

Edith Cowan University
Research Online

ECU Publications 2011

1-1-2011

A new seal verification for Chinese color seal

Zhihu Huang

Jinsong Leng
Edith Cowan University

Follow this and additional works at: <https://ro.ecu.edu.au/ecuworks2011>

 Part of the [Computer Sciences Commons](#)

[10.4028/www.scientific.net/AMM.58-60.2558](https://doi.org/10.4028/www.scientific.net/AMM.58-60.2558)

This is an Author's Accepted Manuscript of: Huang, Z. , & Leng, J. (2011). A new seal verification for Chinese color seal. *Applied Mechanics and Materials*, 58-60(1), 2558-2563. Available [here](#)

This Journal Article is posted at Research Online.

<https://ro.ecu.edu.au/ecuworks2011/536>

A New Seal Verification For Chinese Color Seal

Zhihu Huang^{1,2,a}, Jinsong Leng^{3,b}

¹College of Computer Science, ChongQing University, ChongQing, 400030, China

²Distance Education Center, Chongqing Radio & TV University, ChongQing, 400052, China

³School of Computer and Information Science, Edith Cowan University, 6050, Australia

^azh_huang@yeah.net, ^bj.leng@ecu.edu.au

Keywords: Seal segmentation, Seal verification, Image binarization, Moment invariant

Abstract. Automatic seal imprint identification system is highly demanded in oriental countries. Even though several seal identification techniques have been proposed, it is seldom to find the papers on the recovery of lost seal imprint strokes caused by superimposition. In this paper, a new seal verification for Chinese color seal is proposed. This approach segments the seal imprint from the input image in terms of the adaptive thresholds. The lost seal imprint strokes are recovered based on the text stroke width that can be detected automatically. In addition, the moment-based seal verification is to compare the reference seal imprint and the recovered one. Experimental results show that the proposed method is able to correctly and efficiently verify the genuine and forgery seal imprint.

Introduction

Seals are widely used in oriental countries such as Chinese, Japanese and Korea to identify a person, a social group, or an organization etc [1]. Currently, a variety of seals must be manually verified, which relies on the expertise and experience of professional technicians, which not only consumes so much time, but also inevitably introduces some misidentification. Therefore, a seal imprint verification system is highly demanded to resolve this issue automatically, speedily and reliably.

Seal verification can be regarded as a template match between the reference seal imprint and the candidate one. To exactly match the seals, a variety of features have to be considered, including the characters in the imprint, the scales, distributions, relative spatial positions, strokes etc. As a result, the matching is called “hard-matching”. The hard-matching consists of two steps, i.e. segment seal imprint from the input image, and then verify whether the segmented one is genuine or spurious. There are three main issues on computerizing this procedure. Firstly, the input seal imprint is usually superimposed by other information such as signature or background text, consequently, the segmentation of seal imprint is difficult [2]. Secondly, the difference between the genuine seal imprint and the forgery one is small, so the results are very sensitive to noise. Thirdly, it is very difficult to make the candidate seal imprint have exact same orientation and size as the reference one.

Several seal verification methods have also been proposed for decades [3-4]. These methods mainly include four steps: 1) Rotate the candidate seal imprint to the same orientation as the reference one; 2) Compute the centroid to the candidate imprint and reference one; 3) Overlap the rotated candidate seal imprint and the reference one in terms of the centroid; 4) Match them pixel by pixel. From these steps, we can see that the performance and robustness of seal identification strongly depend upon the precision to detect the angle of rotation and position of centroid. Owing to the difficulty in exactly overlapping the input seal imprint and reference one, the method matching candidate seal imprint and reference one pixel by pixel is difficult to use. Clearly, the exact detection of rotated angle is very complicated and difficult.

