Chinese Payee Name Recognition Based on Seal Information of Chinese Bank Checks

Chao Ren
Graduate School at Shenzhen,
Tsinghua University
Shenzhen, China
renc09@mails.tsinghua.edu.cn

Youbin Chen
Graduate School at Shenzhen,
Tsinghua University
Shenzhen, China
chenyb@sz.tsinghua.edu.cn

***Abstract*—This paper presents a prototype system of Chinese payee name recognition (PNR) based on seal information in the back of Chinese bank checks. First, the seal imprints in the back images of Chinese bank checks are detected and extracted based on the color information. Second, the seal characters representing the payee name are segmented, rotated to horizontal position, and then recognized respectively. Third, the recognized seal characters are considered as the dictionary and payee name recognition is carried out as a verification process. Experiments demonstrate the effectiveness of our proposed method.**

Keywords-seal image; character segmentation; character recognition

I. INTRODUCTION

Bank checks are widely used all over the world. A lot of checks are still processed manually by human operators. The most common and labor consuming operation is the check amount reading and typing [1]. Automatic check processing is helpful [2-4]. But most systems focus on courtesy amount recognition and legal amount recognition. Payee name recognition (PNR) is also important and needed automatic recognition too. Because of the handwriting variability, the Chinese payee name recognition is one of the challenging problems in the area of off-line handwritten Chinese character recognition (HCCR) [5]. To solve this problem, we propose another way in this paper.

Figure 1. A typical image pair of a Chinese bank check

As shown in Figure 1, according to the provision [6] of the State Council, there must be the official circular seal imprints or the specific-use circular seal imprints on the bottom of Chinese bank checks. In these seal imprints there are some characters surrounding the center of the seal, and these characters are needed to be the same as the payee name on the front face of bank checks. So we can extract the characters on the seal imprints and recognize them first. Then consider this seal information as the priori information to drive the payee name recognition.

The rest of this paper is organized as follows. Section Ⅱ presents the framework of our system. Implementation details for every step are given in section Ⅲ and experimental results can be found in section Ⅳ. Section Ⅴ provides our conclusion and future work.

II. FRAMEWORK

The whole system consists of five modules: seal detection and extraction, seal character extraction, seal character recognition, payee name segmentation and payee name recognition, as shown in Figure 2.

First, seal imprint field is located and extracted from the color check back image. We extract the red seal by analyzing the RGB space and HSV space, and then use binarization methods to remove noise and extract red seal. Second, extract the useful characters surrounding the seal center and rotate them to horizontal position. Third, recognize these characters and use the results as the payee name candidates to guide the next steps. Fourth, the extracted payee name characters are segmented and the segmented units are classified into two categories: a single character unit or a sticky character unit (also called as linked category). Finally, handwritten Chinese character recognition is applied with the single character unit and the holistic recognition is used to handle the sticky character units.

III. IMPLEMENTATION DETAILS

A. Seal Extraction

The seal extraction module consists of two sub-steps: seal detection and binarization. For seal detection, we use both the RGB color space and HSV color space for analysis. For seal image binarization, we combine a global threshold method and a local threshold method. Otsu method [7] is applied to remove the background. The details are described

978-0-7695-4774-9/12 $26.00 © 2012 IEEE
DOI 10.1109/ICFHR.2012.191

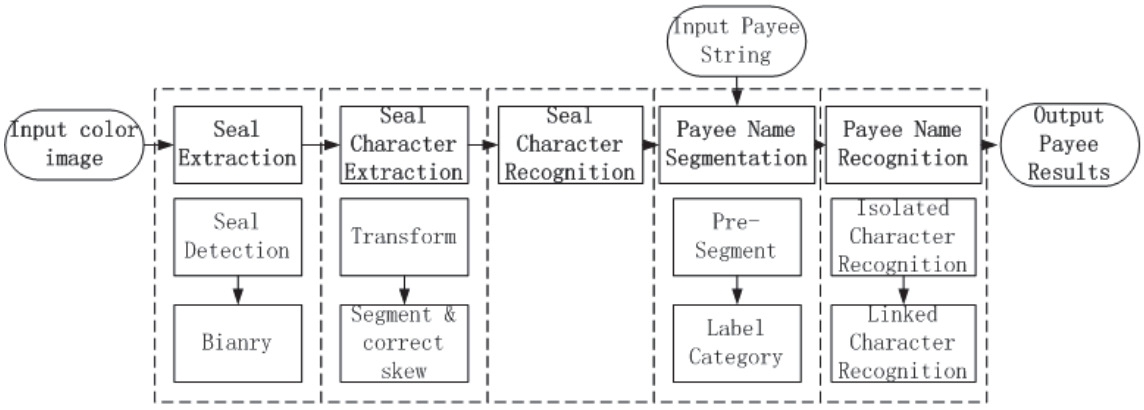

Figure 2. Flow chart of our proposed system

in [10]. The seal detection and binarization results of the check back image in Figure 1 are shown in Figure 3.

