
The Korean Twiddler: One-handed Chording Text Entry for Korean Mobile Phones

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Abstract

We present a text entry method using the Twiddler one-handed chording keyboard to input Hangul, the Korean alphabet, on mobile phones. After estimating keystrokes of various text entry methods, we found that our Twiddler 3 Bul keymap has the fewest keystrokes needed among the methods evaluated.

Keywords

Text entry, mobile phones, mobile input, keypad input, chording, Hangul

ACM Classification Keywords

H.5.2 User interface: Input devices and strategies

Introduction

Mobile phones are pervasive; according to some estimates, there are 1.5 billion mobile phone users and these users sent 135 billion Short Message Services (SMS) in the first quarter of 2004 [1]. In this paper we compare various existing Korean text entry methods for mobile phones and explore a new method for Korean text entry with the Twiddler chording keyboard.

Hangul, the Korean Alphabet

Before the 15th century, Koreans used Chinese characters. In 1443, Sejong the Great, the King of

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Korea, ordered scholars to invent Hangul in an effort to increase literacy. Hangul consists of 24 basic letters which are classified into two groups. The first set is consonants, 'Jaum', and the other is vowels, 'Moum'. By doubling one letter or combining two letters, 14 basic consonants can be used to make 5 doubled and 11 combined consonants, and 10 basic vowels can be arranged to create 11 combined vowels (Figure 1).

With Hangul, multiple letters are combined to form one character which corresponds to a single syllable. A character must have one consonant (called the initial consonant) and one vowel (the middle vowel). Characters may also have an optional third consonant (the final consonant). Figure 2 shows the letters permitted in each position, and Figure 3 shows how the different letters are combined to create a character [2].

30 Consonants	
14 Basic Consonants ㄱ ㅋ ㄴ ㄷ ㄹ ㅁ ㅂ ㅅ ㅇ ㅈ ㅊ ㅋ ㅌ ㅍ ㅎ	5 Doubled Consonants ㄲ ㄴㄴ ㄷㄷ ㄹㄹ ㅂㅂ ㅅㅅ 11 Combined Consonants ㄱㄴ ㄴㄱ ㄷㄹ ㄹㄷ ㄷㄴ ㄴㄷ ㄹㄴ ㄴㄹ ㄱㄷ ㄷㄱ ㄴㄴ
21 Vowels	
10 Basic Vowels ㅏ ㅑ ㅓ ㅕ ㅗ ㅛ ㅜ ㅠ ㅡ ㅟ	11 Combined Vowels ㅝ ㅞ ㅟ ㅠ ㅡ ㅢ ㅣ ㅤ ㅥ ㅦ ㅧ

Figure 1. Letters of Hangul

Initial Consonants	ㄱ ㅋ ㆁ ㄷ ㅌ ㄹ ㄴ ㄷㄹ ㄲ ㄸ ㅂ ㅍ ㅅ ㅈ ㅊ ㅍㅈ ㅍㅊ ㅍㅅ ㅍㅆ ㅍㅉ ㅍㅊㅅ ㅍㅇㅅ ㅍㅏㅅ ㅍㅑㅅ ㅍㅓㅅ ㅍㅕㅅ ㅍㅗㅅ ㅍㅛㅅ ㅍㅜㅅ ㅍㅠㅅ ㅍㅡㅅ ㅍㅣㅅ ㅇ ㅈㅊㅅ ㅈㅇㅅ ㅈㅏㅅ ㅈㅑㅅ ㅈㅓㅅ ㅈㅕㅅ ㅈㅗㅅ ㅈㅛㅅ ㅈㅜㅅ ㅈㅠㅅ ㅈㅡㅅ ㅈㅣㅅ
Middle Vowels	ㅏ ㅑ ㅓ ㅕ ㅗ ㅛ ㅜ ㅠ ㅡ ㅣ ㅏㅅ ㅑㅅ ㅓㅅ ㅕㅅ ㅗㅅ ㅛㅅ ㅜㅅ ㅠㅅ ㅡㅅ ㅣㅅ
Final Consonants	ㄱ ㅋ ㆁ ㄷ ㅌ ㄹ ㄴ ㄷㄹ ㄲ ㄸ ㅂ ㅍ ㅅ ㅈ ㅊ ㅍㅈ ㅍㅊ ㅍㅅ ㅍㅆ ㅍㅉ ㅍㅊㅅ ㅍㅇㅅ ㅍㅏㅅ ㅍㅑㅅ ㅍㅓㅅ ㅍㅕㅅ ㅍㅗㅅ ㅍㅛㅅ ㅍㅜㅅ ㅍㅠㅅ ㅍㅡㅅ ㅍㅣㅅ ㅇ ㅈㅊㅅ ㅈㅇㅅ ㅈㅏㅅ ㅈㅑㅅ ㅈㅓㅅ ㅈㅕㅅ ㅈㅗㅅ ㅈㅛㅅ ㅈㅜㅅ ㅈㅠㅅ ㅈㅡㅅ ㅈㅣㅅ