In this paper, a new approach for seal imprint segmentation and verification is proposed. To improve the precision, an adaptive thresholding method based on RGB components [5] is presented. This segmentation method is very suitable for both seal segmentation and extracting a particular color cluster from an image. The recoveries for the losses of seal imprint strokes are considered for minimizing the errors in seal imprint identification. A moment-based method is employed because it is independent on the image translation, rotation and scaling. As a result, the proposed method not only avoids the complicated match processing but also improves the robustness and precision to identify seal imprints. The proposed method consists of five major steps: 1) Segment the seal imprint in terms of the adaptive thresholds; 2) Recover the losses of seal imprint strokes in segmented seal imprint; 3) Binarize the segmented seal imprint and the reference one using Otsu algorithm [6]; 4) Compute the Hu's moment invariants [7] to the segmented seal imprint and the reference one; 5) Identify them based on Euclidean distance of moment invariants.

The rest of the paper is organized as follows: Section 2 illustrates the proposed approach. The experimental results are presented and analyzed in Section 3. Section 4 concludes this paper.

Proposed Approach

In general, the shapes of seal may be circular, rectangular, or elliptic. The colors of seal imprint may be red or blue. For simplicity, only circular and red seal imprint are selected in our demonstration. The genuine seal imprint is shown in Fig. 1.(a). Obviously, the image is composed of three color clusters, i.e. the red seal imprint, the black text and the white background.

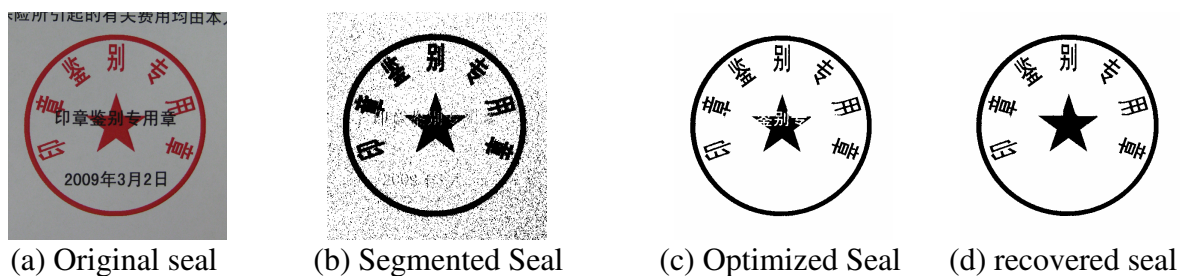


Fig. 1. Seal Segmentation

Seal Segmentation. Seal segmentation aims to extract the seal imprint from the input image and recover the losses of seal imprint strokes caused by superimposition. It mainly contains the following steps: 1) Estimate the adaptive thresholds to segment the seal imprint, 2) Segment the seal imprint and text from the input image, 3) Recover the losses of seal imprint strokes, 4) Binarize the segmented seal imprint and corresponding reference seal imprint.

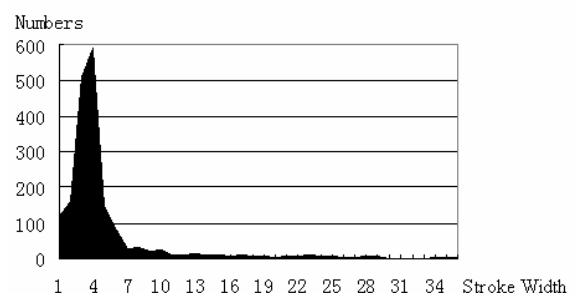
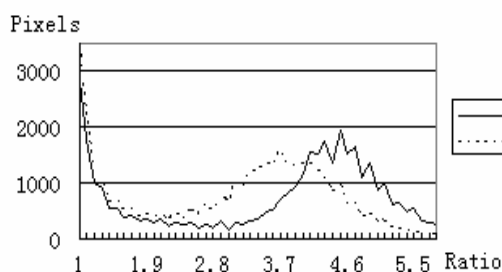


Fig. 2. Histograms for the values of R/G and R/B Fig. 3. Histogram of stroke width on black text

Estimate Thresholds. In our demonstration, the color of seal imprint is red, i.e. the red component of seal imprint is stronger than green and blue components. For three color clusters, i.e. red (seal imprint), white (background) and black (text), the R (Red), G (Green) and B (Blue) components are equal for white($R=G=B=255$) and black($R=G=B=0$), The red seal imprint can be easily segmented under the conditions $R>G$ and $R>B$. Fig. 1(b) shows the segmented result only

based on the conditions $R>G$ and $R>B$. The result shows that so many pixels belonging to background or text are also meet the conditions in practice because of various noisy factors such as camera, illumination.

