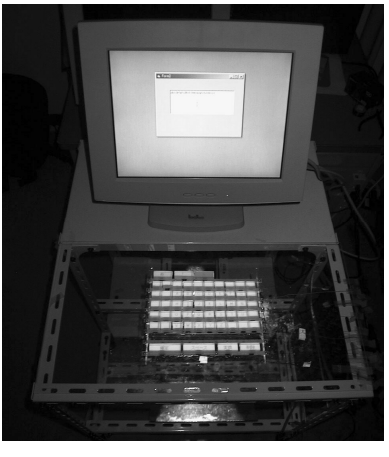

Fig. 4. Keyboard that enables dynamic key layout changes

5 Conclusion

Recently, alternative input methods, such as voice recognition, motion capture, and bio-sensing interfaces, have been emerging. However, explicit input methods and devices for them such as keyboards will still be necessary, especially for situations where voices or motions are not appropriate, where input speed is important, or where explicit data entry is necessary. Thus development and improvement of these input devices should be continuously pursued, taking older users in scope.

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