Figure 2. Classification of Letter

[illegible]

Figure 3. Writing format of Hangul

Text Input Methods for Mobile Phones

There are two predominant brands of mobile phones used in Korea. They are Samsung and LG. The mobile phones market share of these two companies was almost 71% in September 2005[3]. Therefore, we will focus on text input methods of these two companies' mobile phones.

Chonjiin for Samsung Mobile Phones

With Chonjiin, all middle vowels are created with three buttons which represents the strokes needed to form a vowel. These buttons are a vertical bar, a dot, and a horizontal bar. Users press the buttons in the order of strokes for the corresponding letter, left to right and top to bottom as shown in Figure 4.

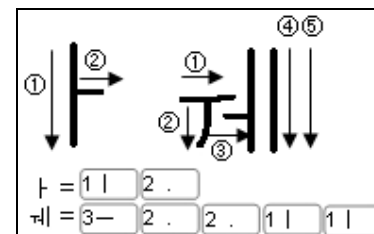


Figure 4. Examples of the order of strokes of letters

Eighteen consonants are assigned to seven keys based on letter shape. Thus, each button has two or three consonants, and users select between them with multi-tap.

While Chonjiin is straightforward, this method of text entry has problems. For example, some vowels require a user to press as many as 5 buttons (Figure 4). Also because Chonjiin uses the multi-tap method for consonants, users may need to press the same button several times to enter the desired letter. In addition, if a final consonant of one character and the initial consonant of the next character are the same, the user must wait until the cursor advances. If the user presses the same button twice without waiting, then the cell phone generates the next consonant of that button in the position of the final consonant (Figure 5). This is similar to what happens in English while writing 'BAG' with multi-tap because 'B' and 'A' are on the same button.

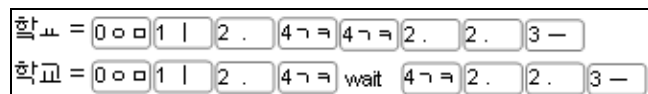


Figure 5. Example of keystrokes for writing letter with a Samsung cell phone

ezHangul for LG Mobile Phones

With ezHangul, the keypad has six buttons for consonants and four for vowels. For letters not printed on the buttons, there are two additional keys used for adding a stroke and doubling a letter.

ezHangul reduces keystrokes by assigning vowels to four keys. Furthermore, the vowels are ordered based upon frequency of use. By using the stroke method and

not multi-tap, it also solves the final and initial consonants conflict from Chonjiin. However, as shown in Figure 6, it still requires several keystrokes to enter a letter. We will explore this issue further in *Evaluation and Results*.

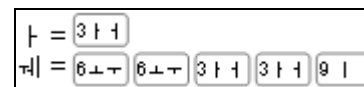


Figure 6. Example of keystrokes for writing a letter with a LG cell phone

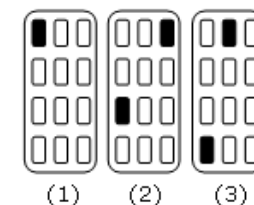


Figure 7. Grip of the Twiddler (left). Examples of chord for 'a' (1), 'j' (2), and 't' (3)



Figure 8. A mobile phone prototype which incorporates chording capabilities

Twiddler

The Twiddler is a mobile one-handed chording keyboard for English. In the past we have explored how this device can be used for mobile phone text entry. Like a

mobile phone, it has twelve keys arranged in a grid of three columns and four rows on the front of the device. Figure 7 shows how users hold the Twiddler. Figure 8 shows a design built into a mobile phone. Users hold it in the palm of their hand with the keys facing away from their bodies. Each row of keys is operated by one of the user's fingers. Instead of pressing keys in sequence to produce a character, multiple keys are pressed simultaneously like a chord. Each letter of alphabet can be typed on the Twiddler by pressing one key or two keys simultaneously [4]. Previously we have found that with sufficient practice our participants reached on average 47 wpm typing in English [8].