We can find that the ratios of R/G and R/B for noise pixels are far less than the ratios of seal imprint pixels. It is possible to find the thresholds of R/G and R/B to divide the pixels which meet the conditions ($R>G$ and $R>B$) into two classes, i.e. the noise pixels and the seal imprint pixels. To find the optimal thresholds for R/G and R/B , the histograms for the ratios of R/G and R/B on pixels whose $R>G$ and $R>B$ are constructed, as shown in Fig. 2. Since both histograms of R/G and R/B have evident bimodality, the optimal thresholds can be acquired using Otsu algorithm [6]. For Fig. 1(a), the optimal thresholds of R/G and R/B calculated by Otsu are respectively 2.1 and 1.8.

Segment Seal Imprint and Text. After acquiring the thresholds, the seal imprint can be segmented easily. Since the text in input image will be used in subsequent process, the seal imprint and text are segmented in the same time. The steps of segmentation are detailed in algorithm 1.

Algorithm 1 Segmenting Seal Imprint and Text from the Input Image

Input: an image with red seal imprint, black text and white background

Output: an image of red seal imprint, an image of black text

- 1: Estimate the threshold THR_G and THR_B using method described in Section 2.1.1;
 - 2: Scan input image, get values of the red, green and blue component in each pixel and save in variable r , g and b respectively;
 - 3: if $r/g > THR_G$ and $r/b > THR_B$
 The pixel is belong to seal imprint I_{seal}
 Else
 The pixel is belong to background or text I_{BT}
 End if;
 - 4: Binarize the pixels in I_{BT} using Otsu algorithm [6] and then get the text image I_{text} ;
 - 5: Remove the black block in I_{text} whose size less than 0.2% size of input image;
 - 6: Return the seal imprint I_{seal} and black text I_{text} .
-

The segmented seal imprint is displayed in Fig. 1(c). And the black text with noise is shown in Fig. 4(a). To remove the noise, the size of each black block is computed. And then remove the small block whose size less than 0.2% size of input image (In the example, the size is 5 pixels). After this operation, a clear text image is acquired and showed in Fig. 4(b).

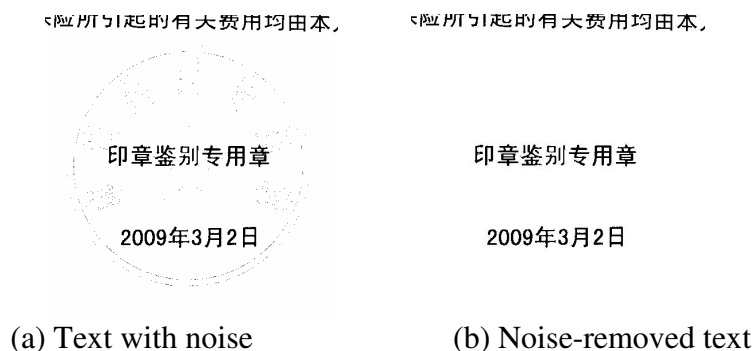


Fig. 4. Images of black text

Recover the losses of seal imprint strokes. Since the brightness and color vary in superimposition of text and seal imprint inks, the character strokes of seal imprint in superimposition may lose in segmented seal imprint. This may cause incorrect result in seal imprint verification. To avoid this, a method for detecting and recovering losses of seal imprint strokes is proposed in this section. Comparing the Fig. 1(c) and Fig. 4(b), we can see that the losses of seal imprint strokes basically take place in superimposition between the seal imprint and text.

Furthermore, the width of lost strokes is very close to the width of strokes corresponding text. Accordingly, we apply the following steps to recover the lost strokes of seal imprint.

