Positional Prediction: Common and User Friendly Text Input Interfaces for Asian Syllabic Languages on Mobile Devices

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Abstract

I believe that text typing on small mobile devices will become a more popular and necessary communication tool in Asian developing countries such as Myanmar (Burma), Bangladesh, Nepal, Bhutan, Laos and Cambodia. 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. But current mobile devices have a wide variety of keyboard mappings or text input methods, which are based on English and not directly applicable to syllabic languages, because those languages have different writing natures and larger numbers of characters in comparison with English alphabets (e.g. Khmer (language of Cambodia) has triple numbers of characters (i.e. 74 excluding subscript characters) of English). My research looks for common and user-friendly keyboard mappings and text input methods for Asian syllabic languages on mobile devices based on their word formation or writing natures. In this paper, I cite two of those languages (i.e. Myanmar and Khmer languages) to present the concept of Positional Prediction.

1. Problem and Motivation

Text input in Asian syllabic languages on mobile devices is a unique challenge to the field of Human Computer Interaction (HCI). The biggest challenge is keyboard mapping on a limited numbers of keys and text input mechanism on a limited size of screen. To my knowledge, there are various keyboard mappings and text input methods for Asian syllabic languages on mobile phones, but none of them are usable enough to emerge as the de-facto standard. Keyboard or keypad mapping and text input mechanism depend on each other, and these two factors are very important in user-friendliness of the text input interface. Today, keyboard mappings are complicated and difficult to memorize for users. Below is an example of MyTap (Technomation Studios, Myanmar) keyboard mapping for Myanmar language.

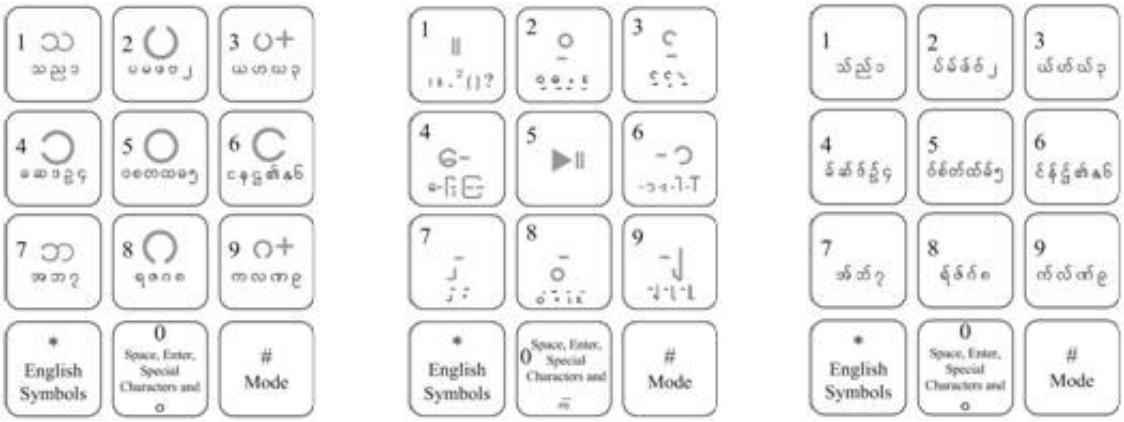
(a) (b) (c)

Figure 1: MyTap Keypad Layout (a) Consonant (b) Dependent Vowel and Medial (c) Consonant with Asat or Killer

MyTap keyboard mapping basically has three layers (1) consonant character mapping (□ mode), (2) vowel character mapping (-□ mode) and (3) consonant character with Asat mapping (□□mode) (see Figure 1). If I count keyboard mapping for independent vowels as one, there exists four keypad layouts in total. Consonant character mapping is mainly to map Myanmar consonants "□" (Ka) to "□" (A) to key 1 to key 9, and "□" (E) vowel and "□ -" (Ra) Medial to key 0. It does not adopt alphabetical order of consonant (e.g. □, □, □, □, □) but use frequency order (e.g. □, □, □, □, □) (see (a) of Figure 1).

