

Katakana EdgeWrite: An EdgeWrite Version for Japanese Text Entry*

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SUMMARY This paper presents our project of designing EdgeWrite text entry methods for Japanese language. We are developing a version of EdgeWrite text entry method for Japanese language: Katakana EdgeWrite. Katakana EdgeWrite specifies the line stroke directions and writing order of the Japanese Katakana character. The ideal corner sequence pattern of EdgeWrite for each Katakana character is designed based on its line stroke directions and writing order.

key words: text entry, text input, EdgeWrite, Japanese, Katakana, assistive technology, mobile interaction

1. Introduction

We are designing a version of EdgeWrite method for Japanese text entry. EdgeWrite is a successful text entry method for preserving high accuracy and stability of motion [1], [5] and for providing high learnability and guessability [6]. A series of research projects conducted by Wobbrock's group proved that EdgeWrite is a versatile text entry method.

Recently, Kim and Lee [2] designed Korean EdgeWrite, which is a pioneering work for applying the concept of EdgeWrite to an East Asian language. Even though it was a preliminary evaluation, their experimentally obtained result for evaluation showed the high learnability of Korean EdgeWrite. The result suggests that the concept of EdgeWrite is useful for East Asian languages.

The purpose of this paper is to design a version of EdgeWrite for Japanese Text Entry. It contributes to expansion of a design space of the EdgeWrite text entry method as it provides a new application for East Asian languages [3].

2. Japanese EdgeWrite Design

Several challenges exist for designing EdgeWrite for East Asian language such as Japanese. Major challenges for Japanese EdgeWrite design include:

- Large number of characters: Principal part of the Japanese phonogram kana contains 46 characters, each of which has two representations: Hiragana and Katakana.

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- More than one line stroke: Each character consists of line strokes—2.35 strokes on average for Katakana.
- No universal unistroke styles of characters: each Hiragana and Katakana character is written as it is.
- Voiced sound marks: voiced consonants introduce sound signs to characters.

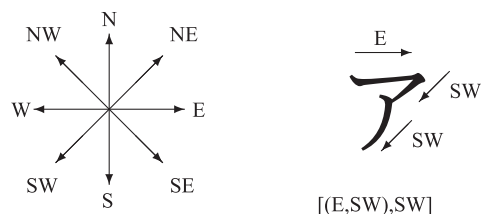
The original EdgeWrite employs a square input area bounded by physical edges. Each corner has a unique assigned number: the top-left corner is 1, the top-right corner is 2, the bottom-right corner is 4, and the bottom-left corner is 8. Corner sequences are defined as a sequence of corner numbers, which represents an EdgeWrite character. For example, 2184 is the corner sequence of character “c” in EdgeWrite (version 3.0.5) [1]. We employ the corner sequence notation to design Japanese EdgeWrite.

3. Katakana EdgeWrite

Considering the challenges described above, we specifically examine Katakana as a candidate for Japanese EdgeWrite design because each Katakana character in writing form consists of straight line strokes and is much simpler than Hiragana character.

Katakana characters have different numbers of strokes. The minimum number of strokes is one for *no*, *fu*, *he*, and *re*, whereas the maximum number of strokes is four for *ne* and *ho*. The average number of strokes for Katakana characters is 2.35. This fact suggests a new challenge for designing Japanese EdgeWrite because EdgeWrite is a *unistroke input technique* [5]. In other words, we need to design kana in unistroke representation.

Detailed analysis of Katakana characters reveals that Katakana consist roughly of straight line strokes made in eight directions (Fig. 1 (a)). Based on this analysis, we pro-



(a) Eight directions to express strokes of Katakana.

(b) Example of line stroke notation for *a*.

Fig. 1 Concept of line stroke notation.

Table 1 Principal part of Katakana EdgeWrite in corner sequence notation. C: Consonant and V: Vowel.