I) Estimate the width of the strokes of black text;

II) Recover the lost strokes in seal imprint image in terms of the width of the strokes of black text.

To estimate the stroke width of black text, we scan each row of black text image (shown in Fig. 4(b)) to calculate the number of each continuous black pixels, and then construct the stroke histogram using all of the number of continuous black pixels. The position of maximum in histogram is considered as the stroke width of black text. For the image shown in Fig. 4(b), the histogram is displayed in Fig. 3. Evidently, the stroke width of black text is 4 pixels.

After getting the stroke width (saved it in variable W_{stroke}) of black text, we can recover the segmented seal imprint using the following procedures. Scan the black text image shown in Fig. 4(b). For each black pixel, detect its $W_{stroke} \times W_{stroke}$ neighbor pixels, if the pixels located at up and down position or left and right position of the black pixel are all red, the white pixel with the same position as the black text image in the seal imprint image is converted into black which is the color of seal imprint. After this process, the lost strokes of seal imprint are recovered. Fig. 1(d) displays the recovery outcome of the Fig. 1(c).

Seal Registration. Normally, the registration includes two steps: 1) Accord the orientation and size of candidate seal imprint with the reference one; 2) Overlap the candidate seal imprint and the reference one in terms of their centroid, and then match them pixel by pixel. Since exact adjustment on the orientation of candidate seal imprint is very difficult or even impossible, especially to circular seal, the precision of registration may be strongly affected by adjusted precision. We propose a novel moment-based approach to address the difficulty. The moment invariants are independent of translation, rotation and scaling, so the complicated adjustment in orientation and size can be avoided.

Table 1. Comparison of moment invariants for reference, genuine and forgery seal imprint

| Seal | Moment invariant | | | | | | | Distance |
|-----------|------------------|--------|---------|--------|---------|---------|---------|----------|
| Reference | -2.395 | -7.063 | -10.118 | -9.273 | -18.971 | -12.847 | -19.870 | 0 |
| Genuine | -2.411 | -7.050 | -10.092 | -9.250 | -18.924 | -12.813 | -19.852 | 0.0199 |
| Forgery | -2.430 | -7.236 | -10.050 | -9.411 | -19.149 | -13.048 | -19.972 | 0.0906 |

To minimize the effect of luminance, we transform all seal imprints into binary images with black background and white seal imprint. The difference among the seven moment invariants (saved in Φ_i) variable is tremendous (e.g. 0.00385 and $-1.14E-20$), which is impossible to directly comparison. Therefore, the seven moment invariants are transformed into corresponding new values using $\log_{10}(|\Phi_i|)$. The Seal registration is achieved by computing the seven moment invariants on all seal imprints and distance computed by Eq. 1) based on these invariants.

$$D = \sum_{i=1}^7 \left| \frac{\log_{10}(|C_i|) - \log_{10}(|R_i|)}{\log_{10}(|R_i|)} \right| \quad (1)$$

where C_i , R_i respectively present the seven moment invariants of candidate seal imprint and reference one. Table 1 displays the results of comparison between the reference seal imprint and genuine or forgery one. Although it is very difficulty to manually distinguish the reference seal imprint from the forgery one, the distance between the reference seal imprint and forgery one is evidently greater than the values between the reference seal imprint and genuine one. Consequently, the forgery seal imprint can be easily identified by the distance.

Experimental Results

To evaluate the performance of the proposed seal segmentation and identification algorithm, extensive experiments are conducted based on sample images. Twelve seals are used in the experiments (displayed in Fig. 5). Seals A to D are circular seals (Type 1), Seals E to H are rectangular seals (Type 2), and Seal I to L are elliptic seals (Type 3). Each type includes two genuine seals and two forgery seals. All seals are engraved by one maker, therefore the difference between the genuine seal and forgery one are very small. The experimental steps are describes as follows.

