

## ミャンマー語パソコンのキーボード配列に関する比較

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ミャンマー語（ビルマ語）パソコンのキーボード配列は多数開発されてきたが、標準化はまだ行われていない。本論は、CE、Win Myanmar、Zawgyi Myanmar、MyaZedi、Myanmar3などのなじみ深いミャンマー語キーボードの配列比較について述べるものであり、キーボードマッピング及びKSPC（1文字入力するのに必要とされるキーストローク数）に関する実験を重点的に実施した。実験結果から、現行のミャンマー語キーボードの配列はいずれも似かよっており、かつてのミャンマー語タイプライターのキーボード配列に基づいていること、また、KSPCは記号、子音と共に表記する子音記号、下付き文字のキーの割り当てに依存することが分かった。

## A Comparison of Myanmar PC Keyboard Layouts

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Many PC keyboard layouts have been developed for Myanmar language (Burmese), but there is no standard keyboard layout yet. This paper reports a comparison of well-known Myanmar keyboard layouts such as CE, Win Myanmar, Zawgyi Myanmar, MyaZedi and Myanmar3 etc. The primary research focuses on examination of keyboard mapping and Keystrokes per Character (KSPC). Its result shows that all of the mappings of current Myanmar keyboards are similar and based on the old Myanmar typewriter keyboard layout. Another interesting point is that KSPC value depends on key assignments of various signs, dependent consonant signs and subscript characters.

### 1. Introduction

In this paper, we present a result of comparison on Myanmar PC keyboard layouts. Currently, there are many keyboard layouts or key mappings and typing methods for Myanmar language. Old Myanmar keyboards or fonts are totally based on ASCII encoding, and existing Myanmar keyboard layouts and typing methods are moving to Unicode encoding (some of them are not fully Unicode standard encoding yet). To our knowledge, most Myanmar computer users are not familiar with Myanmar language PC keyboard layouts, and rarely use Myanmar language for word processing, emailing and chatting etc. Some of the possible reasons for this might be that keyboard mappings and typing methods are frequently updated and difficult to learn for first-time users, and in addition, there is no standard keyboard layout or good user manual etc. Our primary research focuses on keyboard mapping, typing methods and Keystrokes per Characters (KSPC) of current Myanmar keyboards [1]. We also

held a survey of typing Myanmar text with PC keyboards and typewriter in order to compare their typing speeds.

### 2. Typing Order of Typewriter and PC Keyboards

Basically, there are three types of typing order for Myanmar language, which are handwriting order, traditional typewriter order (Martin Tytell) and PC keyboard order.

General *Handwriting order* is 1) left vowel (i.e. “ေ”), 2) consonants (e.g. “ဂ”, “ခ”, “င”, “ည” and “င” etc.), 3) medials (“ံ”, “ံ”, “ံ” and “ံ”), 4) upper vowels (e.g. “ံ”, “ံ” and “ံ” etc.) and lower vowels (e.g. “ံ”, “ံ” and “ံ” etc.), 5) killers (e.g. “ံ”, “ံ”, “ံ”, “ံ” and “ံ”) and 6) right vowels (e.g. “ံ”, “ံ”, “ံ” and “ံ” etc.)

$$\text{၈} + \text{၂} + \text{၀} + \text{၂} + \text{၂} = \text{၂}$$

*Traditional typewriter order* is 1) left vowel (i.e. “၈”) 2) medials (“၂”, “၂”, “၀” and “၂”), 3) upper vowels (e.g. “၀”, “၀” and “၂” etc.) and lower vowels (e.g. “၂”, “၂” and “၂” etc.) 4) consonants (e.g. “၀”, “၀”, “၀”, “၀” and “၀” etc.), 5) killers (e.g. “၀”, “၀”, “၀”, “၀” and “၀”) and 6) right vowels (e.g. “၂”, “၂”, “၂” and “၂” etc) [2].

