Myanmar SignWriting Keyboard Mapping Layout for Fingerspelling

Hlaing Myat Nwe[†], Ye Kyaw Thu[λ] and Hnin Aye Thant[†]

Abstract— Deaf people are facing difficulties to acquire writing system of oral language because they cannot recognize sound. They could communicate through their natural language called Sign Language. We need to support the use of sign language technologies in the interface of computing systems to improve their accessibility for deaf signers. In this paper, we present a new keyboard mapping layout for Myanmar fingerspelling characters with SignWriting symbols that require less effort and significantly saved typing-time by applying kKg (ကခင) keyboard mapping concept for mapping SignWriting symbols. Moreover, we discuss the usability of our proposed prototype based on the user study and the evaluation results. The evaluations were made in terms of typing speed CPM (Character per Minute) and Likert scale feedbacks from participants. We believe that the outcome of this research is useful for the educational contents creation for deaf people and communication between hearing-impaired and hearing users.

Index Terms—Myanmar SignWriting, Myanmar Fingerspelling, kKg Mapping Concept, SignWriting Text Editor.

I. INTRODUCTION

MYANMAR deaf people mainly use Myanmar Sign Language (MSL) as an essential communication language among them. MSL is generally different from Myanmar language in grammatical structure. Therefore, they have many difficulties in communicating with other hearing people and also in education. They can also be attributed to the limited resources of information written in their language. Although SignWriting can be used for writing sign language, there are very few MSL users who know about SignWriting in Myanmar. There is no Myanmar language specific SignWriting text input interface for Myanmar Deaf society yet. The motivation of this research is to find user-friendly and efficient Myanmar SignWriting (MSW) keyboard layout for MSL. Moreover, we believe that SignWriting will be very useful for Deaf children education and documentation of sign language literature in Myanmar. In this paper, we propose SignWriting keyboard layout for Myanmar fingerspelling using kKg keyboard mapping concept. A user study was conducted to study the user-friendliness of the proposed keyboard layout. The comparisons are also made between the proposed SignWriting keyboard layout and phonetic-based keyboard layout for Myanmar Fingerspelling that already developed in terms of CPM and Likert scale feedbacks.

II. MYANMAR FINGERSPELLING AND SIGNWRITING

Myanmar Fingerspelling is the basic language for Myanmar deaf people. It can also be used to represent Myanmar consonant, vowel, and numbers with hands. Especially, it is used for signing names, city names and words that are not expressed in sign language (See Figure 1). Sometimes, fingerspelling is used in combination with existing signs to clearly express the concept or meaning. There are two different fingerspelling character sets for Myanmar language: one is used in southern Myanmar (e.g. used at "Mary Chapman School for the Deaf", Yangon city) and another is used in northern Myanmar (e.g. used at "Mandalay School for the Deaf", Mandalay city). They are similar in consonant but mainly different in vowel, medial and symbols [1]. In this paper, fingerspelling character set that was recognized as a standard in 2007 is used for designing SignWriting keyboard.
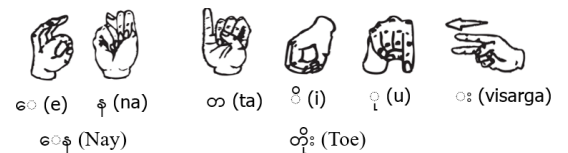

Fig. 1: Example spelling of Myanmar actor name 'Nay Toe' using Myanmar fingerspelling

SignWriting was developed by Valerie Sutton in the 1974s. It is a well-known writing system of sign languages because it is language independent, which contains a large number of basic symbols [8]. It is usable by deaf people in their daily life such as education, communication, and reading. It includes International SignWriting Alphabet (ISWA) with 30 groups of symbols used to write any sign language in the world. It is composed of seven categories of basic symbols [8]: Hand, Movement, Dynamics and Timing, Head and Face, Body, Detailed Location, and Punctuation. The words in SignWriting may be written from the point of view of the signer and assume the right hand is dominant. The filling the glyphs for the hand shape are indicated by the orientation of the palm [8]. A white

glyph indicates that one is facing the palm of the hand, a black glyph indicates that one is facing the back of the hand and half-shading indicates that one is seeing the hand from the side. SignWriting is the first writing system for sign languages to be included in the Unicode Standard. The Unicode block for Sutton SignWriting is U+1D800 to U+1DAAF [9]. SignWriting is widely used as the written form for sign language in over 40 countries.