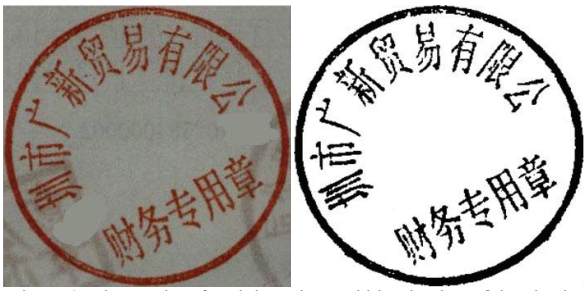

Figure 3. The results of seal detection and binarization of the check back image in Figure 1.

B. Seal Character Extraction

In this module, the characters in a seal representing the payee name are extracted and the skew of each character is corrected so as to rotate the character into the horizontal position.

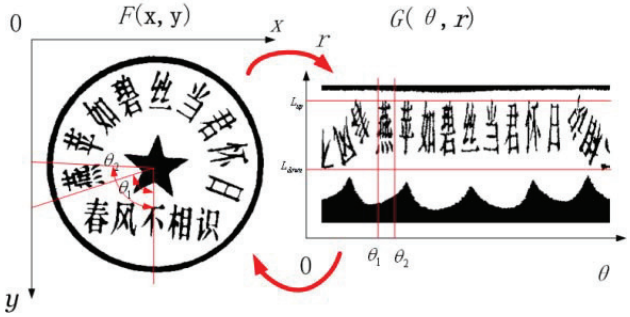

Figure 4. Transforming process for circular seal images

The non-iterative ellipse-specific fitting method [8] is used to so as to convert the circularly arranged characters into a rectangular region [9]. Figure 4 shows the process of skew correction and Figure 5 shows the process of seal character segmentation after rotation. The details can be found in [10].

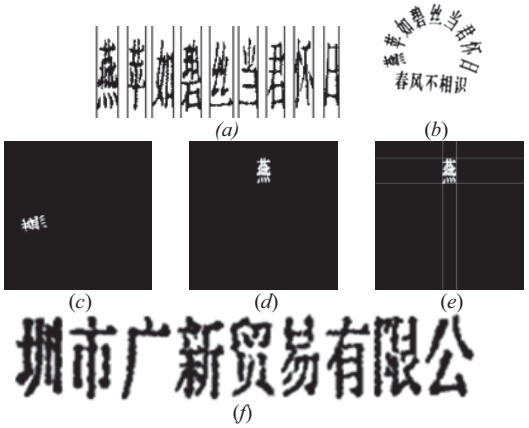

Figure 5. (*a*) Character segmentation on the θ-axis. (*b*) Remove the interference pixels. (*c*) Reserve only the character "燕". (*d*) Skew correction.(*e*) Character segmentation. (*f*) The results of the check in Figure 1.

C. Seal Character Recognition

The character images extracted from seals are sometimes noisy and their strokes are sometimes thicker. These have great impact on the accuracy of OCR. In our system, three different OCR engines are combined. OCR1 is a learning vector quantization (LVQ) classifier. OCR2 is a modified quadratic discriminant function (MQDF) classifier. OCR3 is an Euclidean distance (EUD) classifier. The features used by these three classifiers are gradient direction feature (GRD), chain code feature (CHF), and traversing-time feature (TRF) respectively. The details are described in [10] and the

recognition results are shown in Table Ⅰ. Figure 6 shows the recognition results of the seal characters in Figure 5 (f).