Vowel character mapping is based on the writing position or combination of vowels with a consonant, e.g. upper vowels " -□ (Anusvara), "-□(I), "-□(Ii), "-□(Ai) and "-□(Asat or killer) are mapped to key 1, key 2 and key 3 (upper row keys on a mobile phone keypad), and lower vowels or medials "-□" (Ha), "-□" (Wa), "-□(U) and "-□(Uu) are mapped to key 7, key 8 and key 9 (lower row keys). However, character mapping to key 5 is not based on the writing position of vowels because " -F" (kinzi) is always written on the upper part of a consonant. Consonant character with Asat mapping or (□□mode) is for typing the combination of Asat character with a consonant (e.g. □□ + □ + -). Key "*" and "#" are used for changing from one mode to another, but the function varies depending on the active layer. For example, although key "*" is used to change exiting mode to consonant mode (□ mode) while "dependent vowel" or "consonant with Asat" mode is active (see Figure 1(b) and (c)), it works to change to vowel mode (-□ mode) while "consonant" mode is active (see Figure 1(a)). Paiksint or subscript characters can be typed by a long press of key "*". MyTap is a phase predictive text input method, which does not predict Myanmar syllable, word or phrase. It predicts a next typing step or a change from one mode to another especially from vowel mode to consonant mode, and the keyboard layout always pops up. This is because developers had foreseen that users would have a difficulty in memorizing the three or four layers of keyboard mapping.

Another example is M9 (Myanmar9) keyboard mapping or text input method (R & S Software, Myanmar), which is based on the glyph or shape of Myanmar characters as follows:



(a) (b) (c)

Figure 2: M9 Keypad Layout (a) Consonant (b) Dependent Vowel and Medial (c) Consonant with Asat or Killer

Most of Myanmar character glyphs or shapes consist of various combinations of circle or Landolt C structure such as consonants "□" (Ka), "□" (Kha), "□" (Ga), "□" (Gha) and "□" (Nga), vowels "- □" (Aa), "- □" (Visarga), "- □(I) and "-□(Ii), independent vowels "□" (U) and "□" (Uu), and numbers "□" (1), "□" (3), "□" (4), "□" (8) and "□" (0) [1, 2]. They can be grouped as circle shaped characters (e.g. "□", "□" and "□"), left gap shaped characters (e.g. "□", "□" and "□"), right gap shaped characters (e.g. "□", "□" and "□"), bottom gap shaped characters (e.g. "□", "□" and "□") and up gap shaped characters (e.g. "□", "□" and "□"). I have found that M9 keypad layout for Myanmar consonants are mapped based on the glyph or shape (see (a) of Figure 2), and its vowel mapping is based on the writing position or combination of vowels with a consonant (see (b) of Figure 2). Consonant character with Asat mapping is also supported by this keyboard mapping (see (c) of Figure 2). English symbols such as "!", ":", ";", ",", "?", "(" and ")" are assigned to key "*", and mode can be changed by pressing button "#". Paiksint or subscript characters can be typed by pressing key "0" four times while vowel mode is active. M9 is also a phase predictive text input method like MyTap. The main difference is that users can turn on or off this feature (i.e. i-mode=on or i-mode=off option in the M9 setting).

Although MyTap and M9 keypad layouts support Myanmar language typing on mobile phones, Myanmar text input using one of these mechanisms is still a challenge even for experienced users. As was mentioned in the above two examples, Myanmar language keyboard mapping needs to take into consideration consonant, dependent vowels, independent vowels, consonant with Asat or killer and Paiksint or subscript characters (i.e. called "half consonants" in Indian languages such as Hindi, Marathi and Bengali). And I also need to count punctuation symbols and special characters or various signs. Myanmar characters and their groups can be seen in the chart of Unicode (Range:1000-109F) [1].

