

3-4 Handwritten Chinese Character Segmentation using Local Potential Threshold and Minimum Potential Search

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Abstract

Human can segment a character from handwritten Chinese character text line having many overlaps or joins. Therefore, a fairly high degree of accuracy in the character segmentation may be attained by imitating the human visual processing. In the cognitive science field, it is proposed that the method called 'field of induction on the retina' is similar to human subjective image processing. But, there are some problems (overlaps or joins characters) in character segmentation method using field of induction on the retina.

To solve these problems, this paper proposes the local potential threshold method to imitate human movement of viewpoint and the minimum potential search method to segment joined characters.

1 Introduction

The accuracy of character segmentation from text line is an important factor in the character recognition system. But, it is too difficult to segment a character from handwritten Chinese character text line. Because handwritten Chinese character text line have many complicated overlaps and joins. Consequently, in most of the normal methods, the characters are segmented by trial and error using the result of character recognition or intelligence rule (checking the appropriateness of character elements).

Human can segment a character from handwritten Chinese character text line having many overlaps or joins. So, in this paper we would like to consider the effectiveness of imitating the human visual processing.

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2 Field of Induction on the Retina

It has been proposed that DOG and LoG filter processing are similar to human initial image processing. But, from the standpoint of human subjective image processing, these method are different from present image processing method. On the other hand cognitive science field, it is proposed that the method called 'field of induction on the retina' is similar to human subjective image processing^[1].

Field of induction on the retina is defined by Eq.(1)(See Fig.1(a)). As shown in the field of induction on the retina in Fig.1(b), the potential field match up to human subjective processing. But, there are some problems (overlaps or joins characters) in a character segmentation method from handwritten Chinese character text line using field of induction on the retina^[2].

$$P = \frac{1}{n} \sum_{i=1}^n \frac{1}{r_i} \quad (0 \leq P < 1) \quad (1)$$

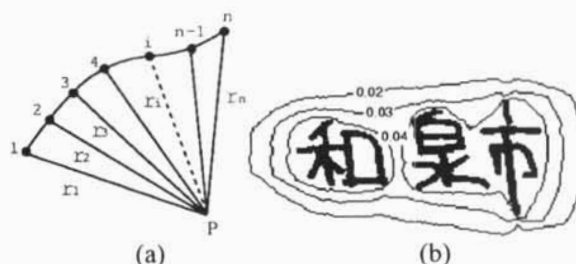


Figure 1: Field of induction on the retina

3 Local Potential Threshold

So far, an appropriate potential field is not always given. Because the potential field is defined by all of characters in the text line.

To solve this problem, in this paper propose the local potential threshold method to imitate human movement of viewpoint

3.1 Neighboring Area of Character Text Line

First, as shown in Fig.2(a), the average width of the character text line is defined as W , and the potential values at certain distances from the character text line are defined as P_0 and P_1 . Then, P_0 or P_1 , whichever has the greater potential value, is defined as a reference point, and the area enclosed with the closed loop contour line is defined as S_a . The potential value which is judged to be the fittest by the human will be defined as S_b (See Fig.2(b)). S_{ab} is defined by Eq.(2).

As shown in Fig.3, the ratio of the blank region in the neighborhood of a character text line and the potential to segment character is distributed around 0.3 to 0.5, according to the results of the preliminary experiments. It is possible to segment a character when it is based on these correlations.

$$S_{ab} = \frac{S_a}{S_b} \quad (2)$$

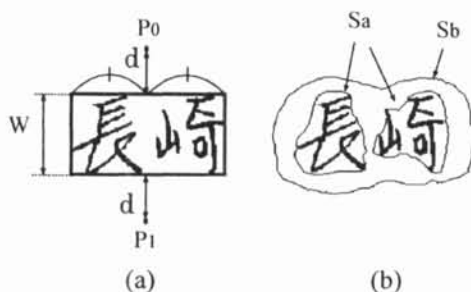


Figure 2: Neighboring area of character string

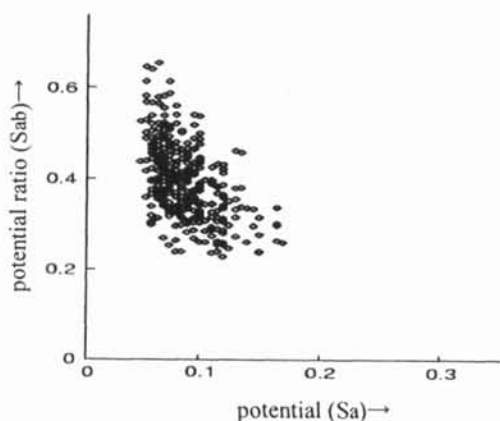


Figure 3: Relation between S_{ab} and potential(S_a)

3.2 Setting of Local Mask

It is difficult to get an appropriate potential field. Because normal character text line may be longer

than these employed preliminary experiments stated in Section 3.1.

Therefore, in this paper propose that local masks have different lengths as shown in Fig.4. The method shown in Section 3.1 is operated within each of the local masks to extract the candidates for closed loops used for character segmentation. As the results, candidates for closed loops assuming different shapes depending upon the length of the mask are extracted to be used for character segmentation as shown in Fig.4.

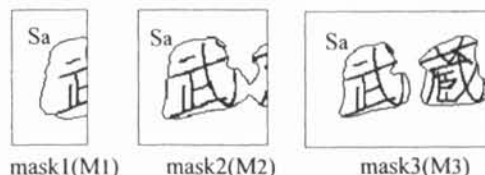


Figure 4: The relation between local mask and potential(S_a)

3.3 Define of Character Segmentation Point

The relative positions of the candidates for closed loops extracted in Section 3.2 are examined. If the vertical overlapping is not significant (10% or less in this paper, considering the results of preliminary experiments), the middle point between the other closed loop is defined as a candidate for character segmentation point(See Fig.5). The least point in the coordinates (to the left) among a number of candidates nominated in this process will be defined as the character segmentation point.