There are many text editor programs to write their sign language with SignWriting such as SignMaker 2015 [10], SignPuddle Online [11], SignWriter studio [12], Rand SignWriting Keyboard [13], DELEGS SignWriting editor [14] and so on. SignWriting is not widely used in Myanmar deaf society, and in deaf education. We defined Myanmar fingerspelling characters with SignWriting symbols (See Figure 2, Figure 3, and Figure 4).

Fig. 2: Consonant

Fig. 3: Vowel, consonant sign, various sign and symbol

Fig. 4: Independent vowel and symbol

III. Related Work

Ye Kyaw Thu et. al. proposed Direct Keyboard Mapping (DKM) fingerspelling software keyboard based on the existing Unicode Myanmar keyboard layout named "Myanmar3 keyboard layout" [4]. They developed the first Myanmar fingerspelling TrueType font. They also used standard Myanmar fingerspelling character set [2]. The DKM software keyboard prototype provided two typing methods: one is typing with a physical QWERTY keyboard and another is typing with a software keyboard by using a mouse. The experiment compared three text input methods (typing with physical QWERTY keyboard, typing with software keyboard labeled by fingerspelling, typing with software keyboard labeled by Myanmar character) with 18 hearing-impaired users, 16 general users,

and 14 DTP staff. For each text input method, the user study was held for 10 users who entered a total of 5 fingerspelling names for 10 times. From their user study results, there are various CPM values depends on typing with a physical keyboard, a software keyboard labeled by fingerspelling and a software keyboard labeled by Myanmar characters. However, they reported based on the users' comments and Likert scale evaluation that the fingerspelling software keyboard layout labeled by Myanmar character has a better user interface for the first-time users than one labeled by fingerspelling.

The first keyboard layouts for Myanmar SignWriting were developed by Hlaing Myat Nwe, Ye Kyaw Thu, et. al. [5]. They proposed two fingerspelling keyboard layouts for Myanmar SignWriting: phonetic-based and symbol-based keyboard layouts. The phonetic-based keyboard layout is mapping Myanmar characters based on their phonetic similarities with English characters and the symbol-based keyboard layout mapping is based on the shape similarities of SignWriting symbols. For typing a SignWriting symbol with these two keyboard layouts, a combination of symbol modifier is needed, such as, fill modifier and rotation modifier keys. Mostly, we need to press at least two keys (i.e. symbol modifier and fill modifier keys). For example: to type Myanmar character ' ' (Kha in SignWriting),

symbol and filling keys are needed. Here, the typing order is symbol key, filling key and rotation key. Therefore, they need to map the filling modifier keys and rotation modifier keys, in addition to mapping of symbol modifier keys for Myanmar consonants, vowels, and other various signs. The phonetic-based keyboard layout and symbol-based keyboard layout for Myanmar SignWriting can be seen in Figure 5 and Figure 6.

They made an experiment to compare these two keyboard layouts with 8 hearing-impaired and 11 hearing users. For each keyboard layout, they selected three poems to enter one poem for 10 times. From the evaluation results of both CPM and Likert scale, they concluded that both of the keyboard layouts are applicable for typing Myanmar fingerspelling SignWriting. They also presented that phonetic-based keyboard layout is more flexible and easy to use for users based on participants' comments and suggestions.

In this research, we only focus to develop text input method of fingerspelling characters with SignWriting by capturing strengths and avoiding some weakness of the phonetic-based keyboard layout. We also take into the consideration the kKg (ကခဂ) Myanmar keyboard mapping concept [6].

IV. Prototype Development

Generally, typing SignWriting symbols are very different with typing Myanmar characters. In this paper, we propose Myanmar SignWriting keyboard layout that saves typing-time of SignWriting symbols. This keyboard is designed for Myanmar fingerspelling and based on the kKg keyboard mapping layout. This keyboard is intended for users with a normal QWERTY (English) keyboard.