Using the Twiddler for Korean Mobile Phones

Given the potential for rapid text entry for English, we no explore using this device to enter Korean text.

Design 1: Twiddler 2 Bul

Our first method is the Twiddler 2 Bul. In Korean 'Bul' means a pair. On a desktop keyboard the consonants are on the left hand side of the keyboard and the vowels are on the right forming two sets (Bul) of letters. Our Twiddler 2 Bul method uses this mapping from desktop keyboards. For example with a Korean desktop keyboard, if the user presses 'a', then 'ㄱ' is written. Similarly, if the user presses the Twiddler chord for 'a' ('L000'), 'ㄱ' is written (Figure 9).

Design 2: Twiddler 3 Bul

While Twiddler 2 Bul retains the familiar mapping of the desktop keyboard, we wanted to explore mappings that are better suited the Twiddler. Our second keymap is Twiddler 3 Bul. It consists of three sets of keys that correspond to the initial consonants, middle vowels, and final consonants of a character (Figure 10). First,

the keypad is configured so the user can enter an initial consonant. After pressing a key, the keymap is changed to allow the user to enter the middle vowel. After the middle vowel, the keymap is again modified to allow the user to enter the final consonant. If the character does not contain a final consonant, the user presses a special skip key. While this does incorporate different modes in the input, it mirrors the sequence of written Hangul.

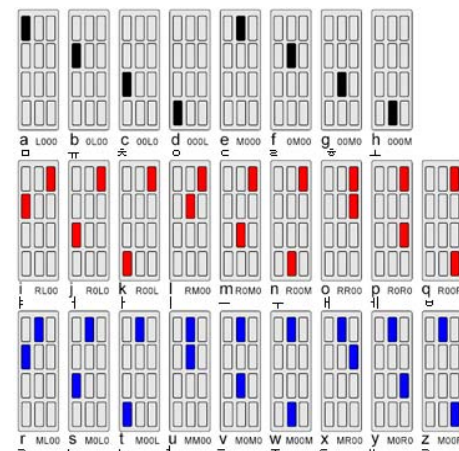


Figure 9. Keymap for chording on the Twiddler 2 Bul

Chord	I.C	M.V	F.C	Chord	I.C	M.V	F.C	Chord	M.V	Chord	M.V
L000	ㄱ	ㅏ	ㄱ	RL00	ㅓ		ㅓ	ML00	ㅑ	LL00	ㅑ
OL00	ㄴ	ㅓ	ㄴ	ROLO	ㅕ		ㅕ	MOLO	ㅓ	LOLO	ㅓ
O0LO	ㄷ	ㅓ	ㄷ	ROOL	ㅖ		ㅖ	MOOL		LOOL	ㅓ
O0OL	ㄹ	ㅓ	ㄹ	ROOM	ㅗ		ㅗ	MM00	ㅓ	LM00	ㅓ
M000	ㅍ	ㅓ	ㅍ	RM00	ㅛ		ㅛ	MM00	ㅓ	LM00	ㅓ
OM00	ㅈ	ㅓ	ㅈ	ROMO	ㅜ		ㅜ	MM00	ㅓ	LM00	ㅓ
OOM0	ㅊ	ㅓ	ㅊ	ROOM	ㅠ		ㅠ	MM00	ㅓ	LM00	ㅓ
O0OM	ㅋ	ㅓ	ㅋ	ROOM	ㅡ		ㅡ	MM00	ㅓ	LM00	ㅓ

Figure 10. Keymap for chording on the Twiddler 3 Bul. Initial Consonant (I.C), Middle Vowel (M.V), Final Consonant (F.C)

