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An aerial handwritten character recognition based on motion direction and ratio of stroke length

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Abstract: This paper describes a method to recognize a character handwritten in the air. This recognition method evaluates the motion direction instead of positions of the device. It also doesn't evaluate the motion direction of pen's up-down, so it is one-stroke cursive character recognition. It selects character candidates with dynamic programming (DP) matching algorithm. We made one-stroke cursive character recognition software prototype based on mouse pointer trajectory. We adopted Genetic Algorithm in order to define matching parameters. We improved recognition rates by comparing "motion direction and ratio of stroke length" of detected data with dictionary. As a result, we achieved correct recognition rate about 90% for categories of Hiragana characters and numeral characters.

Keywords: on-line character recognition, one-stroke cursive character

I. INTRODUCTION

Recently, we have a lot of opportunity to use Cloud services. However, it is necessary to input text data in order to use many Cloud services. It is difficult for us to input text or character without the desk. If we can use a new device which provides the input function by handwriting in the air at anytime and anywhere, it is more convenient for us to use Cloud services. So, we study on-line aerial handwritten character recognition system. There are many problems to realize such recognition system. Our issues are "detection of pen's up-down in the air" and "limitation of handwriting area, character size and writing speed".

We proposed an on-line one-stroke cursive character recognition method based on motion direction. This recognition method regards a character as one-stroke and evaluates the motion direction instead of position information. The recognition system obtains the direction data (called "direction code") when a user moves an input device. And it selects character candidates with DP matching algorithm. One of the advantages of using DP matching algorithm is that the recognition system obtains the pattern of the inputted character and avoids individual differences.

We made one-stroke cursive character recognition software prototype based on mouse pointer trajectory. In this paper, we present an improvement of an aerial handwritten character recognition based on both motion direction and ratio of stroke length.

II. RELATED WORK

In the preceding researches, these character recognition systems use the pen lifting information (pen's up-down information) [1] [2]. The pen's up-down is natural operation to write the character on the paper. But when we write the character in the mobile environment in which there is neither tablet nor paper, the system should be designed so that the pen's up-down operation is omitted from the user job. Therefore, we adopted one-stroke cursive character recognition.

III. CODING METHOD

In our previous work [3], we adopted the series of the stroke direction code "a"-"h" and "S" code which means the start point, the end point and slight movements, to find the characteristic of the Hiragana pattern (as shown in Fig. 1). In this case, the sample code of Hiragana character "し" shown in Fig.2. was

"SdcbaS".

And we applied Genetic Algorithm in order to define penalty codes and dictionary parameters for DP matching algorithm. As a result, we got general penalty codes which don't depend on users' habit of writing and the dictionary. The system's correct recognition rate has come to 85% for categories of Hiragana characters. But there are some recognition errors in similar shape characters, for example "う","ら" and "ろ". This is because our previous system is not based on the information of stroke length.

Our new method accumulates same direction code based on proportion of stroke length.

For example, if Hiragana character "し" consists of 50% code "d", 10% code "c", 10% code "b" and 30% code "a" and if total number of coding data size is 30, the sample code of Hiragana character is

"ddddddddddddddddcccbbbaaaaaaaaa".

Table1 shows dictionary examples of new method (total number of coding data size is 50).

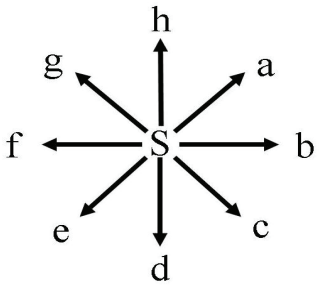

Fig.1. Direction code data

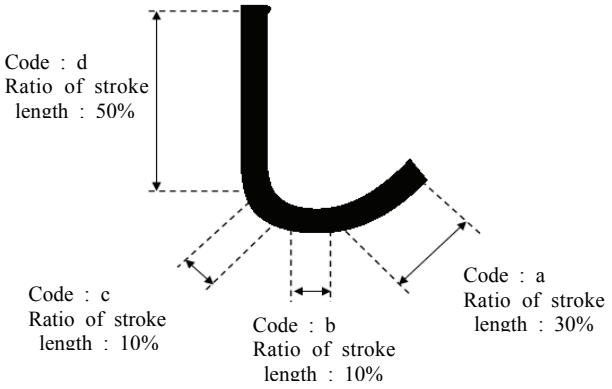

Fig.2. The shape of Hiragana character "し"

Table1. A part of dictionary code

Char.	Code
あ	bbbbbbbbbggggeeddddccaaeeefhaaabbbbccddee
い	ddddddddcccccaaaaaaaaaaaaaaaaaaacccddddddddd
う	ccccccfffffeeeeeaaabbbbbbbbbcccddddddeeeeeeee

IV. EVALUATION

We made one-stroke cursive character recognition prototype system based on mouse pointer trajectory and evaluated correct recognition rate by comparing our new method to our previous method.

Fig.3 shows a dialog of the prototype system's GUI view and Table2 shows comparison between the previous method and the new method with correct recognition rates and recognition failure characters.

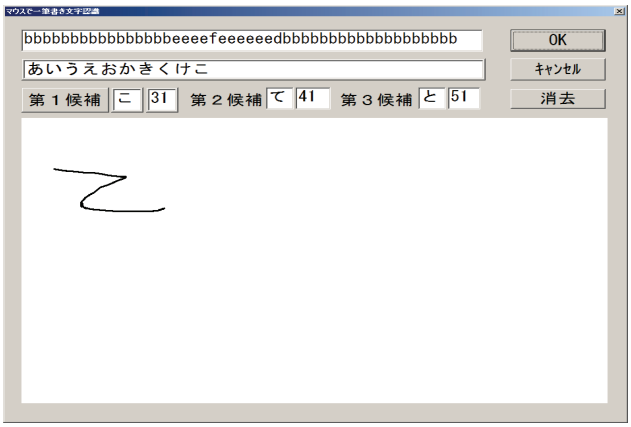

Fig.3. A screen-print of the prototype system's GUI

Table2. Improvement of ratio of stroke length

	Previous method		New method	
	Rec. rate	Error	Rec. rate	Error
い	8/10	り,し	10/10	-
う	8/10	ら	9/10	ら
こ	9/10	て	10/10	-
ら	6/10	う	9/10	す
ろ	6/10	ら,う	10/10	-
Total	400/470 (85.1%)		436/470(92.8%)	

V. CONCLUSION

This paper has shown the on-line one-stroke cursive character recognition and its improvement method of the aerial handwritten character recognition based on both motion direction and ratio of stroke length. Not only characters "う", "ら", and "ろ", the correct recognition rate grow up as a whole. The system's correct recognition rate has come to about 90% for categories of Hiragana characters and numeral characters. The new method can ignore the detection noise caused by the slight movement code "S". This method is more robust and effective for addition of new characters than the previous system.

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