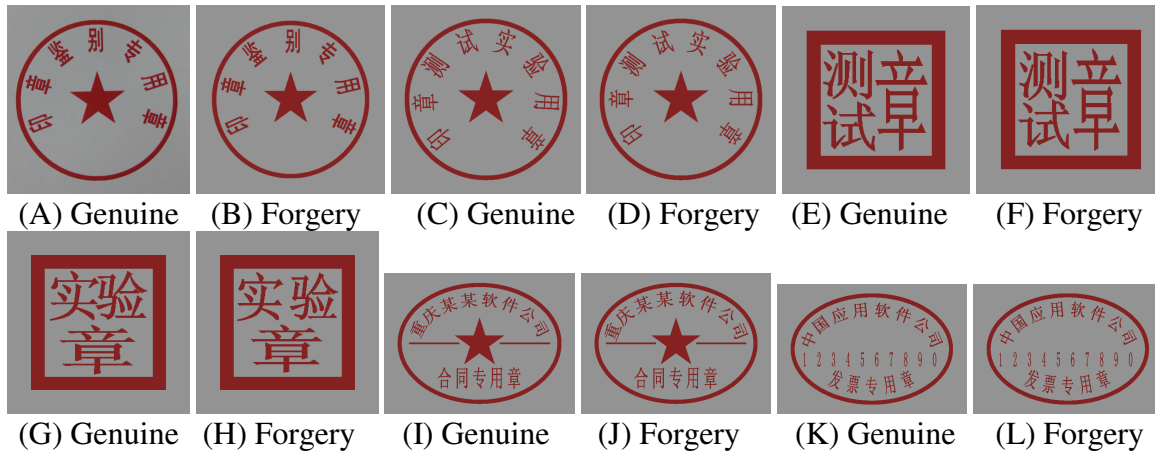


Fig. 5. Twelve seals for experiments

- I. Stamp each genuine seal on white paper, and convert it into a digital image by EPSON V30 SE scanner as a reference seal imprint. Then transform them into binary images and calculate the moment invariants on the binary images;
- II. Arbitrarily stamp each of twelve seals on five different documents. And then convert them into digital images by EPSON V30 SE scanner. Thus, sixty candidate seal imprints are applied to examine the proposed algorithm;
- III. Segment each seal imprint from input images with seal imprint and recover losses of seal imprint strokes. Then, transform them into binary images;
- IV. Calculate the moment invariants on each image from last step.
- V. Calculate the distance between the reference seal imprint and corresponding candidate seal imprints.
- VI. Make sure whether the candidate seal imprint is genuine or not in terms of the selected threshold.

Fig. 6 shows the results of recovered seal imprints segmented from the input image (only Seal A and B are displayed). Although the orientation of seal imprints are different from each other, which not affects the results of identification due to the moment invariants are independent to rotation. The experimental results are displayed in Table 2. From this table, we can see that the distance between genuine and reference seal imprints are all less than 0.03, and the distance between the reference and forgery seal imprints are all greater than 0.08. In real application, the errors to verify a forgery seal imprint as a genuine one is not acceptant. Therefore, in our experience, we select 0.04 as the threshold to verify whether the seal imprint is genuine or forgery.

Our Proposed approach has been implemented using Visual Basic .NET, and running on a PC (CPU P4 2.0G, RAM 1G). The processing time to segment and recover the seal imprint is about 0.9 second for 500*500 color image. And the processing speed for calculating the moment invariants is about 0.8 second. As a result, the whole computational time is less than 2 seconds.

Conclusion

In this paper, a new seal verification for chinese color seal is proposed. This method is composed of segmentation of seal imprint, recovery of losses of seal imprint strokes, and identification of seal imprint. The segmentation automatically extract seal imprint from the color input image in terms of the adaptive thresholds. To minimize the errors, the losses of seal imprint strokes are recovered by detecting the width of black text stroke and superimposition pixels between the red seal imprint strokes and the black text strokes. To avoid complicated adjustment on orientation and size between the reference seal imprint and candidate one, the moment-based technique is applied to seal imprint identification. Experimental results showed that the proposed method is able to correctly and efficiently verify the genuine and forgery seal imprint.