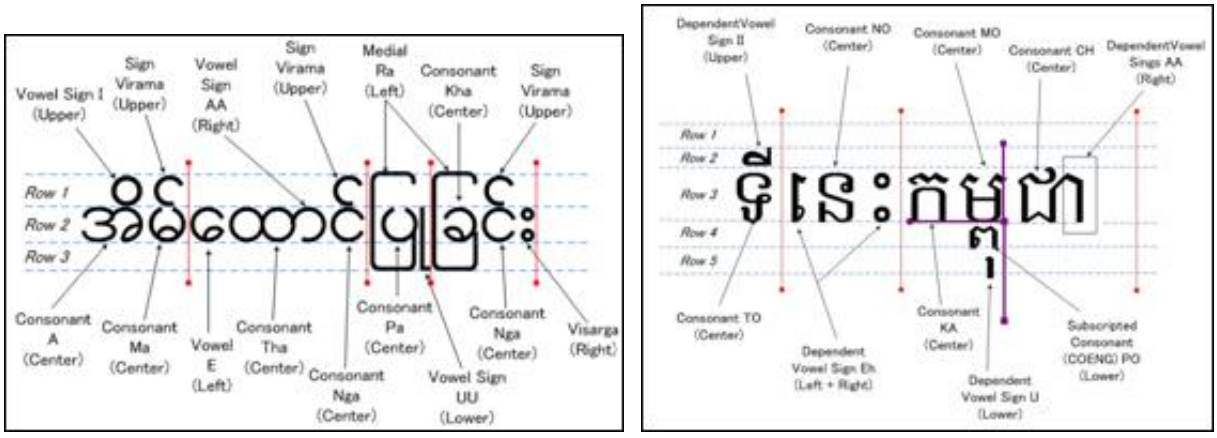
Another possible text input method is Romanized text input interface like Japanese "Romaji". If Romanized text input is applicable for Myanmar language, I do not need to consider keyboard mapping on a limited mobile phone keypad. In Myanmar language, unfortunately, many words are spelled differently from the way they are pronounced. For example, the word for "snack" is pronounced as tha-ye-sar (□□□□□) but spelled thwa-ye-sar (□□□□□□□□), and therefore, it is difficult to replicate Myanmar sounds in Roman script [3], [4]. There is a Pali-based Romanization system but it fails to replicate consonants in contemporary Myanmar language. There are various Romanization methods such as Duroiselle's System,

Latter's System, Grant Brown's System, Stewart's System (IPA), Cornyn's System (typewritten), Minn Latt's 1966 System and Myanmar Language Commission's Pronunciation System [3]. Current Romanization rules for Myanmar language are not easy to understand for first-time users, and it will be even more difficult to apply for text input process on small mobile devices. For example, Burglish Romanized text input system has no definite or concrete definition for Romanization rule for their system, because they try to cover all possible or similar pronunciation ("ye" represents "□", "□", "□□", "□□", "□□", "□□□", "□□", "□", "□", "□", "□□", "□□", "□□", "□□□", "□□", "□", "□□", "□□", "□□□", "□□□□" and "□□□", "thape" and "thi pf" for typing a syllable "□□"(very) and "ta ka Ka thol" for typing a word "□□□□□"(university)) [5]. And thus, Romanization text input is also difficult to apply directly for mobile devices as a lot of candidates are listed and capital letters are used for subscript characters etc. Another interesting point is that Japanese Romaji text input method is widely used for PC and QWERTY keyboard mobile devices but not used for mobile phones.

The development of keyboard mapping and user-friendly text input interface is a challenge not only for Myanmar language but also for other Asian syllabic languages. Moreover, I assume that text entry is one of the most frequent human-computer interaction tasks, which should be considered for the languages of developing countries in Asia. The main goal of this research is to find out common and user-friendly text input interfaces for Asian syllabic languages on mobile devices.

2. Background and Related Work

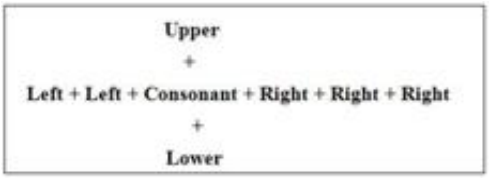
Through my study, I have noticed that there are many common characteristics among the writing system of Asian syllabic language. Because of this, most of them are related to each other, and their writing system largely depends on adding left, right, upper and lower characters to a consonant (i.e. consonant clusters or syllable). Here, left, right, upper and lower characters mean dependent vowels, directives and subscript consonants that are always written with a consonant.

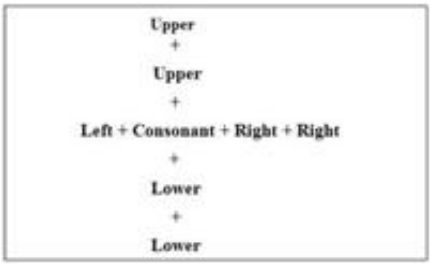


(a) (b)

Figure 3: Word Formation in Asian Syllabic Languages
(a) Myanmar Word "Marriage" (b) Khmer Sentence "This is Cambodia."

In Figure 3(a), a Myanmar word "Eain Htaung Pyu Gyin" (Marriage) is formed by the combinations of left, right, upper and lower characters and it takes three rows. Here, four vertical lines indicate the pronunciation breaks of "Eain", "Htaung", "Pyu" and "Gyin". In Figure 3(b), a Khmer sentence "Ti Nih Kampuchia" (This is Cambodia) is formed by the combinations of left, right, upper and lower characters and it takes four rows. Here, three vertical lines indicate the pronunciation breaks of "Ti", "Nih" and "Kampuchia". In the word "Kampuchia", "pu" (Po + U) is written as subscript consonant. Khmer characters and their groups are shown in the chart of Unicode (Range:1780-17FF) [6]. The similar nature of "Logical Structure or Combination Structure" of Myanmar and Khmer languages' consonant clusters are shown in Figure 4(a) and Figure 4(b).