$$\text{၂} + \text{၀} + \text{၂} + \text{၂} + \text{၂} = \text{၂}$$

*PC keyboard order* can be divided into two groups; one is *typewriter based typing order* and the other is *Unicode typing order*. *Typewriter based typing order* is similar to typewriter order, which is 1) left vowel (i.e. “၈”) and left medial (“၂”), 2) consonants (e.g. “၀”, “၀”, “၀”, “၀” and “၀” etc.), 3) other medials (“၂”, “၀” and “၂”), 4) upper vowels (e.g. “၀”, “၀” and “၂” etc.) and lower vowels (e.g. “၂”, “၂” and “၂” etc.), 5) killers (e.g. “၀”, “၀”, “၀”, “၀” and “၀”) and 6) right vowels (e.g. “၂”, “၂”, “၂” and “၂” etc).

$$\text{၂} + \text{၀} + \text{၂} + \text{၂} + \text{၂} = \text{၂}$$

*Unicode typing order* is the same as Handwriting order. It is totally based on correct combination order of consonant and vowels or consonant and medials. The main difference is that subscript or stack characters need a signal or Virama sign (U+1039).

$$\text{၀} + \text{၀} + \text{၀} = \text{၀}$$

### 3. Comparison of PC Keyboard Layouts

In order to find out similarities and differences of current Myanmar PC keyboard layouts and their typing methods, we selected 12 well-known keyboards such as CE, WinMyanmar, Zawgyi Myanmar, MyaZedi and Myanmar3 etc. We focused on examination of keyboard mapping and Keystrokes

per Character (KSPC). Here, almost all of the keyboard layouts are PC keyboards because Apple Macintosh computers are not widely used by Myanmar users. We used “MyMyanmar phonetic” keyboard in consideration of Macintosh keyboard layouts, as it represents Macintosh keyboards [3].

### 3.1 Keyboard Mapping

We created a table for keyboard mapping of selected 12 Myanmar keyboards (see Table 1 and Table 2). We referred to figures of keyboard layouts provided by the developers and web resources. As far as we know, CE, WinMyanmar, GeoComp and Metrix keyboard layouts or ASCII fonts are old (1992-) and still famous in Myanmar desktop publishing shops. Myanmar ASCII fonts assign Myanmar characters, numbers and symbols to English ASCII code table, e.g., consonant “၀” to “u”, independent vowel “၀” to “T” and number “၀” to “1” etc. To use ASCII based keyboard layout, “input method editor” is not needed but only font installation is required. And thus, it is very accessible to end-users but does not support word processing functions such as searching, sorting and saving in Myanmar language. Today, all of the font or keyboard layout developers are trying to make their products full Unicode. Unicode table of Myanmar language is from 1000 to 109F, and the latest Unicode standard is version 5.1 [4]. For the web, Zawgyi, WinMyanmar and Myanmar1 fonts are used for Myanmar magazines, newspapers and radio news etc. [5, 6, 7]. In general, Unicode font and keyboard layouts depend on each other in Myanmar language. Some Unicode Myanmar fonts use input method editors such as Tavultesoft keyman and KeyMagic [8, 9].

Through our study, we have noticed that Myanmar keyboard mappings except phonetic keyboards are based on traditional typewriter (see Table 1 and Table2). However, many Myanmar characters are missing and cannot be typed exactly as original glyph on a Myanmar traditional typewriter such as “၀” (consonant Ra), “၀” (number 8), “၀” (subscript consonant င), “၀” (subscript consonant ဝ) and “၀” (consonant Nya Lay) etc. It is because there are only 49 keys on a typewriter, which is not enough to assign all of the Myanmar characters (see Figure. 1). On PC keyboard, the number of keys are more than traditional Myanmar typewriter, and thus, keyboard mappings of undefined characters especially medials, independent vowels and subscript consonants differ from each other (see Table 1 and Table2).