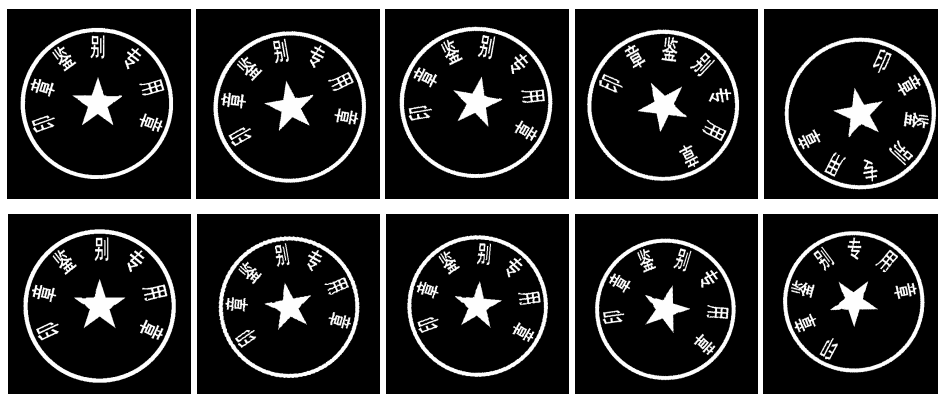


Fig. 6. Five seal imprints of A (row 1) and five seal imprints of B (row 2)

Table 2. Comparison of moment invariants for twelve seals

| Groups | Distance for genuine seals | | | | | Distance for forgery seals | | | | |
|---------|----------------------------|-------|-------|-------|-------|----------------------------|-------|-------|-------|-------|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| A and B | 0.021 | 0.019 | 0.018 | 0.022 | 0.017 | 0.101 | 0.102 | 0.102 | 0.100 | 0.100 |
| C and D | 0.017 | 0.030 | 0.029 | 0.031 | 0.021 | 1.011 | 1.012 | 1.015 | 1.020 | 1.011 |
| E and F | 0.032 | 0.017 | 0.013 | 0.020 | 0.009 | 0.087 | 0.091 | 0.090 | 0.091 | 0.092 |
| G and H | 0.007 | 0.007 | 0.012 | 0.019 | 0.016 | 0.116 | 0.117 | 0.116 | 0.116 | 0.114 |
| I and J | 0.018 | 0.028 | 0.020 | 0.019 | 0.031 | 0.100 | 0.100 | 0.089 | 0.090 | 0.091 |
| K and L | 0.022 | 0.022 | 0.019 | 0.018 | 0.022 | 0.101 | 0.091 | 0.099 | 0.101 | 0.088 |

References

- [1] J. J. Brault and R. Plamondon, Segmentation handwritten signatures at their perceptually important points, *IEEE Trans. Pattern. Ana. Mach. Intel*, vol. 15(1993), p. 953-957.
- [2] Yung-Sheng Chen, Approach to the Chinese Seal Registration, in *Advances in Communication Systems and Electrical Engineering*. vol. 4(2008), p. 529-542.
- [3] Ching-Liang Su, Edge distance and gray level extraction and orientation invariant transform for Chinese seal recognition, *Applied Mathematics and Computation*, vol. 193(2007), p. 325-334.
- [4] Aureli Soria-Frisch, Color Seal Extraction from Documents: Robustness through Soft Data Fusion, *EURASIP Journal on Applied Signal Processing*, vol. 2005:13(2005), p. 2146-2152.
- [5] Rafael C. Gonzalez and Richard E. Woods: *Digital Image Processing(Third Edition)*: (Prentice Hall, USA, 2007).
- [6] N. Otsu, Threshold Selection Method from Gray-Level Histograms, *IEEE Transactions on Systems Man and Cybernetics*, vol. 9(1979), p. 62-66.
- [7] Hu Ming-Kuei, Visual pattern recognition by moment invariants, *Information Theory, IRE Transactions*, vol. 8(1962), p. 179-187.