(a) (b)

Figure 4: Combination Patterns of Dependent Vowels with a Consonant in Asian Syllabic Languages
(a) Combination Pattern of Myanmar Language (b) Combination Pattern of Khmer Language

After making analysis on word formation of Myanmar, Khmer, Bengali, Hindi and Nepal, I can affirm that Asian syllabic languages have a common nature in their word formation. Then, I developed Positional Prediction (PP) text input prototype and introduced the PP text input interface for Myanmar (SRC of CHI2008) [7]. Positional Prediction is a concept of predicting possible combinations of a consonant cluster or vowels with a consonant, which is applicable for other Asian syllabic languages [8]. I also presented "the background process of PP "or "deciding possible or impossible combinations of vowels with a consonant" with Nepali language [9].

3. Uniqueness of the Approach and Results

PP text input mechanism or prediction of vowel combinations with a consonant is unique and simple. The approach is totally based on word formation of Asian syllabic languages. The text input process of PP is 1) type or select a consonant, 2) give parameters (Left, Right, Up and Down) for combination of vowels and 3) select a syllable from a candidate list. For example, “Myanmar consonant "□" (Ka) + Right” for “□□”, “□□□”, “□□”, “□□□”and “□□□□”, “Myanmar consonant "□" (Ka) + Down” for “□□”, “□□”and “□□” and “Myanmar consonant "□" (Ka) + Down + Up” for “□□”, “□□”, “□□□”, “□□□” and “□□□”etc. Figure 5 shows typing steps of a Myanmar word "□□□□"(be skillful) with PP. The obvious merit of PP is that there is no need to consider keyboard mapping for dependent vowels, medial and consonant with Asat. And thus, PP keypad layout on mobile phones only needs a consideration of consonants (33 to 44 consonants) of Asian syllabic languages. Figure 6 shows PP mobile phone keypad layout for Myanmar language.

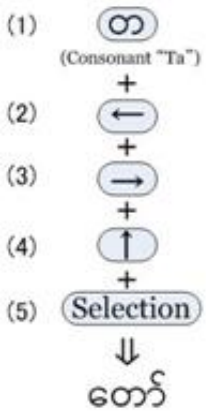


Figure 5: Typing Steps of a Myanmar word "□□□□"(be skillful) Figure 6: Positional Prediction Keypad Layout for Myanmar

When I compare PP keypad layout with commercial keypad layouts MyTap and M9, "dependent vowel and medial mode" and "consonant with Asat or killer mode" is not required for PP keypad layout. Theoretically, by using PP keypad layout, users' mental preparation time will be reduced for switching from one mode to others and for searching each vowel, medial and consonant with Asat. On the other hand, predicting vowels with four directional arrow keys is a new text input concept, which might cause user-irritation. I used alphabetical order for PP keyboard mapping because it is familiar to users since they are at primary school.

For the evaluation, I held user study with ten Myanmar users for measuring the first-time users' typing speed and their feedbacks. Participants ranged from 24 to 34 years (*mean* = 29.2, *sd* = 3.0). I installed MySM Release 1.9.2 (MyTap version 1.5), SM3 (free version) and PP prototype (developed with J2ME) to a Nokia mobile phone. I used a Nokia mobile phone (Model: 3110c) for user study on MyTap, M9 and PP text input methods. Myanmar text for user study consisted of 107 characters including 41 consonants, 52 vowels, 7 numbers, 6 symbols and 1 space.

The procedures for user study are (1) explaining the keypad layout and text input method of MyTap, M9 and PP, (2) making demonstration of typing Myanmar text with Nokia mobile phone, (3) allowing practice time to finish each model, (4) recording the participants' typing speed of short Myanmar message for 10 times (including error correction time) (Note: M9 setting is imode=on and i-speed=6x) and (5) discussing with them and getting their evaluation.

Figure 7 shows the users' typing speed to finish short Myanmar message with MyTap, M9 and PP. The speed was

calculated based on the Characters per Minute (CPM), which is generally calculated as [characters per second] x 60. Average CPM of PP is 61.07 % higher than MyTap and 65.52% higher than M9. A post-test questionnaire was completed by each participant. In it, PP text input was rated as easier to learn (10:0), quicker (7:3) and less typing mistake (8:2).