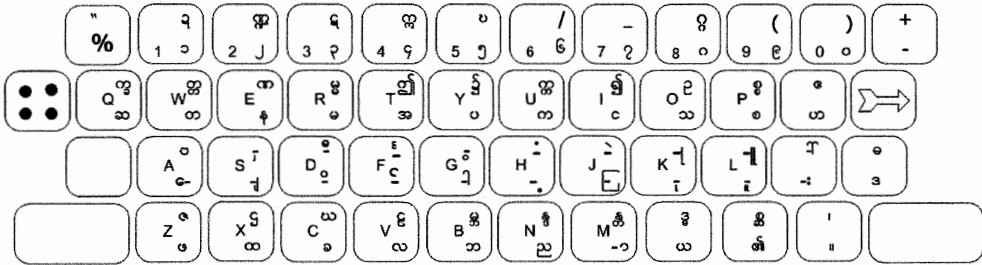


Figure 1 Traditional Myanmar Typewriter Keyboard Layout

Table 1 Keyboard Mapping of 12 Myanmar PC Keyboards for Number Row

Key (Shift)	~	!	@	#	\$	%	^	&	*	(	)	-	+
(Unshift)	`	1	2	3	4	5	6	7	8	9	0	_	=
<b>WinMyanmar (Version 2.6)</b>	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂
<b>CE</b>	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂
<b>GeoComp</b>	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂
<b>Metrix</b>	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂
<b>Zawgyi Myanmar Unicode Keyboard L</b>	ZK	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂
<b>Myazedi</b>	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂
<b>MyMyanmar (Typewriter)</b>	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂
<b>MyMyanmar (Phonetic)</b>	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂
<b>Myanmar3</b>	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂
<b>Myanmar Keyman</b>	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂
<b>Kuniyoshi (US Keyboard)</b>	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂
<b>UniBurma (Version 2.0.1)</b>	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂	၂

Table 2 Keyboard Mapping of 12 Myanmar PC Keyboards for Top or QWERTY Row

Key (Shift) (Unshift)	Q	W	E	R	T	Y	U	I	O	P	{	}	
	q	w	e	r	t	y	u	i	o	p	[	]	\
<b>WinMyanmar (Version 2.6)</b>	ခ ဆ	ပ ဝ	ဇ ဂ	ဆ ဇ	တ အ	ယ ဝ	ယ ဝ	ဣ ဠ	ဥ ဝ	ဧ ဖ	ဧ ဖ	'	န
<b>CE</b>	ခ ဆ	ပ ဝ	ဇ ဂ	ဆ ဇ	တ အ	ယ ဝ	ယ ဝ	ဣ ဠ	ဥ ဝ	ဧ ဖ	ဧ ဖ	]	ဝ
<b>GeoComp</b>	ခ ဆ	ပ ဝ	ဇ ဂ	ဆ ဇ	တ အ	ယ ဝ	ယ ဝ	ဣ ဠ	ဥ ဝ	ဧ ဖ	ဧ ဖ	]	ဝ
<b>Matrix</b>	ခ ဆ	ပ ဝ	ဇ ဂ	ဆ ဇ	တ အ	ယ ဝ	ယ ဝ	ဣ ဠ	ဥ ဝ	ဧ ဖ	ဧ ဖ	'	န
<b>Zawgyi Myanmar Unicode Keyboard L</b>	ခ ဆ	ပ ဝ	ဇ ဂ	ဆ ဇ	တ အ	ယ ဝ	ယ ဝ	ဣ ဠ	ဥ ဝ	ဧ ဖ	ဧ ဖ	SK	န
<b>Myazedi</b>	ခ ဆ	ပ ဝ	ဇ ဂ	ဆ ဇ	တ အ	ယ ဝ	ယ ဝ	ဣ ဠ	ဥ ဝ	ဧ ဖ	ဧ ဖ	]	န
<b>MyMyanmar (Typewriter)</b>	ခ ဆ	ပ ဝ	ဇ ဂ	ဆ ဇ	တ အ	ယ ဝ	ယ ဝ	ဣ ဠ	ဥ ဝ	ဧ ဖ	ဧ ဖ	)	
<b>MyMyanmar (Phonetic)</b>	ဃ ဃ	ဝ ဝ	ဇ ဂ	ဆ ဇ	တ အ	ယ ဝ	ယ ဝ	ဣ ဠ	ဥ ဝ	ဧ ဖ	ဧ ဖ	]	န
<b>Myanmar3</b>	ခ ဆ	ပ ဝ	ဇ ဂ	ဆ ဇ	တ အ	ယ ဝ	ယ ဝ	ဣ ဠ	ဥ ဝ	ဧ ဖ	ဧ ဖ	]	န
<b>Myanmar Keyman</b>	ခ ဆ	ပ ဝ	ဇ ဂ	ဆ ဇ	တ အ	ယ ဝ	ယ ဝ	ဣ ဠ	ဥ ဝ	ဧ ဖ	ဧ ဖ	]	န
<b>Kuniyoshi (US Keyboard)</b>	ခ ဆ	ပ ဝ	ဇ ဂ	ဆ ဇ	တ အ	ယ ဝ	ယ ဝ	ဣ ဠ	ဥ ဝ	ဧ ဖ	ဧ ဖ	]	န
<b>UniBurma (Version 2.0.1)</b>	ခ ဆ	ပ ဝ	ဇ ဂ	ဆ ဇ	တ အ	ယ ဝ	ယ ဝ	ဣ ဠ	ဥ ဝ	ဧ ဖ	ဧ ဖ	]	န