A. Myanmar SignWriting Keyboard Layout for Myanmar Fingerspelling

The proposed keyboard layout is mapping Myanmar characters on English QWERTY keyboard based on their phonetic similarities with English characters such as Myanmar consonant "က" (Ka) on k key, "ခ" (Kha) on K (Shift + k) key, "ဂ" (Ga) on g key, "စ" (Ca) on s key, "ဆ" (Cha) on S (Shift + s) key and so on. The merit point of the kKg keyboard mapping is very easy to type Myanmar characters even for the first-time users who already familiar with English QWERTY keyboard. From this reason, we applied kKg keyboard mapping concept for mapping SignWriting symbols. Although all Myanmar characters are difficult to map based on phonetic similarities with English keys, most of Myanmar consonants and vowels are easily mapped on English keyboard layout. Figure 7 shows Myanmar SignWriting keyboard layout for Myanmar fingerspelling unshift mode and Figure 8 shows that of shift mode.

Generally, Myanmar SignWriting fingerspelling characters' symbols under the group of unaspirated Myanmar consonants that are frequently used such as (Ka in SignWriting), (Kha in SignWriting), (Ga in

SignWriting) etc. on unshifted keys and the other characters are mapped on shifted keys. However, because some Burmese words' sound are so similar, English is not enough to map. In addition, the number of Myanmar letters is 33 in total. The total number of English words is 26, so it is impossible to place all Burmese words based on sound. As a result, some Burmese words are positioned in different English keywords. For example, (Na in SignWriting) is in the lowercase letter n key and (Na Gyi in SignWriting) is in N (Shift n) key. Therefore, (Nya in SignWriting) is placed in the English word q key. However, it is positioned as easily as possible. For example: (Nya in SignWriting) is located in the q key. The corresponding (Nya Lay in SignWriting) is positioned in Q (Shift Q). In addition to the positioning concept based on the sound on the keyboard, another concept is based on the similarity of word-shape and the proximity to usage. For example: (Nga in SignWriting) is located in the small c key, (○ in SignWriting) and (○ in SignWriting) are placed on "." full stop key, and so on. Similarly, Myanmar vowels are basically mapped based on the pronunciation, and only a few words are positioned by the similarity of the word-shape.

B. Implementation

The proposed keyboard layout is developed for any operating system using Keyman Developer engine [7]. Keyman Developer is the most powerful tool for creating keyboard layouts for any popular platform for any language around the world and keyboard layouts can be built for desktop, web, tablet and phone. The proposed keyboard uses a Basic English layout and Unicode (UTF-8). In Keyman Developer keyboard source files, Unicode characters are specified with U+xxxx, where xxxx is a four-digit hexadecimal number. We used Sutton Unicode and True Type font of Sutton SignWriting built with SignWriting 2010 Tools to display Myanmar fingerspelling characters with SignWriting [15].

V. Methodology

A. Participants

The user experiment has been conducted with thirty-two volunteer participants (6 males, 26 female) including both hearing-impaired and hearing users. Five hearing-impaired participants are ranging in age from 14 to 38. Two of them are teachers from School for the Deaf, Tarmwe, Yangon and the others are students from Mary Chapman School for the Deaf in Yangon. User study with hearing-impaired users was held at both School for the Deaf, Tarmwe, Yangon and Mary Chapman School for the Deaf in Yangon. Twenty-seven hearing participants are ranging in age from 19 to 35 years. All of them are students of Faculty of Information Science, University of Technology (Yatanarpon Cyber City), Pyin Oo Lwin city,

Fig. 5: Phonetic-based keyboard layout for Myanmar SignWriting

Fig. 6: Symbol-based keyboard layout for Myanmar SignWriting

Fig. 7: Myanmar SignWriting keyboard layout for Myanmar fingerspelling (unshift mode)

Fig. 8: Myanmar SignWriting keyboard layout for Myanmar fingerspelling (shift mode)

Myanmar and all they are familiar with one of the Myanmar Keyboard Layouts (Zawgyi or Myanmar3). None of them had prior experience with SignWriting Symbol for Myanmar fingerspelling characters. The user experiment was held at Net-class room, University of Technology (Yatanarpon Cyber City), Pyin Oo Lwin city, Myanmar.