Evaluation and Results

We analyzed each of the different input methods to investigate the efficiency for entering Korean text. To measure the efficiency of text entry, MacKenzie presented Keystrokes Per Character (KSPC) metric [5]. It calculates average keystrokes for entering one English character. As mentioned above, unlike English, one Hangul character consists of two or three letters. Therefore we also calculate the number of key presses needed for each character (KSPC) as well as each letter (KSPL):

$$\text{KSPC} = \frac{\text{Total Number of Keystrokes}}{\text{Total number of Characters of Transcribed Text}}$$

$$\text{KSPL} = \frac{\text{Total Number of Keystrokes}}{\text{Total Number of Letters of Transcribed Text}}$$

Figure 11 shows the calculation of the two metrics for on desktop keyboards assuming 5 keystrokes are needed.

Transcribed Text: 학교	KSPL = 5 / 5 = 1
Characters: 학, 교	KSPC = 5 / 2 = 2.5
Letters:ㅎ, ㅣ, ㄱ, ㅊ, ㅇ	
Transcribed Text: house	KSPL = 5 / 5 = 1
Characters: h, o, u, s, e	KSPC = 5 / 5 = 1
Letters: h, o, u, s, e	

Figure 11. Calculation of KSPL and KSPC

Phrase Set

For our evaluation, we used 100 Korean novels for estimating keystroke frequency. Properties of the novels were investigated by analysis software [6]. These novels include 541,224 words, 1,478,078 characters and 3,613,371 letters. The correlation for

this corpus on a letter by letter basis with Korean is 0.92.

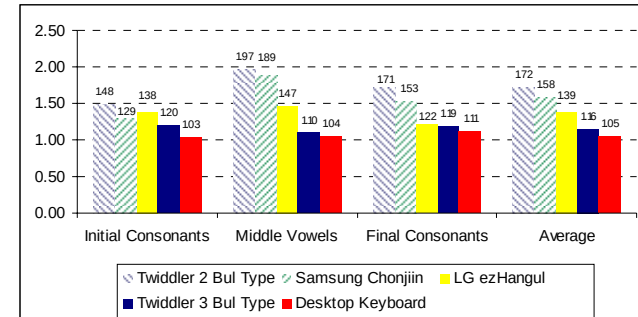


Figure 12. Keystrokes per letter

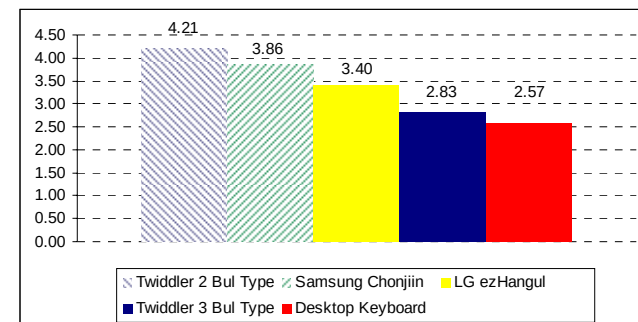


Figure 13. Keystrokes per character

Keystrokes Per Letter

The KSPL of the Twiddler 3 Bul is less than that of other mobile text entry methods (Figure 12). In particular, the number of keystrokes needed for middle vowels is fewest with this method. While some vowels require 5 keystrokes with Samsung and LG cell phones, the Twiddler 3 Bul needs at most 2 keystrokes for any vowel.

Keystrokes Per Character

Even though on average one Hangul character consists of 2.5 letters, more than 3 keystrokes are needed for the existing mobile phone methods. Again, as can be seen in Figure 13, the Twiddler 3 Bul method required fewest keystrokes.

Future Work and Conclusions

There are some issues we would like to explore in the future. First, we would like to examine how quickly novice users can learn the Twiddler 3 Bul method and examine how fast people can type. Also, we would like to explore decreasing keystrokes further by adopting multi-character chords. It is possible that we can create chords to generate entire Korean characters instead of individual letters.

In this paper, we introduced a method of using the Twiddler for Korean mobile phones. By applying the frequency of Hangul letters and using the structure of Korean characters, we are able to decrease the number of keystrokes needed with our Twiddler 3 Bul method. Furthermore, the number of required keystrokes is only slightly larger than that of a Korean desktop keyboard.

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