Keyboard Layout

All of the ASCII or typewriter based PC keyboards assign various glyphs of the same medial or possible combinations of the medial with other medials (e.g. “င”, “ခ”, “ဆ”, “ဇ”, “တ”, “ယ”, “ဣ”, “ဥ”, “ဧ”, “ဖ”, “ဖ”, “ဂ”, “ဇ”, “ခ”, “ပ”, “ဝ”, “ယ”, “တ”, “အ”, “ဣ”, “ဠ”, “ဥ”, “ဝ”, “ဧ”, “ဖ”, “န” etc.), subscript consonants (e.g. “ခ”, “ပ”, “ဇ”, “တ”, “ယ”, “ဣ”, “ဠ”, “ဥ”, “ဝ”, “ဧ”, “ဖ”, “န” and “န” etc.) and other symbols (“<”, “>” and “ရပ်” etc.) [10]. Obviously, the number of PC keyboard keys are not enough to assign all of the different glyphs and subscript consonants of Myanmar language. And thus, font or keyboard layout developers made keyboard mapping to use not only shift key but also other key combinations such as “Ctrl + Alt” and “Ctrl + Alt + Shift”. It has caused a bad user interface. Users are

required to memorize all key mappings or combinations (e.g. press “z” for consonant “ဖ” (Pha), press “Shift + z” for consonant “ဇ” (Ja), press “Ctrl + Alt + z” for subscript of consonant Pha “ဖ” and press “Ctrl + Alt + Shift + z” for subscript of consonant Ja “ဖ” in WinMyanmar keyboard layout) [11]. Actually, the old version of ASCII keyboard layouts such as WinMyanmar, CE and GeoComp used “Alt + Numeric numbers” for extended characters (e.g. “Alt + 0247” for “န”) [12].

In the Unicode keyboards, key mappings for various glyphs and subscript consonants do not need to be considered, and appropriate glyphs are changed automatically by input method editor. With the

Unicode standard encoding, various glyphs of medial Ra (e.g. “꠸”, “꠹”, “꠺” and “꠻”) are represented with one glyph or a character such as “꠸”. And subscript consonants can be typed with Virama sign (U+1039) such as “သ” + “꠸” (Virama sign) + “သ” for typing “သသ”. Myanmar3 keyboard (Myanmar Unicode and NLP Research Center), MMUnicode keyboard (Technomation Studio) and Kuniyoshi keyboard (Kazuomi Kuniyoshi) are Unicode keyboards, which do not use “Ctrl + Alt + key”, “Ctrl + Alt + Shift + z” and “Alt + Numeric numbers” key combinations [13, 14, 15].

Phonetic keyboard or keyboard mapping based on the Myanmar characters pronunciations (e.g. “k” for “တ” (consonant Ka), “Shift + k” for “ခ” (consonant Kha) “r” for “ရ” (consonant Ra) and “R” for “꠸” (Medial Ra)) was used for Apple Macintosh computers in Myanmar. Ava ASCII font or keyboard layout (John Okell) is famous for Apple Macintosh computers, and we used MyMyanmar (Phonetic) keyboard layout (Technomation Studio) for making comparison with others [14]. We assume that phonetic keyboard mapping method is user-friendly, because users who are already familiar with English keyboard can type easily. But English keyboard or English alphabets is not one to one relationship with Myanmar characters (e.g. “သ” (Tha) and “သသ” (Tha Gyi) characters mapped on “q” key in MyMyanmar (Phonetic) keyboard).

