Common and User-Friendly Text Input Interfaces for Asian Syllabic Languages Mobile Devices

Ye Kyaw Thu
Global Information and Telecommunication Studies
Waseda University
29-7 Waseda University Bldg., 1-3-10 Nishi-Waseda, Shinjuku-ku,
Tokyo 169-0051 JAPAN
Tel: +81-3-5286-9839
yktisi@acm.org

ABSTRACT
I believe that text typing on small mobile devices will become more popular and necessary communication in Asian developing countries such as Myanmar (Burma), Bangladesh, Nepal, Bhutan, Laos and Cambodia etc. In these countries, however, there is no efficient and user-friendly text input method for mobile devices yet. Asian languages are syllabic languages that derived from Indic script or Brahmi around BC third century. And thus, Myanmar language or Burmese, Bengali, Nepali, Dzongkha (language of Bhutan), Lao and Khmer have common writing natures with Indian languages such as Hindi, Marathi, Punjabi and Tamil etc. But current mobile devices key-mapping or text input methods such as multi-tap or T9 [1] are based on English and not directly applicable to syllabic languages, because writing natures of Asian syllabic languages are different and have larger numbers of characters than English alphabets (e.g. Khmer has triple numbers of characters (i.e. 74) of English). My research looks for common and user-friendly keyboard mappings and text input methods for Asian syllabic languages based on their word formation or writing natures for mobile devices. I have already proposed 1) "Positional Mapping (PM)" [2], [3], [4] for mobile phone or Personal Digital Assistant (PDA) keyboard mapping 2) "Positional Gesture (PG)" [5] for gesture text input interface and 3) "Positional Prediction (PP)" [6], [7] for consonant cluster predictive text input.

Categories and Subject Descriptors: H.5.2 **[User Interfaces]:** Graphical User Interfaces (GUI), Interaction styles, Input devices and strategies.

Additional Keywords and Phrases: Text Input, Mobile Devices, Syllabic Languages, Keyboard Mapping, Gestures, Predictive Text Input

INTRODUCTION
Through my study, I have noticed that there are many common characteristics among the writing system of Asian syllabic language. Because of this, most of them are related to each other, and their writing system largely depends on adding left, right, upper and lower characters to a consonant (i.e. consonant clusters or syllable). Here, left, right, upper and lower characters mean dependent vowels, directives and subscript consonants that are always written with a consonant. I present the similar nature of "Logical Structure or Combination Structure" of Myanmar, Bangla and Khmer languages' consonant clusters. (see Fig.1, Fig.2 and Fig.3).

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

Figure 1: Myanmar Consonant Clusters Combination Structure

Upper
+
Left + Consonant + Right
+
Lower

Figure 2: Bangla Consonant Clusters Combination Structure

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

Figure 3: Khmer Consonant Clusters Combination Structure

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I investigate keyboard mapping, gesture text input and consonant cluster or syllable prediction method for Asian syllabic languages based on their word formation or structure of a consonant cluster.

POSITIONAL MAPPING (PM)

Positional Mapping (PM) is a concept of keyboard or keypad mapping for mobile phone based on common characteristics of writing systems of Asian syllabic languages (see Fig.4) [2], [3], [4]. I divide a mobile phone keypad into three levels, e.g. 1, 2 and 3 keys are upper, 4, 5 and 6 keys are normal or middle and 7, 8 and 9 keys are lower. In the normal level, 4 key is seen as a front part (Left), 5 key as a center position and 6 key as a rear part (Right). This key mapping concept is applicable to all syllabic based Asian languages. According to my studies, PM concept is simple and its keypad layout is very easy to memorize for native users as well as foreigners who understand the basic writing system of Myanmar, Bangla and Khmer languages. Although this concept is based on the key mapping of mobile phone, it is applicable not only to mobile phone but also to other mobile devices such as PDA, electronic dictionaries and Tablet PC etc [4].

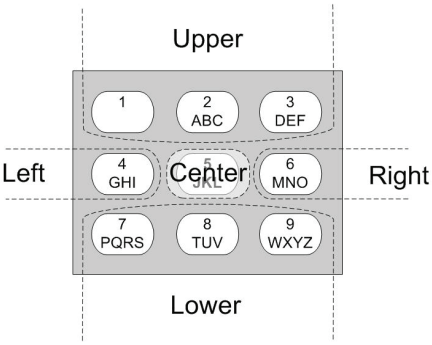

Figure 4: Concept of Positional Mapping for mobile phone

POSITIONAL GESTURE (PG)

Positional Gesture (PG) is a simple gesture text input method for mobile devices based on common characteristics of syllabic scripts writing system [5].