TABLE I. RECOGNITION RATES (%) OF INDIVIDUAL CLASSIFIERS AND THE COMBINED CLASSIFIER

OCR Engine	Feature	Classifier	Accuracy
OCR1	GRD	LVQ	88.9%
OCR2	CHF	MQDF	68.0%
OCR3	TRF	EUD	72.3%
Combined			97.0%

Figure 6. The seal character recognition results

D. Payee Name Segmentation

Given that the payee names in Chinese bank checks usually represent entities, such as state administrative offices, public institutions and social organizations, these characters are usually uncomplicated. Because people are always writing as clearly as possible on bank checks, the characters consist of great amount of isolated characters and a few linked ones. So the aim of this stage is to segment these characters into isolated characters (IC) and linked ones (LC).

Based on the seal character information, we have known the number *N* of the payee characters and the 10 candidates of each character from the OCR engine. Because of the high accuracy of the seal character recognition, it is reasonable to suppose that the correct results of payee name recognition come from these *N*10* candidates. To help us segment payee characters, OCR4 is designed to recognize handwritten Chinese characters, which is a EUD classifier using directional element feature (DEF) [11] trained with CASIA300 database [12]. First, connected component (CC) analysis and vertical projection are used to merge some CCs. Second, the average height of the whole payee name string can be estimated as *H*. By the analysis of *H* and the width of each CC, we can label it as an IC or LC.

In the next stage, the features of the *N*10* candidates can be searched in OCR4. The right recognition results are supposed to come from these *N* categories, where every category has 10 units. The aim of this step is to determine which category each IC belongs to and which categories' units compose the LC. First, extract every IC's DEF feature, and use ORC4 to compare it with the *N*10* features to get every IC's first candidate and its confidence. Second, find the highest confidence which label this IC into this category *L* which is from *1* ~ *N*. Repeat the same operations to the other ICs. Figure 7 shows the results of payee name character segmentation in Figure 1.

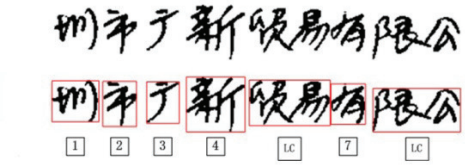

Figure 7. Results of payee name segmentation in Figure 1

E. Payee Name Recognition

ICs and LCs are recognized with different strategies. OCR4 is used for IC recognition. Seal OCR results, i.e. 10 candiates of each seal character, are used as the character set of each IC. Cross-validation is used to choose the highest rank candidate as IC recognition result.

After all the ICs are recognized and cross-validated with their corresponding seal characters, LCs are recognized. For each LC, the number of characters and its corresponding character sets can be derived from the seal information. Based on this prior information, the nonlinear shape normalization is applied first and then OCR4 is used for the verification-oriented recognition. Cross-validation is used again to determine the final LC recognition result. An example is shown in Figure 8.

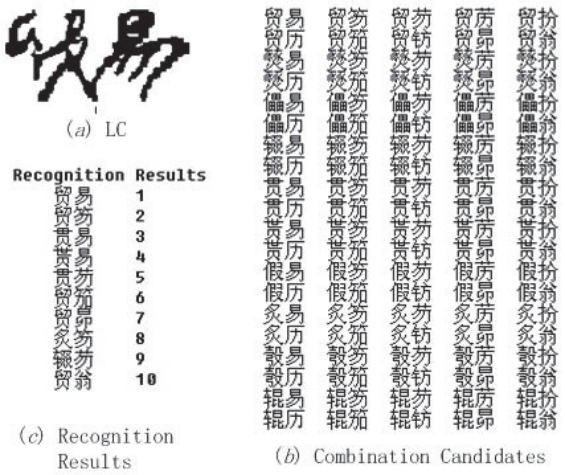

Figure 8. An example of the LC recognition

IV. EXPEIMENTS

All the experiments are carried out with the data collected by ourselves since there are not any public data sets. In our experiments, 600 real checks are collected from different banks and scanned into color images with the resolution of 200 DPI for both sides.

The payee name recognition is carried out and a list of result candidates with corresponding confidence is given for each IC or LC. The one with the highest confidence is

regarded as the final result. The recognition rate is defined as the ratio of checks with correct payee recognition results to the total number of checks. Experimental results are shown in Table Ⅱ.

TABLE II. RECOGNITION RATES (%) OF CHECKS WITH CORRECT RESULTS IN THE TOTAL NUMBER OF CHECKS

System	Cor-rect rate	Reje-ction rate	Recog-nition error rate	Segme-ntation error rate	Seal locat-ion error rate	Total error rate
System in [13]	46.5%	–	–	–	–	53.5%
Our system	72.1%	10.2%	8.5%	5.6%	3.6%	27.9%

V. CONCLUSION AND FUTURE WORK

In this paper, we proposed a prototype system of payee name recognition for Chinese bank checks. Seal extraction, seal character extraction, seal character recognition, payee name segmentation and payee name recognition are sequentially carried out. In the future, we aim at improving our system in the following ways: 1) designing a quality analyzing module to reject the sample with poor quality seal imprints; 2) designing a verification module for further analysis of recognition results with rejection to the uncertain ones.

