



A metasynthetic approach for segmenting handwritten Chinese character strings

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Abstract

In this paper, a metasynthetic method is proposed to segment handwritten Chinese character strings. The Viterbi algorithm is firstly applied to search segmentation paths and several rules are used to remove redundant paths. Then a background-thinning method is further adopted to obtain non-linear segmentation paths. If there are not touching characters, a dynamic programming algorithm is applied to merge components. For touching characters, we apply background and foreground information to obtain candidate segmentation paths and the feature vectors are constructed in terms of peripheral features. Then the mixture probabilistic density function whose parameters are obtained by the EM algorithm is used to choose the best segmentation path. Experimental results demonstrate that the proposed scheme effectively segments handwritten Chinese characters and achieves an improvement over previous methods.

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1. Introduction

Off-line recognition of handwritten characters is playing increasingly important roles in many fields

such as mail-sorting machines, form-preprocessing and bank check reading. Due to various handwriting styles, it is still a challenging issue in present pattern recognition. At present, most existing recognition systems adopt segmentation-based methods to recognize characters. Moreover, some researchers pointed out that recognition results severely rely on the segmentation performance of

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characters. Therefore, segmentation of characters is an important and key step in the handwritten character recognition systems.

Some papers concerning segmentation of characters had been published in previous literature. Lu (1995) reviewed various segmentation techniques in machine-printed documents. Then Lu and Shridhar (1996) further summarized handwritten character segmentation methods. In general, much attention is paid to segmenting touching characters. Lu et al. (1999) proposed a background-thinning approach for segmenting connected handwritten characters strings. Chen and Wang (2000) combined background and foreground information to segment single-or multiple-touching numeral strings. Recently, Ashraf and Reda (2003) roughly classified segmentation methods of characters into three categories: region-based (Shridhar and Badreldin, 1986; Chi et al., 1995), contour-based (Hu and Yan, 1998) and recognition-based (Lee and Kim, 1999; Favata, 2001).

Different from occidental characters, Chinese characters usually consist of more than one radical and even some radicals themselves are characters. Moreover, characters with the left–right structure are common in Chinese characters. In this case, a Chinese character appears as more than one disconnected radical. Hence it is necessary to merge these radicals to obtain correct Chinese characters. Overlapping characters can also be observed in Chinese characters. In general, non-linear paths are used to segment characters in such a case. However, how to obtain non-linear paths is still an important issue in segmenting handwritten Chinese character strings. In addition, ligatures between radicals are often met in handwritten Chinese character strings. Moreover, types of touching characters are very complicated, which leads to the most difficult subtask in segmenting characters. In short, due to the complicated structure of Chinese characters, the variety of fonts and different handwriting styles, segmentation of handwritten Chinese characters is still a challenging task for many researchers in pattern recognition. Fortunately, many researchers would like to take this challenging task and had gained some encouraging results. Tseng and Chen (1998) proposed a segmentation method for handwritten Chinese characters. In their ap-

proach, strokes are firstly used to build stroke bounding boxes. Then the knowledge-based merging operations are used to combine stroke bounding boxes. Finally, a dynamic programming method is applied to search the best segmentation path. Tseng and Lee (1999) proposed a recognition-based segmentation method for handwritten Chinese characters. Zhao et al. (2003) proposed a two-stage segmentation method for unconstrained handwritten Chinese characters. They firstly use the vertical projection and the background skeleton to segment non-touching characters. Then fuzzy decision rules are used to find suitable paths. In the fine segmentation stage, background and foreground information is used to obtain candidate segmentation paths. Similarly, fuzzy decision rules are applied to obtain the best segmentation path. Lu et al. (2000) utilized character elements and their topological structure to merge the components of characters and connected characters are separated in terms of features of Chinese character strokes. Jiang et al. (2001) discussed features of Chinese characters and proposed a penetrating algorithm to segment overlapping characters.

In this paper, the Viterbi algorithm is firstly applied to obtain as many segmentation paths as possible. Then several rules are applied to remove redundant segmentation paths. Although many non-linear segmentation paths for overlapping characters can be obtained by the Viterbi algorithm, severely overlapping characters are still not well separated. To this end, the background of character blocks is thinned and the background skeleton is obtained. Then the Width-First algorithm is used to search the connected lines from the background skeleton. If there are not touching characters, these components are merged by a dynamic programming algorithm in terms of peripheral features of Chinese characters. For touching characters, major branch segments are chosen from the background skeleton and the feature points (fork points, corner points) are labeled in the foreground skeleton. Then candidate segmentation paths are constructed in terms of major branch segments and feature points. Thus the feature vectors are set up in terms of the segmentation path and the mixture density function is applied to obtain suitable segmentation paths.

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