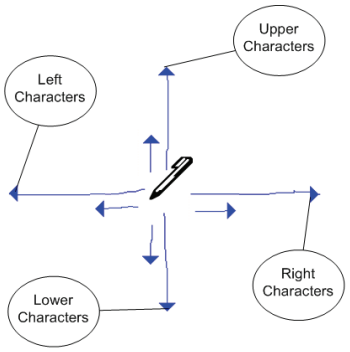

Figure 5: Concept of Positional Gesture text input

Its concept is totally based on four simple gesture commands, which are “Left”, “Right”, “Up” and “Down”. “Left gesture command” is for left characters or symbols, “Right gesture command” is for right characters or symbols, “Up gesture command” is for upper characters or symbols and “Down gesture command” is for lower characters or symbols. Here, as a concept, “Left gesture command” can be “dragging mouse pointer to left” or “moving data glove to left” or “pressing left arrow key” or “moving eye ball to left” or anything. For the consonant characters, we can use additional gesture like “drawing dot” or “writing circle” etc. In my prototypes, I use “Double Click” to make it simple. PG text input concept is shown in Fig. 5.

POSITIONAL PREDICTION (PP)

Positional Prediction (PP) is a concept of predicting consonant clusters or syllable based on the positional information (i.e. Left, Right, Upper and Lower) of vowels, medials or consonant symbols etc. [6], [7]. Here, I explain with Myanmar language or Burmese. In Myanmar language, left, right, upper and lower characters mean Myanmar dependent vowels, directives and subscript consonants that are always written with a consonant (e.g. Left: “ေ” (Vowel Sign E) and “ျ” (Consonant Sign MEDIAL RA), Right: “ါ” (Consonant Sign MEDIAL YA), “ာ” (Vowel Sign AA) and “း” (Sign VISARGA) etc., Up: “ိ” (Vowel Sign I), “ီ” (Vowel Sign II) and “ံ” (Sign ANUSVARA) etc. and Down: “ု” (Vowel Sign U), “ူ” (Vowel Sign UU),” ့ ” (Consonant Sign MEDIAL HA), “ြ” (Consonant Sign HA + Vowel Sign U), “ွ” (Consonant Sign MEDIAL WA), “ွွ” (Consonant Sign MEDIAL WA + Consonant Sign MEDIAL HA), “ှ” (Sign AUKMYIT) and “္က” (Subscripted KA) etc.). They have to be written always with consonants (i.e. dependent), and their positions are defined when they are combined with consonants. Taking this into consideration, I propose a new consonant cluster prediction method based on the given positional information of dependent characters. For example, [Ka + Right] for “ကာ”, “ကား”, “ကျ”, “ကျာ”and “ကျား”, [Ka + Down] for “ကု”, “ကူ” and “ကွ” etc., [Ka + Down + Up] for “ကို”, “ကုံ”, “ကွံ”, “ကွိ”, “ကွီ” and “ကွဲ” etc. The adding order of the vowel positional information can be “Consonant + Left + Down + Up + Right” or Consonant + Left + Up + Down + Right (i.e. typing Consonant at first). This text entry order is similar to Myanmar Unicode input order. Logically, it can also support hand writing order (i.e. Left + Consonant + Down + Up + Right or Left + Consonant + Up + Down + Right). Users need to press a directional arrow key just once, and then, all the possible combinations of characters are listed. (e.g. in order to type [Ka + Right] for “ကျား” (tiger/male) that contains three right characters “ါ”, “ာ” and “း”, users only need to press a right arrow key once not three times). Based on the given positional vowel information, the system calculates all the possible consonant cluster combinations and removes impossible vowel combinations for the given consonant (i.e. unpronounceable or meaningless combinations), and then sorts possible consonant clusters with average usage frequency. Here, note that there is no proper or standard usage frequency table for Myanmar characters and words yet, and I use my own usage fre-

quency table of consonant, which is the result of my previous work. Finally, the system sorts the consonant cluster according to users' typing history. Typing steps of a Myanmar word "ထူး" (that means "special") with PP concept is shown in Fig. 6.

(∞) + (↓ + →) + Selection = ထူး

(Consonant "Tha") + (Positional Information of Vowels) + (Selection from the Possible Combination List of "Tha")

Figure 6: An example of typing Myanmar word "ထူး" (Special) with Positional Prediction text input method

PROTOTYPES OF PM, PG AND PP AND EVALUATIONS

I built several prototypes to evaluate the feasibility and user-friendliness of PM, PG and PP. I implemented PM, PG and PP prototypes for Myanmar, Bangla and Khmer languages. For the implementation, Visual Basic programming language was chosen, which is simple coding and suitable for rapid development. I held initial user studies with those prototypes in order to recognize users' typing speed and feedbacks.

The evaluation process is based on 1) how many keystrokes are required to type a character or Keystrokes per Character (KSPC) [8], 2) how many characters can be typed in a minute or Characters per Minute (CPM) [9] by first-time users and 3) users' feedbacks on text typing with prototypes. I did typing speed evaluation with CPM instead of Word per Minute (WPM), because there is no standard definition for a word in Myanmar, Bangla and Khmer like in English (i.e. common definition of a word = 5 characters including spaces) [9]. To get users' feedbacks on text typing with prototypes, I gave them four Likert scales (1-5) questions, which are 1) Difficult-Easy, 2) Painful-Enjoyable, 3) Slow-Fast and 4) Slow-Fast.

