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Text Location and Extraction for Business Cards Using Stroke Width Estimation

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ABSTRACT

Text extraction and binarization are the important pre-processing steps for text recognition. The performance of text binarization strongly related to the accuracy of recognition stage. In our proposed method, the first stage based on line detection and shape feature analysis applied to locate the position of a business card and detect the shape from the complex environment. In the second stage, several local regions contained the possible text components are separated based on the projection histogram. In each local region, the pixels grouped into several connected components based on the connected component labeling and projection histogram. Then, classify each connect component into text region and reject the non-text region based on the feature information analysis such as size of connected component and stroke width estimation.

Keywords: *line detection, projection histogram, color segmentation, shape extraction, text detection, stroke width estimation.*

1. INTRODUCTION

For a long time, either table equipment such as the PC or handheld mobile devices such as smart phone, iPad, iTouch, the keyboard as the main and only input equipment making an important role between the users and IT devices. The manual input method let users spent lots of time on reading and writing the text information from the target object to the equipment. Moreover, Present day, the handheld mobile devices become more important for the daily life for the human being. Subject to the size of the mobile devices, the keyboard of the mobile devices is small that frequently leads to input mistakes. It wastes the time of the user demands the patience of the user.

Beside manual keyboard input, the research on image processing and pattern recognition area is applied to make the equipment can recognize the text information automatically. The text recognition is that based on the text localization and detection method to extract the text region from the printouts/images or books. Then, based on the binarization technique, extract the key feature of text component to recognize the text directly. The whole procedure just needs the user capture the target image.

Business Card Reader (BCR) is one of popular applications, involving the location of the business card position and the detection/recognition of the text information automatically. The key word of BCR application called “Text Information Analysis (TIA)”. The TIA contains two main parts that text detection and text binarization. The goal of text detection is that precise locate the region of text and remove the non-text region based on some criterion and algorithm. For text binarization, separate the text region as the foreground and the other area into background is the main demand. According to the recognition procedure, the accuracy of binarization directly affects the component feature detection and final recognition result. The capture quality of mobile camera is keeping on improving. Some degradations and color distortion still need to consider such as blur, low contrast, shadow and noise covering. Also that, perspective distortion will occurred when the user put the business card with different skew angle or the camera captured image with different skew angle. In this kind of cases, the image plane and the card are not parallel to each other. Because of the natural scene situation, shadow, uneven illumination and complex background is relate to accuracy of text information detection and binarization. Text information analysis is the efficient method to localize and detect the text component from the complex environment.

The text information contained several features that we can use them to estimate. Including, intensity information of text , edge information of text, color information of text, texture information of text, Connected-component information such as size, font, stroke width of text. There have been many proposed method based on these feature for text localization and detection in the past few years. In [2], one text extraction method using neural network on canny edges from name card images is proposed, the neural network combine with spatial and relative features like sizes color attributes and relative

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alignment features to identify the text area. But there are several small connected components such as eyes, small logo and non-text symbols are miss-classification as the text area. The same issue also appeared in the [1] with an adaptive but light weight binarization technique applied to identify the text area and gather the connected components using a block based on intensity value of gray-level image.[3] consider the issue of shadow and un-even illumination. A blocked adaptive binarization method is proposed to against with the shadow and un-even illumination issue. Also, the binarization method do not contained the non-text region removal concern. [23] deal with the challenge of limited resource in mobile device for business card reader. The proposed method improves computation speed and reduces memory requirement of the image-processing step by detecting the text areas in the downscaled image and analyzing each detected area in the original image.[8] focus on the issue of skew correction in business cards. The proposed method estimated the skew angle and corrected the skew by that angle and binarization thereafter for English-Chinese mixed script business card images. [24] ,[25]and [26] focus on the text recognition procedure that the text information already detected from the business card images. [27] present a system to automatically extract, rectify and enhance business card image.

As the current work which are already mentioned in the previous section, it is easy to figure out that the whole procedure of BCR application combined with three major stages:

(1). Card position localization
(2). Text region extraction
(3). Text recognition.

