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Analysis on Four Directional Arrow Keys (4DAK) and Left, Right, Up, Down and Center (LRUDC) Button Text Input Interfaces for Myanmar Language

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1. Introduction

Since there is no efficient predictive text input method for Myanmar language, we have proposed "Positional Prediction" (PP) text input concept with "Four Directional Arrow Keys" (4DAK) [1]. PP is the prediction method of possible combinations of a consonant and vowels based on positional vowel parameters for Myanmar language. PP concept is also applicable for other similar syllabic based languages such as Khmer, Lao, Bangla, Thai, Hindi and Nepali etc. In this paper, we investigate PP text input method with "Left, Right, Up, Down and Center" (LRUDC) button interface. Initial user studies reported here show that 4DAK button interface has 31.22% higher Keystrokes per Character (KSPC) [2] than LRUDC button interface. Also, Characters per Minute (CPM) [3] of LRUDC is 5.01% higher than 4DAK. With LRUDC interface, even first time users were able to type at ~38.55 CPM with mouse and ~35.53 CPM with stylus pen. According to the mentioned results, we can prove that LRUDC button is a possible text input interface for Myanmar language.

2. Predictive Text Entry Method

The earliest predictive text entry method for phonetic language was done in Japan in the 1960s (Kurihara & Kurosaki, 1967). Today, all Japanese mobile phones support word-based predictive, and some of them support phrase-based predictive as well. For English, the most widely used predictive method is T9 by Tegic (Grover et al., 1998). Other predictive methods are eZiText by Zi Corporation (Zi Corporation, 2002) and iTAP by Motorola (Lexicus Division, 2002). By using predictive text entry method, frequently used words can be typed faster than multi-tap or multi-press, however, users have to spend time for searching and selecting a desired word from the list (e.g. pressing * key or next suggestion key). Another demerit point of predictive text input is that users have to switch to multi-tap mode if they cannot find the desired word in the list, because suggestion words are usually retrieved from the dictionary and sorted by usage frequency. To solve this demerit, we predict possible combination of vowels with a consonant or a consonant cluster instead of predicting a word.

3. Writing System of Myanmar Language

Myanmar or Burmese language has a phonetic writing system, and words are basically formed by combination of a consonant and vowels (e.g. "ေ-", "ိ", "ံ" and "ာ" etc.). But independent vowels (e.g. "အ", "ဣ", "ြ" and "ဪ" etc.) do not need to be combined with consonant to get a pronunciation. Myanmar language has various types of characters compared to English (i.e. consonants, dependent vowels or medials, independent vowels, finals, tones and subscript characters or conjunction alphabet etc). And Myanmar language contains many Pali words especially in religious vocabulary such as praying. Overall writing direction is from left to right, and the word order is SOV (Subject + Object + Verb). In a Myanmar sentence, spaces are used to mark phrases, not to divide words. From our studies, possible combinations of a consonant and vowels (i.e. a consonant cluster) are formed by four directions or Left, Right, Upper and Lower positions (see Fig.1).

Upper
+
Left + Left + Consonant + Right + Right + Right
+
Lower

Fig.1 Logical structure of Myanmar consonant cluster (here, Left = left vowels, Right = right vowels, Upper = upper vowels and Lower = lower vowels)

A Myanmar word can contain one or more consonant cluster(s). For example, "ကျောင်းသား" (student) contains 3 consonant clusters (i.e. "ကျော", "င်း" and "သား").

4. Concept of Positional Prediction (PP)

Here, we briefly explain our proposed "Positional Prediction" or consonant cluster prediction concept for Myanmar language [1]. Myanmar language writing system largely depends on adding left, right, upper and lower characters to consonant. Here, left, right, upper and lower characters mean Myanmar dependent vowels, directives and subscript consonants that are always written with a consonant, and their positions are defined when they are combined. PP uses four directional arrow keys to get positional information of dependent characters. For example, to type "လူ" meaning human in Myanmar language, users only need to type "လ" (La) consonant and down arrow key, and then make selection from the possible combination list of La consonant with lower vowels. The typing steps can be seen in Fig.2.

လ + ↓ + Selection

(Consonant "La") (Positional Information of Vowel) (Selection from the Possible Combination List of "La")

Fig.2 Typing steps of a Myanmar word "လူ" (human) with PP

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The vowel positional information adding order can be “Consonant + Left + Down + Up + Right” or “Consonant + Left + Up + Down + Right”. Logically, it can also support hand writing order (i.e. “Left + Consonant + Down + Up + Right” or “Left + Consonant + Up + Down + Right”). Users only need to mention positional vowel information once for one direction even for the words that need to combine more than one positional vowel. For example, users need to type “consonant + right” only for “consonant + right + right + right” consonant clusters.