Prototypes of PM

I developed mobile phone text input simulation prototype. Keypad mapping for text input simulation can be configured with configuration files (see Fig.7). I proposed character assignments on mobile phone keypad or keyboard mapping for Myanmar and Bangla languages based on PM concept [2], [3], [4].

The experiment result indicates that PM enables appropriate typing speeds with various input devices, 31% faster than normal multi-tap in Myanmar language and 46% faster than AKTEL key mapping in Bangla language. When I compare "Keystrokes" for each model, PM requires more keystrokes, since all consonants are assigned as a list only onto No.5 key. And thus, typing of consonants requires pressing of some arrow keys. But this model achieves the highest tapping speed because users can type consonants simply by selecting from the list.

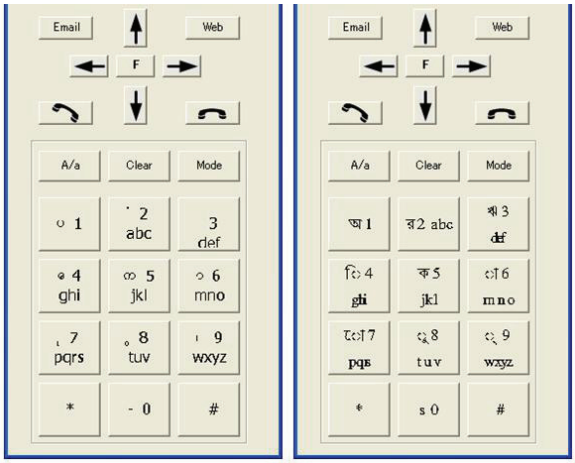

Figure 7: Positional Mapping prototype (left: running Myanmar configuration file and right: running Bangla configuration file)

I also implemented PM prototype for PDA and made user experiment for Myanmar language. I created this prototype in order to prove that my PM is applicable not only for key based text input methods but also for pen based text inputs [4]. In PDA, users can easily type Myanmar language with stylus. Typing speed goes up compared to previous mobile phone prototypes, since users can directly reach the desired letters shown on the PDA screen. The average typing speed of PDA by five first-time users is 23.9 CPM, and good responses and valuable suggestions were given from them at the follow up discussions.

Prototypes of PG

I developed PG prototypes for Myanmar and Khmer, which are usable with pen stylus, trackball or mouse [6]. Average CPM for PG with first-time users for Myanmar language is 19.27 CPM with mouse and 14.29 CPM with pen. As for Khmer language, it is 17.69 CPM with mouse and 17.72 CPM with trackball.

It is desirable to compare user study results of my prototype with handwriting; however, there is no handwritten text input system for Myanmar and Khmer language yet. PG concept is very simple and easy to understand. With my prototypes, even first-time users can type Myanmar and Khmer text with appropriate typing speed. I use very few gesture commands for text input (basically four gesture commands such as left, right, up and down), and thus, it is a possible typing method not only for children but also for handicapped people. PG text input concept is applicable for many other input methods such as hand gesture, eye gaze and brain input etc. and also extendable for other similar syllabic languages.

Prototypes of PP

I developed PP prototypes for Myanmar and Khmer languages and held initial user studies [6], [7]. Their result shows that the average typing speed of PP text entry method to finish six Myanmar sentences is 3 minutes 15 seconds (32.62 CPM) by mouse and 3 minutes 21 seconds (31.64 CPM) by stylus pen. As for Khmer, the average typing speed is 5 minutes 44 seconds (24.62 CPM) by mouse, with the fastest typing speed 4 minutes 11 seconds (32.27 CPM) and the slowest typing speed 9 minutes 48 seconds (13.78 CPM).

Although PP is a new text input concept, even first-time users including 5-year-old children can understand it and type with appropriate typing speed. Users sometimes face difficulties in dividing a word into each consonant cluster, but I believe that this difficulty will be gradually overcome through typing practice. PP text input method is applicable for many kinds of mobile devices, as almost all 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).

FUTURE WORK

So far, I have made evaluations of my proposals with KSPC, CPM and users' Likert scales. My future work will focus on evaluation with typing error rate and learning curve on my proposed concepts of keyboard mapping, gesture text input interfaces and consonant cluster prediction. I have already developed PG prototype for Bangla language, and am now developing PP prototype for Thai language. I also plan to make user study and follow up analysis in the near future.

RESEARCH CONTRIBUTION

In total, my thesis will contribute to the text input interfaces for Asian language mobile devices. At the initial user study, only five minutes were given to participants as practice time followed by the explanation of PM, PG and PP concepts, but even first-time users including children successfully typed with appropriate CPM. From this result, it is proved that PM, PG and PP approach is user-friendly. In addition, I would say that keyboard mapping, gesture text input and predictive method based on word formation or consonant cluster combination structure is practical and applicable for various syllabic based Asian languages as well.

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