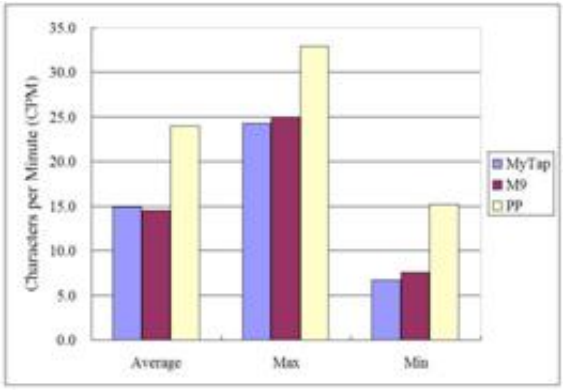


Figure 7: Typing Speed Comparison for MyTap, M9 and PP

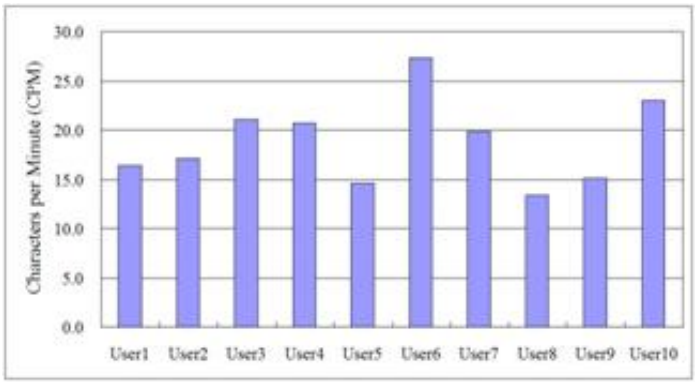


Figure 8: Characters per Minute of 10 Users with PP_Clickwheel

I also developed PP_Clickwheel (Positional Prediction with Clickwheel) prototype for Khmer to prove that PP text input interface is applicable for small mobile devices such as iPOD. PP_Clickwheel prototype was developed with Microsoft Visual Basic. For the implementation, Visual Basic programming language was chosen, which is simple coding and suitable for rapid development. I assigned the 7 commands for Khmer text typing with clickwheel as follows:

Clockwise and Anti-clockwise Scrolling: Highlighting a group of characters in the main menu or a character in a candidate list
Left, Right, Up and Down Click: Giving parameter for vowel combinations (e.g. "ក" (ka) + Right for "កា")
Center Click: Selecting a character group or typing a character

Ten volunteer participants (6 males and 4 females) were recruited in Phnom Penh, Cambodia, and they ranged from 22 to 35 years (*mean* = 26.4, *sd* = 3.6). All of them were familiar with PC but had no prior experience of Khmer text typing with PP text input method, and it was the fist time for them to use clickwheel. I used a notebook computer equipped with optical clickwheel mouse (BOMU-RHW01/SWH, Buffalo Inc.) for simulation of using mobile device with clickwheel. The procedures for user study are the same as MyTap, M9 and PP user study. The results show that the average typing speed of first-time users with PP_Clickwheel prototype to finish five Khmer sentences by clickwheel mouse is 18.9 CPM. With the current PP_Clickwheel prototype, the fastest typing speed is 28.9 CPM and the slowest typing speed is 8.2 CPM. Figure 8 shows CPM comparison for ten native users for ten trial times to finish five Khmer sentences. Questionnaires were conducted to the users immediately after the typing experiments. I set four Likert scales questions (1 to 5) to rate the user-friendliness of PP_Clickwheel text input method. The four scales are (1) Difficult-Easy (2) Painful-Enjoyable (3) Slow-Fast and (4) Dislike-Like. The mean values of user evaluation are 3.8 for (1), 4.2 for (2), 4.2 for (3) and 44 for (4). From these results, I can generally say that all of the users preferred text entering with PP_Clickwheel.

4. Contributions

The contributions of Positional Prediction include:

- Common and user-friendly text input interface for Asian syllabic languages
- 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
- No need to consider keyboard mapping for dependent vowels, medials and subscript consonants or half consonants
- Received positive feedbacks from the native users such as "there is no need to memorize the keyboard mapping", "PP_Clickwheel text input method is easier than software keyboard" etc
- Applicable for many kinds of mobile devices such as notebook, PDA, portable game player and music player etc.

Figure 9: User Study with children in Myanmar

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