### 3.2 Keystrokes per Character

To compare the average Keystrokes per Character (KSPC) [1] of 12 keyboard layouts, we used short 5 sentences email message (106 characters including Myanmar numbers and punctuations) and 10 Pali words (52 characters) (see Figure. 2 and Figure. 3).

သူငယ်ချင်း၊  
မတွေ့ရတာကြာပြီနော်။  
နေကောင်းရဲ့လား။  
ငါ့ဖုန်းနံပါတ်အသစ်၅၀၀၇၄၅၉၊  
အားတဲ့အခါဖုန်းပြန်ဆက်ကွာ။  
ဒါပဲနော်။

Figure 2 Short Email Message used for Calculating Keystrokes of PC Keyboard Layouts

Pali language is important for Myanmar language because many Pali words are used in the daily conversion such as “တက္ကသိုလ်” (University). Keystrokes comparison of PC keyboards can be seen

in Table 3. There is no big difference in the number of Keystrokes requirement to finish email message with current PC keyboards, and it is from 116 to 134 (1.13 KSPC on average). Keystrokes requirement to finish 10 Pali words is 70 to 94 (1.58 KSPC on average). Here, note that we did not count the error rate.

တက္ကသိုလ်၊ ဝဏ္ဏ၊ ဥက္ကာ၊ ဥက္ကဋ္ဌ၊ ဝိဇ္ဇာ၊  
သိပ္ပံ၊ ဗြဟ္မာ၊ လက္ခဏာ၊ ဝေဿန္တရာ၊  
ယောက္ခမ။

Figure 3 10 Pali words for Calculating Keystrokes of PC Keyboard Layouts

Table 3 Keystrokes of PC Keyboards to Finish 5 Sentences Short Email Message and 10 Pali Words

Keyboard Layout	Keystrokes	
	Email Message	Pali Words
WinMyanmar (Version 2.6)	116	85
CE	122	81
GeoComp	120	76
Metrix	116	85
awgyi Myanmar Unicode Keyboard	117	76
Myazedi	117	73
MyMyanmar (Typewriter)	117	73
MyMyanmar (Phonetic)	134	70
Myanmar3	123	86
Myanmar Keyman	121	73
Kuniyoshi	123	73
UniBurma (Version 2.0.1)	117	94

### 4. Typing Speed of PC Keyboards

We held a small survey in Yangon, Myanmar to know current famous keyboard layouts and make comparison with typewriter typing speed. The survey was held in 2007 with 10 subjects (age from 18 to 36 years, and work service from 1 to 10 years) for PC keyboard layouts, and 10 subjects (age from 21 to 72 years, and work service from 1 to 50 years) for typewriter keyboard.

The text used for the survey is 1) consonants (e.g. Ka to A), 2) vowels combinations, 3) frequently used Myanmar syllables and words, 4) short email message and 5) Pali words [16]. We requested 20 subjects to type the text for 3 times including error correction time. Average Characters per Minute (CPM) of the desktop publishing staff can be seen in Figure 4. Their average CPM is 146. An interesting point is that all the participants spent more time to finish Pali words than short email message.