PP text input method is applicable for many kinds of mobile devices because almost all of current mobile devices contain four directional arrow keys (e.g. Nokia N76 mobile phone, Dell X51 PDA, Sony PSP portable game player and XO laptop). The merit of the proposed predictive text input method is that even first time users can type Myanmar sentences with appropriate typing speed (i.e. average typing speed is 32.96 CPM and ~41.57 CPM with mouse, ~41.84 CPM with stylus pen) [1].

5. Left, Right, Up, Down and Center (LRUDC) Button Interface

LRUDC button is a new proposal of typing interface for Myanmar language. The main idea is to apply the PP text input concept to each Myanmar consonant button or key. We logically divide a button into 5 areas (i.e. Left, Right, Up, Down and Center). “Left area” is for left characters, “Right area” is for right characters, “Up area” is for upper characters, “Down area” is for lower characters and “Center area” is for a consonant. For example, to type “Ma consonant + Down vowel + Right vowel” consonant cluster, users only need to press Down and Right part of the Ma Consonant button (see Fig.3).

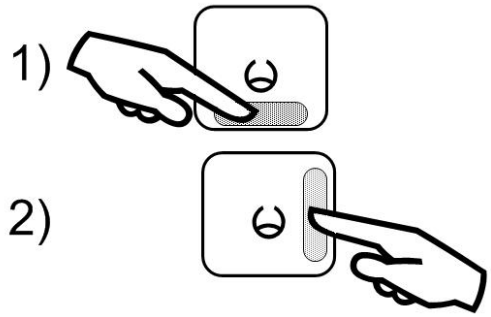

Fig. 3 Typing steps of a Myanmar word “မှား” (wrong) with LRUDC button interface text input

By using LRUDC button interface, the movement time between consonant buttons or keys and four direction arrow keys can reduce. But the size of the LRUDC buttons needs to be bigger than normal buttons. LRUDC button interface can be applicable not only for software button but also for hardware button. If we consider LRUDC button interface for mobile phones, the performance will also depend on keyboard mapping, size of the keys and interactive feedback etc.

6. Implementation

We implemented a software prototype of LRUDC button interface for Myanmar language text input (see Fig.4) with Microsoft Visual Studio 2005. We choose Visual Basic programming language because it is simple coding and suitable for rapid development. The program was designed to run on a tablet PC and electronic white board. The program computes a list of possible vowel combinations based on the left, right, up and down parameter for the consonant of the pointed button. The program also removes impossible or unmeaning and unpronounceable vowel combinations, and the best suggestion is displayed as a list. Users can easily type the same consonant cluster repeatedly. This is useful because some Myanmar words and names use the same consonant cluster twice (e.g. “မေမေ” (mother), “ဖေဖေ” (father), “လာလာ” (come) and “အေးအေး” (Aye Aye, common name of Myanmar girls) etc.)

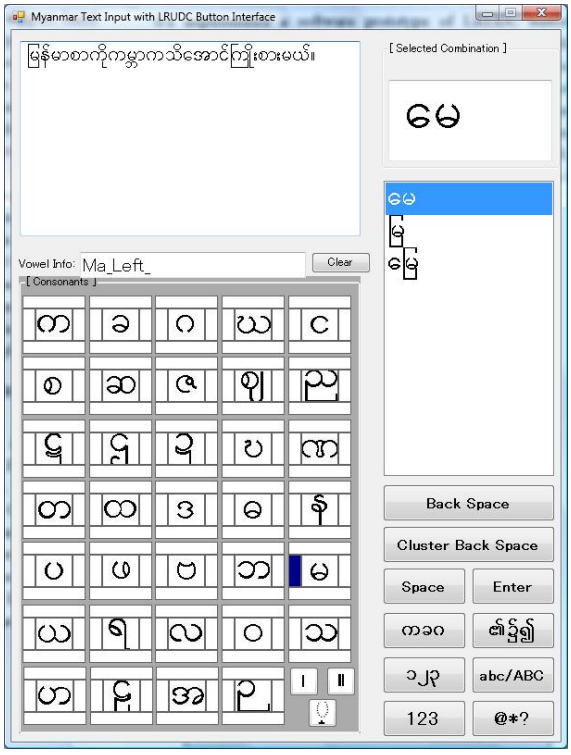

Fig. 4 LRUDC Button Interface Prototype

7. Initial User Study

We held user experiments with our LRUDC button interface prototype in order to know the users’ typing speed. We used a mouse and stylus pen with Tablet for the user study with five Myanmar native participants who are between 21 and 43 years old. Three of the participants are familiar with PC but don’t have an experience of using stylus pen. The experiments procedures are as follows:

1. Explaining the concept of Positional Prediction text input

2. Making demonstration of text input with prototype
3. Allowing 5 minutes practice time for each user to learn 4DAK and LRUDC button interface
4. Recording users' typing speed of short message (6 Myanmar sentences) [1] for 5 trial times (including error correction time)
5. Getting users' feedback for 4DAK and LRUDC button interface

In our initial user study, a 5 years old primary school girl student was also contained. The first author explained to her how to type Myanmar text with 4DAK and LRUDC button interface and then asked to type her name. Then, it was found that she can easily type her name and other basic Myanmar words with our prototypes (see Fig.5).

Fig. 5 Photo of user study with 5 years old child

8. Evaluation

As an evaluation of the efficiency of LRUDC button interface, we made an initial comparative test between LRUDC button and 4DAK interfaces. Fig. 6 shows average CPM and standard deviation of 4DAK and LRUDC from the result of the initial user study mouse. The average CPM of the 4DAK is 32.96 CPM and the average CPM of the LRUDC button interface is 34.61 CPM. It was found that LRUDC button interface is 5.01 % higher than 4DAK.

For the performance analysis, we also calculate Keystrokes per character (KSPC) [2] and CPM [3] of 4DAK and LRUDC button interfaces. We used 10 random Myanmar words, Pali words, names, place names, phrases, proverbs [4] and poems from the database. In the database words of Myanmar-English dictionary (published by Myanmar Language Commission), 500 Myanmar names, 200 Myanmar place names, 500 phrases, 100 Myanmar proverbs and 10 Myanmar famous poems such as "A Phoe Gyi O" were typed by the first author and his brother Mr. Ye Kyaw Thein. Currently, the electronic version of various corpuses for Myanmar language cannot be found.

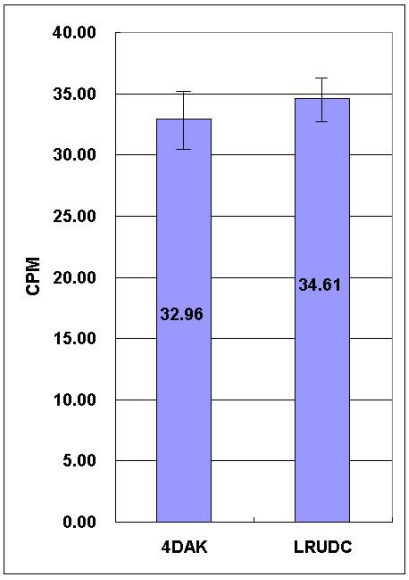

Fig. 6 Average CPM and standard deviation of 4DAK and LRUDC (vertical lines on the bars show standard deviation)

KSPC is the calculation of the average number of keystrokes required to enter a character, for example, "home" on a standard T9 mobile phone requires 5 keystrokes "4,6,6,3 and *". Here, * is the key for next suggestion word. In this case, KSPC for typing "home" is 5/4 = 1.25. Higher KSPC values indicate that users need to type next key or any additional letters to get a desired word. A KSPC value of 1.0 shows perfect disambiguation. From our detail analysis, 4DAK is 1.40 KSPC and LRUDC is 0.96 KSPC. KSPC of LRUDC button interface is 31.22% lower than 4DAK interface (see Fig. 7). The main reason is that users need to press one time for every consonant in the 4DAK interface and that is no need for the LRUDC interface.