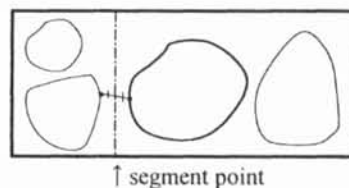


Figure 5: Define of character segmentation point

3.4 Resetting of Local Mask

Character segmentation point is found by the process stated in Section 3.3, the character segmentation point is designated as the starting point of a new mask, and the operation mentioned above is repeated until the end of the character text line(See Fig.6).

This operation corresponds to the operation when a man reads a character text line with the movement of viewpoint.

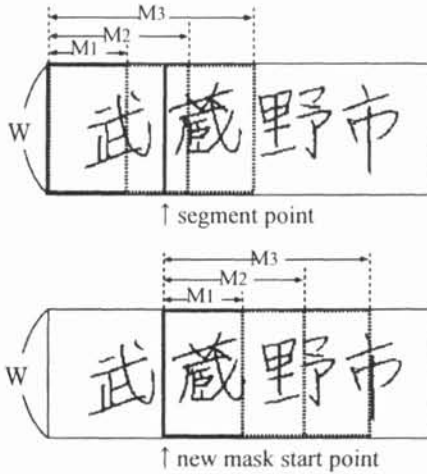


Figure 6: Resetting of local mask

3.5 Linear Interpolation of Local Potential

Character segmentation processing is executed on the basis of position and potential level extracted in Section 3.4. However, the character segmentation process will be adversely affected if the potential level of character segmentation undergo discontinuous changes. Therefore, the potential level of character segmentation are linearly interpolated as shown in Fig.7.

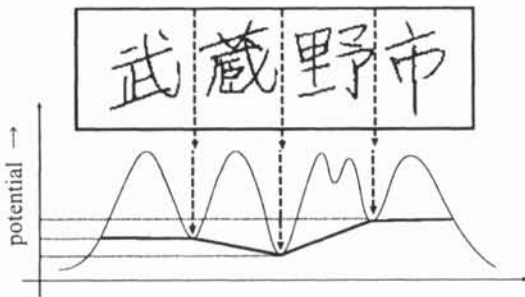


Figure 7: Linear interpolation of local potential

4 Minimum Potential Search

The local potential threshold method can segment a character from a character text line having a many overlaps. But, if the characters are joined together, the character segmentation method may not proceed properly in some cases.

To solve this problems, this paper propose the minimum potential search method to segment joined characters.

4.1 Setting of Searching Field

The area of a rectangle touching a character is defined as S_c , and the ratio of length and width of a character is defined as R_c (horizontal length/ W). If the S_c and R_c values satisfy the condition of Eq.(3), the character dividing process is executed assuming that the characters are joined together.

The character dividing field to the vertical centerline of a character is defined by Eq.(4). As shown by Eq.(4), the search field should be defined in proportion to the horizontal length of a character.

$$S_c > W^2 \text{ and } R_c > C_0 \quad (C_0 = \text{constant}) \quad (3)$$

$$D_l = C_1 \cdot W \cdot R_c \quad (C_1 = \text{constant}) \quad (4)$$

4.2 Searching of Dividing Line

Each point on the horizontal center line (D_l) is defined as the starting point of searching. Vertical searching is executed so as to pass through the point having the minimum potential level. In this process, the search line having the minimum number of crosses with the original image should be designated as the character segmentation line (See Fig.8).

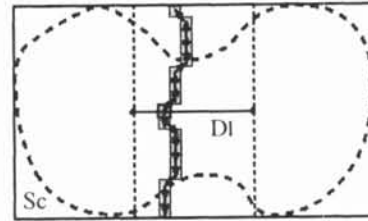


Figure 8: Minimum potential search

5 Results of Experiments

The results of experiments on handwritten character text lines (total 56 text lines, include 709 characters) are shown in Table.1. The local potential threshold method improved the recognition efficiency by 10% over the old method as shown in Table.1. With the joint use of the minimum potential search method, the efficiency was enhanced by approximately 20% overall.

The results in practical character text line using these methods are shown in Fig.9. The externally touching rectangle shows the recognition by the local potential threshold method, and the curve within the externally touching rectangle shows the minimum potential search method.

6 Conclusion

In this paper proposes the local potential threshold method to imitate human movement of viewpoint and the minimum potential search method to segment joined characters. These methods applied

Table 1: Rate of character segmentation

Method type	Rate(%)
Old method	70.9
Local potential threshold	79.9
Local potential threshold +Minimum potential serch	89.1

to character segmentation from a handwritten Chinese character text line. As the results, it showed 20% improvement compared with the old method using field of induction on the retina.

An investigation of unsuccessful examples showed that almost of all the failed examples were characters caused by the other characters except Chinese characters(See Fig.10). Presently, we are studying the character segmentation applicable to other characters except Chinese characters.



(a)original image



(b)local potential threshold



(c)minimum potential search

Figure 9: Example of character segmentation



Figure 10: Unsuccessful example

References

- [1] Zensho YOKOSE, "A Study on Character-Patterns Based Upon the Theory of Psychological Potential Field", Japanese Psychological Research, Vol.12, No.1, pp.18-25, 1970
- [2] Michihiro NAGAISHI, "A Consideration on Segmentation of Handwritten Characters using Field of Induction on the Retina", Technical Report of IE-ICE. Japan, PRU92-120, pp.17-24, Jan.1993