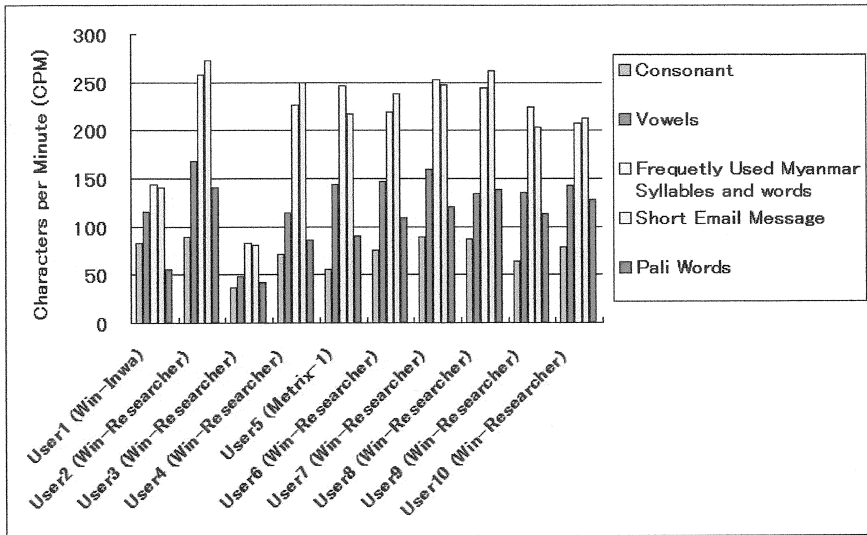


Figure 4 Average Characters per Minute (CPM) of 10 Desktop Publishing Staff

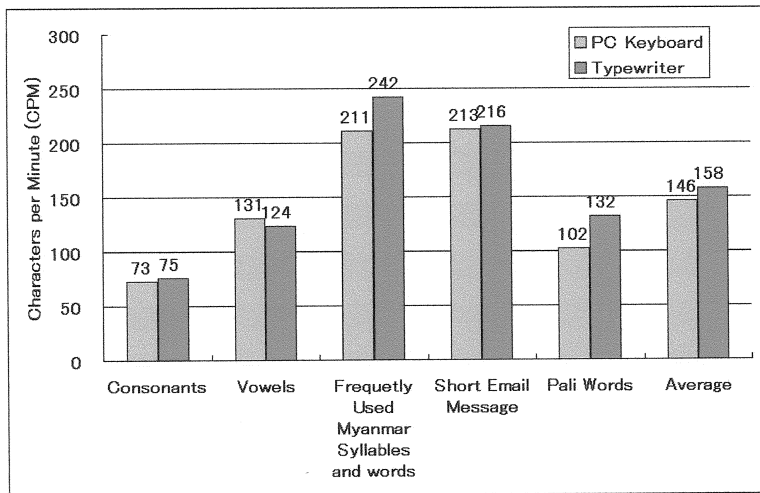


Figure 5 Average Characters per Minute (CPM) Comparison for PC Keyboard and Typewriter

Average CPM of typewriter users to finish the experiment text is 156. The CPM comparison between PC keyboard users and typewriter users can be seen in Figure 5. Typewriter users also spent more time on typing Pali words. Although their average work experience is more than PC keyboard users, we noticed that they still have difficulties in typing Pali words or stacked characters than normal words.

## 5. Discussion

From this study, we can say that almost all Myanmar PC keyboards mappings are based on traditional typewriter. We can divided them into 3 groups, which are ASCII encoding based keyboard, Phonetic keyboard and Unicode keyboard (some of them are not fully Unicode standard such as Myazedi keyboard and Zawgyi Myanmar keyboard) [17, 18]. Virama

sign mappings on the keyboard are not identical but most Unicode keyboard put on “Shift + f” or “F” key. It was also found that most desktop publishing shops in Myanmar are still using ASCII keyboard layout such as Win-Inwa, Win-Researcher and Metrix etc. The average CPM of 10 subjects with PC keyboards for consonants Ka to A is 73, for vowels combinations is 131, for frequently used Myanmar syllables and words is 211, for short email message is 213 and for Pali words is 102. It is clearly seen that typing Pali words with Win-Inwa, Win-Researcher and Metrix-1 keyboards is difficult for the subjects.

Although ASCII keyboard layouts are difficult to learn, most users are already familiar with them and Unicode keyboards are not popular yet. However, we assume that Unicode keyboard layout or typing method is easier compared to old Myanmar PC keyboards for end-users.

## 6. Conclusion

This paper has reported our investigation into Myanmar PC keyboard layouts. It is proved that almost all of the Myanmar PC keyboard mappings are similar and based on traditional typewriter. Average KSPC and CPM are not so different, either. This research is in progress, and we plan to make comparison on other keyboard layouts or text input methods such as software keyboard layouts and Romanized text inputs etc. in the near future.

## 7. Acknowledgement

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