B. Apparatus

Myanmar SignWriting keyboard prototype ran on standard Windows 10 desktop computers. The keyboard and necessary Sutton SignWriting fonts were installed in advanced. Figure 9 shows user study environment with volunteer participants at Mary Chapman School for the Deaf in Yangon.
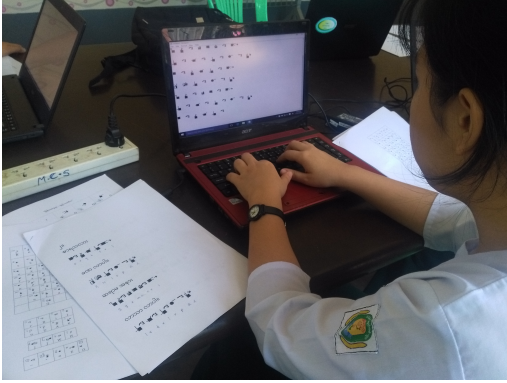

Fig. 9: Experimental Environment with hearing-impaired users

C. Procedure

Participants sat in front of a desk of a desktop computer that were already installed our keyboard prototype. We also provided printouts of the keyboard layout, mapping chart and three SignWriting poems (parallel sentences with Myanmar language) for the user study (See Figure 9). At first, we introduced what is SignWriting and the mapping concept of keyboard layout to all participants. We demonstrated how to type Myanmar SignWriting characters for all Myanmar consonants (characters Ka to A) and one poem was given before starting the user study. All participants were allowed to practice typing all Myanmar consonants (characters Ka to A) to get some level of understanding on the keyboard layout. The typing speed of all participants for each poem for 10 times were recorded using screen recorder software. After finishing typing processes, we made discussion with participants and collecting their feedback, suggestions, and comments.

D. Design

We selected three poems that cover most combination patterns of vowel(s) and medial with a consonant from Myanmar language Primary School textbook for user study and they are as shown in Figure 10 [3]. All Myanmar participants are already familiar with all these three poems. They cover most combination patterns of vowels and medial with a consonant.

VI. Result and discussion

A. Typing Speed

The time taken for the user to type the given passage is calculated which is used to calculate the Character per Minute (CPM) – typing speed of a given keyboard. The formula for computing CPM is as the following equation:

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

Here, T is the number of SignWriting word in a poem. S indicated how many seconds are spent from the entry of the first character to the last. Although some space was put between SignWriting symbols in Figure 10 for easier reading, we don't need to consider a space for calculating CPM. This is because we did not allow users to type a space between symbols. The value of T for poem1 is 31, for poem2 is 68 and for poem3 is 58.

Fig. 10: Three fingerspelling poems with SignWriting for user study

The process of evaluating given keyboard layout is in terms of the comfort level of its first time users. The users of this experiments, though they are regular users of normal QWERTY keyboard, are first time users with SignWriting keyboard for Myanmar fingerspelling in general. Figure 11 shows average CPM values of fifteen users for 5 trial times to finish each poem. With the current keyboard prototype, the fastest typing speeds are 46.9, 49, and 42.5 CPM values for poem1, 2, and 3, respectively. The CPM values of the slowest typing speeds are 23, 20.1, and 22.8 for poem 1, 2, and 3, respectively. We can also see that the typing speeds of each participant are different based on the familiar with computer keyboards.
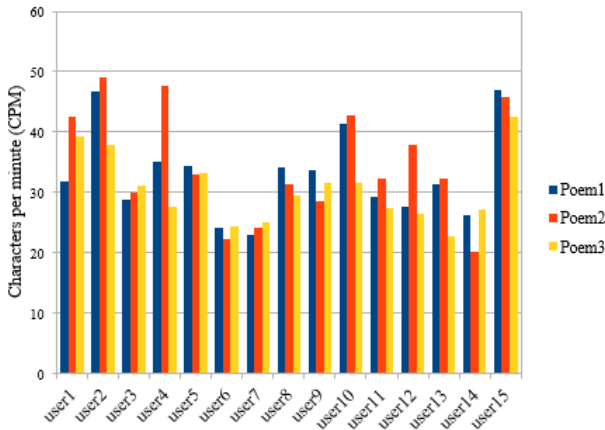
Fig. 11: Average CPM value of 15 hearing participants for typing three poems for 5 times