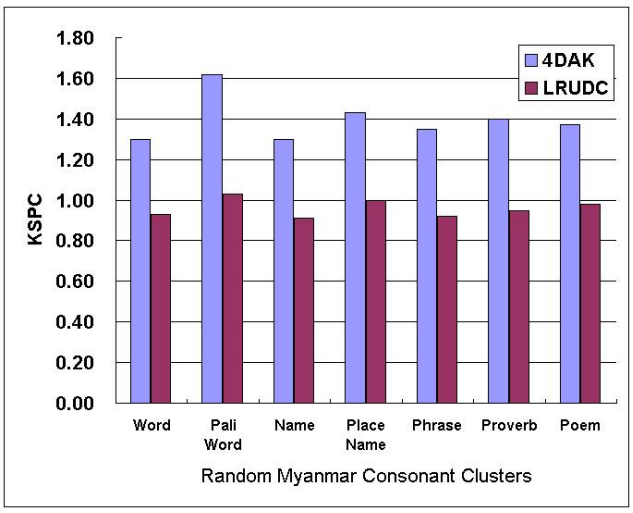

Fig.7 KSPC of random Myanmar consonant clusters for 4DAK and LRUDC button interfaces

We also make analysis on KSPC values versus number of characters length of a consonant cluster in 4DAK and LRUDC button interfaces. From our analysis, it was found that the maximum length of a consonant cluster is 5 such as "ကြိုး", "ကျော်" and "မျိုး". We also randomly retrieve 10 consonant clusters for length of 2, 3, 4 and 5 from the database. Fig. 8 shows KSPC values comparison between 4DAK and LRUDC button interfaces based on the length of consonant cluster. From these results, we can clearly see the difference in KSPC value between 4DAK and LRUDC (Average values are 4.03 KSPC for 4DAK and 3.08 for LRUDC).

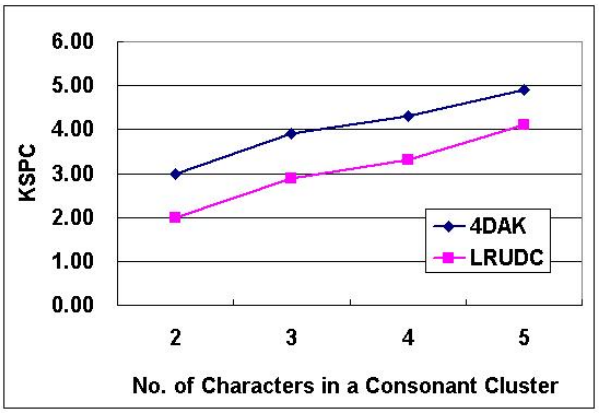

Fig. 8 KSPC versus mean consonant cluster length in LRUDC button

9. Discussion

We did typing speed evaluation with Characters per Minute (CPM) instead of Word per Minute (WPM) [3]. This is because there is no standard definition for a word in Myanmar like in English (i.e. common definition of a word = 5 characters, including spaces) (Yamada, 1980) [3]. Thus the formula for computing CPM is as follows:

$$CPM = \frac{|T|-1}{S} \times 60$$

Here, T is the typed transcribed string entered by a user, and $|T|$ is the length of this string. T may contain Myanmar characters, numbers, punctuation, spaces etc. but not backspaces. S is seconds measured from the entry of the first character to the last.

Although average KSPC value of LRUDC button interface is 31.22% lower than 4DAK interface, the CPM or users' actual typing speed is only 5.01% higher than 4DAK. From the users' feedback, it was found that some possible reasons are because of consonant button highlighting according to the mouse pointer positions, users cannot add only a missed vowel like in 4DAK and size of the consonant buttons. Almost all the 6 participants in the initial user study feedback that LRUDC is better than 4DAK interface. From the initial user study results, even first time users can type Myanmar sentences with appropriate typing speed and need no practice in either 4DAK or LRUDC button interface. Based on the feedback from two of the participants, typing with 4DAK is hand tiring because of the movements between consonant buttons and four directional arrow keys. However, one of the participants mentioned that an attention is necessary to choose a correct position of a LRUDC button.

10. Conclusion and Perspectives

This paper has reported our investigation into Positional Prediction text input interfaces. We propose a new possible text input interface for Myanmar language called LRUDC button interface. This text input interface is very simple, easy to understand and applicable for similar syllabic based languages. This work was motivated by three desires: to reduce the hand or finger movement distances between consonant buttons and four directional arrow keys, to obtain more user-friendly predictive text input interface for Myanmar language, and to extend the Positional Prediction of Myanmar consonant clusters. KSPC values from the initial user study proved that LRUDC button interface can reduce the movement distances and keystrokes (31.2%) than 4DAK. Users' average typing speed of current LRUDC prototype with mouse is 34.61 CPM and with pen is 31.14 CPM, which is only 11.14% slower. We will make further refinements on the current prototype and follow up analysis on such as error rate comparison. We also plan to apply LRUDC button interface for Khmer (language of Cambodia) and Bangla (language of Bangladesh) in the near future.

References

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