Katakana C	V	Eight Direction Notation	Corner Sequence	
			Ideal	User-generated
φ	a	(E,SW),SW	12828	12818
φ	i	SW,S	2824	2824
φ	u	S,S,(E,SW)	2418128	18124
φ	e	E,S,E	12184	12184
φ	o	E,S,SW	841828	12428
k	a	(E,SW),SW	12828	12428
k	i	E,E,SE	128414	121214
k	u	SW,(E,SW)	28128	18124
k	e	SW,E,SW	28128	18124
k	o	(E,S),E	12484	1248
s	a	E,S,S	841824	1218124
s	i	SE,SE,NE	141482	14142
s	u	(E,SW),SE	12814	12814
s	e	(E,SW),(S,E)	128184	12184
s	o	SE,SW	1428	1824
t	a	SW,(E,SW),SE	2812814	1812814
t	i	SW,E,S	28418	2128
t	u	SE,SE,SW	141428	1818128
t	e	E,E,SW	12128	12128
t	o	S,SE	1814	1814
n	a	E,S	8418	128
n	i	E,E	1284	1284
n	u	(E,SW),SE	12814	12814
n	e	SE,(E,SW),S,SE	141282414	12824
n	o	SW	28	28
h	a	SW,SE	2814	1824
h	i	SW,(S,E)	84184	2184
h	u	(E,SW)	128	128
h	e	(NE,SE)	824	814
h	o	E,S,SW,SE	84182814	1242814
m	a	(E,SW),SE	12814	1284
m	i	SE,SE,SE	141414	141414
m	u	(SW,E),SE	28414	28424
m	e	SW,SE	2814	2814
m	o	E,E,(S,E)	1284184	1212184
y	a	(E,SW),SE	82414	1214
y	u	(E,S),E	12484	12484
y	o	(E,S),E,E	1241284	124848
r	a	E,(E,SW)	12128	12128
r	i	S,S	1824	1824
r	u	S,(S,NE)	18182	18182
r	e	(S,NE)	182	182
r	o	S,(E,S),E	1812484	1812484
w	a	S,(E,SW)	18128	18124
w	o	E,E,SW	128428	12128
n	φ	SE,NE	1482	14142

pose a Katakana notation with line direction and strokes. In addition, the writing order of each stroke is important to express a character. Consequently, each character is represented as a sequence of line directions. For example, Katakana a is expressed as [(E, SW), SW] where (E, SW) and SW in the brackets denote the writing order of separate line strokes, whereas E and SW in parentheses denote the writing order of continuous line stroke (Fig. 1 (b)).

We define all the Katakana characters in the line direction and stroke notation and translate them into corner sequences. For example, (E, SW) is translated into 128; SW is translated into 28. As a result, [(E, SW), SW] is translated into 12828.

Line directions are categorized into horizontal and ver-

tical directions such as N, E, S and W, or diagonal directions such as NE, SE, SW and NW. Each horizontal and vertical direction can be translated into two corner sequences whereas each diagonal direction is translated into unique corner sequence. For example, E can be translated into 12 or 84 whereas SE is translated into 14. This ambiguity produces various possible corner sequences for a single character.

In summary, we show our design of Katakana EdgeWrite in corner sequence notation in Table 1, which express ideal corner sequence patterns. Some Katakana characters have the same corner sequence in Katakana EdgeWrite. Therefore, it may require a method to disambiguate them such as dictionary-based disambiguation [4].

4. User Study

We conducted user studies to investigate the efficacy of our design approach by collecting user-generated corner sequences for Katakana characters. Eleven graduate and undergraduate students participated in the study. They were asked to generate corner sequences by tracing a square edge with a finger under an eye mask. Each participant created three corner sequences for a Katakana character. Table 1 shows the most frequently generated corner sequences. User-generated corner sequences for eighteen characters are the same as the ideal corner sequences. Eight characters have a corner number difference and six characters have two corner number differences.

5. Conclusion

This paper presented a version of Japanese EdgeWrite: Katakana EdgeWrite. To design the Katakana EdgeWrite, this paper introduced a new device: line stroke directions and writing order of Katakana characters. Then we translated each Katakana character in eight direction notation into corner sequence notation, which enables prediction of various possible corner sequences for a single character.

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