TABLE I: Example of typing Myanmar word 'အဖေ' (Father in English word) with SignWriting

အဖေ		အ		ေ		ဖ	
		S*	K*	S*	K*	S*	K*
Myanmar SignWriting Keyboard Layout		■	a	🖐	A	◪	P
Phonetic-based	Symbol	□	a	🖐	A	◲	p
Keyboard	Filling	■	/	🖐	.	◪	?
Layout	Rotation					◪	-

S* = Symbol, K* = Key

TABLE II: Total Keystrokes for three poems with both Myanmar SignWriting keyboard layout and Phonetic-based keyboard layout

Total Keystrokes	Myanmar SignWriting Keyboard Layout for Myanmar Finger-spelling	Phonetic-based Keyboard Layout for Myanmar Finger-spelling
for Poem-1	31	74
for Poem-2	68	169
for Poem-3	58	145

We also made a comparison of typing speed between Myanmar SignWriting keyboard layout and published phonetic-based keyboard layout for fingerspelling [5]. These two keyboard layouts are based on the phonetic-based similarity with English keys like kKg Myanmar keyboard mapping concept. The main difference between these two keyboard layouts is the typing process of SignWriting characters. For example: to type Myanmar character 'င' (Nga) with SignWriting, ⬒ (c key for symbol modifier), ⬔ (/ key for filling modifier), and ⬛ (- key for rotation modifier) are needed to press with phonetic-based keyboard layout although ⬛ (c key) is only needed with proposed Myanmar SignWriting keyboard layout. The another example is typing a Myanmar word 'အဖေ' (Father in English) with SignWriting, we need to type 7 keys with phonetic-based keyboard layout and only 3 keys with Myanmar SignWriting keyboard layout (See Table I). The total keystrokes comparison between previous Phonetic-based keyboard layout and the propose Myanmar SignWriting keyboard layout for three poems can be seen in Table II. The total number of keystrokes significantly reduced by using propose Myanmar SignWriting keyboard layout.

The average CPM values of 5 hearing-impaired users for typing each poem 10 times can be seen in Figure 12. CPM values of typing with phonetic-based keyboard layout are 8.3, 10.9, and 12.6 for poem 1, 2, and 3, respectively. CPM values of typing with Myanmar SignWriting keyboard layout are 24.1, 25.5, and 28.1 for poem 1, 2, and 3, respectively. The CPM value of typing with published phonetic-based keyboard layout is significantly lower than that of typing with proposed Myanmar SignWriting keyboard layout for all three poems.

Figure 13 shows average CPM of 12 hearing users for each user study. CPM values of typing with phonetic-based keyboard layout are 18.9, 24.1, and 26.5 and that of typing with Myanmar SignWriting keyboard layout are 51.9, 48.1, and 47 for poem 1, 2, and 3, respectively.

From the results, CPM values of typing with Myanmar SignWriting keyboard layout got higher typing speed for three poems.
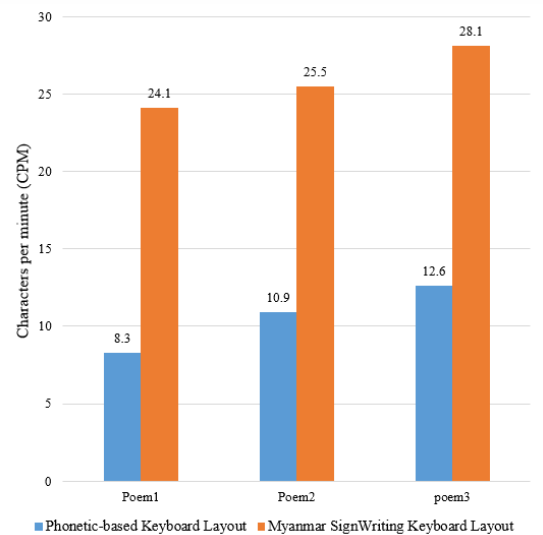