REFERENCES

[1] V. Anisimov,E. Augustin, O. Baret, D. Price, J.C. Simon, " A2iA Check Reader: a family of bank check recognition systems", 5th International Conference on Document Analysis and Recognition (ICDAR 1999), Sept. 1999, pp. 523-526, doi: 10.1109/ ICDAR. 1999. 791840.

[2] F. Chin and F. Wu, "A microprocessor-based optical character recognition check reader", 3rd International Conference on Document Analysis and Recognition (ICDAR 1995), Aug. 1995, Vol. 2, pp. 982-985, doi: 10.1109/ICDAR.1995.602066.

[3] E. Lethelier, M. Leroux and M. Gilloux, "An automatic reading system for handwritten numeral amounts on French checks", 3rd International Conference on Document Analysis and Recognition (ICDAR 1995), Aug. 1995,Vol.1, pp. 92-97, doi: 10.1109/ ICDAR. 1995. 598951.

[4] P. Zhao, T. Yasuda and Y. Sato, "Cursivewriter: On-line cursive writeing recognition system", 2nd International Conference on Document Analysis and Recognition (ICDAR 1993), Oct. 1993, pp. 703-706, doi: 10.1109/ICDAR.1993.395640.

[5] Tong-Hua Su, Tian-Wen Zhang, Hu-Jie Huang and Cheng-Lin Liu, "Segmentation-free recognizer based on enhanced four plane feature for realistic Chinese handwriting", 19th International Conference on Pattern Recognition (ICPR 2008), Dec. 2008, pp. 1-4, doi: 10.1109/ ICPR. 2008. 4761543.

[6] Xiaoyang Wang and Youbin Chen, "Seal Image Registration Based on Shape and Layout Characteristics", 2nd International Congress on Image and Signal Processing (CISP 2009), Oct. 2009, pp. 1-5, doi: 10. 1109/ CISP. 2009. 5302120.

[7] N. Otsu, "A threshold selection method from graylevel histograms", IEEE Trans. SYst., Madn. & Cybrn., 1979.9(62-66).

[8] R. Halif and J. Flusser, "Numerically Stable Direct Least Squares Fitting of Ellipses", in Department of Software Engineering, Charles University, Czech Republic. 2000.

[9] Hong Liu, Ye Lu, Qi Wu and Hongbin Zha, "Automatic seal image retrieval method by using shape features of Chinese characters", IEEE International Conference on System, Man and Cybernetics (ISIC 2007), Oct. 2007, pp. 2871-2876, doi: 10.1109/ ICSMC. 2007. 4414010.

[10] Chao Ren, Dong Liu and Youbin Chen, "A New Method on the Segmentatio and Recognition of Chinese Characters for Automatic Chinese Seal Imprint Retrieval", 11th International Conference on Document Analysis and Recognition (ICDAR 2011), Sept. 2011, pp. 972-976, doi: 10.1109/ICDAR.2011.197.

[11] N. Kato, M. Suzuki, S. Omachi and Y. Nemoto, "A handwritten character recognition system using directional element feature and asymmetric Mahalanobis distance", IEEE Transactions on Pattern Analysis and Machine Intelligence, Mar. 1999, Issue. 3, Vol. 21, pp. 258-262, doi: 10.1109/34.754617.

[12] Cheng-Lin Liu, "High Accuracy Handwritten Chinese Character Recognition Using Quadratic Classifiers with Discriminative Feature Extraction", 18th International Conference on Pattern Recognition (ICPR 2006), Vol.2, pp. 942-945, doi: 10.1109/ICPR.2006.624.

[13] Tong-Hua Su, Tian-Wen Zhang, Hu-Jie Huang and Yu Zhou, "HMM-Based Recognizer with Segmentation-free Strategy for Unconstrained Chinese Handwritten Text", 9th International Conference on Document Analysis and Recognition (ICDAR 2007), Sept. 2007, Vol. 1, pp. 133-137, doi: 10.1109/ICDAR.2007.4378690.