Fig. 12: Average CPM value of hearing-impaired users' typing for three poems with both Phonetic-based keyboard Layout and Myanmar SignWriting keyboard layout

According to the average CPM values, typing speed with Myanmar SignWriting keyboard layout is obviously faster than phonetic-based keyboard. From the result, it
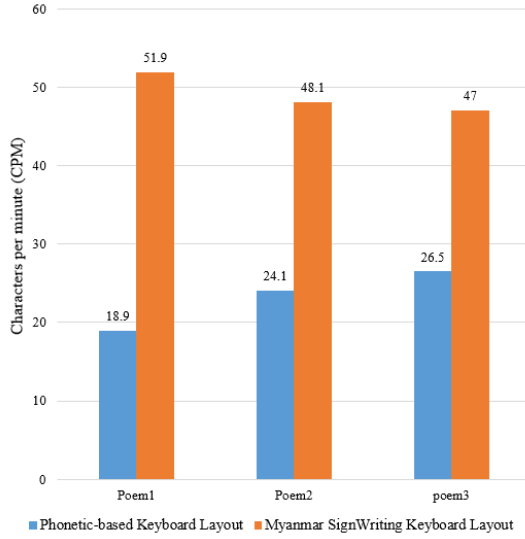
Fig. 13: Average CPM value of hearing users' typing for three poems with both Phonetic-based keyboard Layout and Myanmar SignWriting keyboard layout

can also be said that users enjoyed typing with Myanmar SignWriting keyboard layout for Myanmar fingerspelling characters.

B. Participant Questionnaire

Questionnaires were taken to the participants immediately in order to get their comments and suggestions on that keyboard layout after the typing experiments. Four Likert scales (1 to 5) are set to rate the user-friendliness of Myanmar SignWriting keyboard layout. The scales are (1) difficult-easy (2) slow-fast (3) dislike-like (4) impossible-possible. Likert scales value 1 is the most negative, value 3 is neutral and value 5 is the most positive. Table III and Table IV show the average or arithmetic mean results of Likert scale questions to hearing-impaired and hearing users, respectively for typing with proposed Myanmar SignWriting keyboard layout and the phonetic-based keyboard layout. From the result, we can generally say that all of the users preferred text entering with both keyboard layouts. However, we can conclude that users can type easily and quickly with Myanmar SignWriting keyboard layout.

TABLE III: Evaluation by hearing-impaired users

Likert scales	Myanmar SignWriting Keyboard Layout	Phonetic-based Keyboard Layout
Difficult-Easy	4.6	4.1
Slow-Fast	4.2	3.9
Dislike-Like	4.8	4.3
Impossible-Possible	4.4	4

TABLE IV: Evaluation by hearing users

Likert scales	Myanmar SignWriting Keyboard Layout	Phonetic-based Keyboard Layout
Difficult-Easy	4.6	4.5
Slow-Fast	4.4	4.1
Dislike-Like	4.5	4.4
Impossible-Possible	4.8	4.8

In Myanmar, there is no text entry method for Myanmar sign language with SignWriting symbol yet. Although Myanmar SignWriting keyboard layout is a new text input interface, even first-time users can understand and type with appropriate typing speed. However, we have noticed that users sometimes face difficulties in mapping of keys. This is because the proposed keyboard layout mapping is slightly different from their familiar Myanmar keyboard. However, we can say that the proposed keyboard layout concept is applicable to use Myanmar fingerspelling, although the users are not familiar with SignWriting symbols.

VII. Conclusion

This research is in progress, we have updated the developed phonetic-based keyboard layout for Myanmar SignWriting based on user comments and suggestions and have introduced new Myanmar SignWriting keyboard layout in this paper. From the user study, we can prove that the new proposed keyboard layout is a possible text input interface for Myanmar fingerspelling and to be easy to use. We also plan to extend Myanmar SignWriting keyboard layout concept for other languages and to develop Myanmar SignWriting text editor to cover the whole Myanmar Sign Language (MSL).

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