In this paper, the stages of (1) and (2) are the major concern of our proposed method. The stage (1) based on line detection and geometry feature analysis will be discussed in part A of session III . And, stage (2) will be discussed on part B of session III. The experimental results and evaluation of the proposed method are shown in session VI and the conclusion is given in session V.

2. SYSTEM OVERVIEW

The input images proposed in the paper based on the “The Stanford Mobile Visual Search dataset (SMVS)” [4]. Fig. 1 shows a comparison of SMVS dataset and other sample images from other current work.

Current work dataset	The SMVS dataset
	

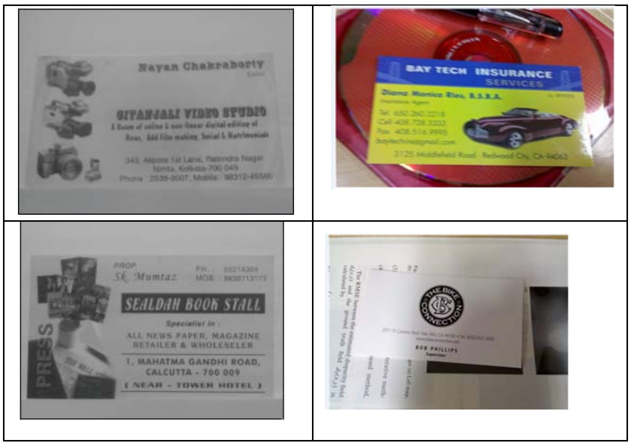


Fig. 1. Some examples of current work dataset and SMVS dataset for comparison.

According to the comparison, a major issue is easy to figure out that the environment in SMVS dataset is more complex and the card position with some kind of perspective projection caused by the different location of camera. To solve this issue, a card position localization procedure is applied based on line detection and card geometry feature analysis to locate and detect the shape of business cards.

Secondly, inside the business card, the text components contained different size, colors and font. Also, there are several non-text components such as logo, pictures or small symbols mixture in the text region. How to remove the non-text region is another big challenge also major contribution in our proposed method.

For the second challenge, a projection histogram method is used to segment the whole image into several local regions which are contained the possible text region. Then, the local binarization procedure is used to each local region. The connected component labeling is applied to group the possible text pixels into separated connected-components (CC’s). Finally, based on the analysis of possible text components features such as CC size, stroke width, ratio of height and width, a series of conservative but efficient criterion are generated to classify a component is text CC or not. The brief procedure of the proposed method is given in Fig. 2:

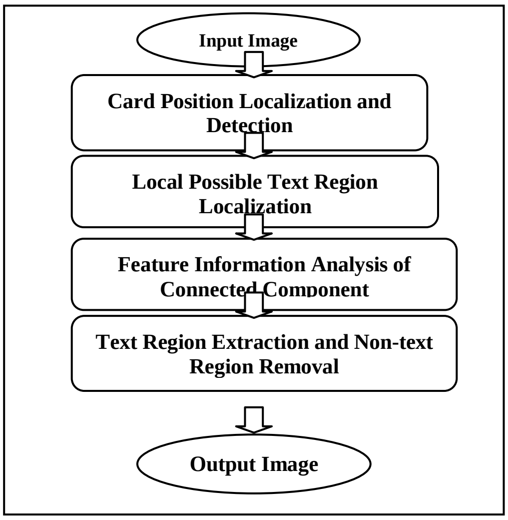


Fig. 2. Overall system flowchart for character segmentation.

3. PROPOSED METHOD

A. Localization of Card Position and Shape Extraction

To extract the location of the business cards, the geometry information of the cards is consider to gather some major features of the business cards. Firstly, the common size of a business card is width with 90mm * height with 45mm or almost. It means that the ratio of card width and height is 2:1. Secondly, in the ideal situation, the business card can abstractly represents by a rectangle shape.

According to the basic features of the rectangle, there are two features be used for the card position detection:

(1). There are two pairs of lines that parallel to each other denoted as $pair(L_{para\_i.1}, L_{para\_i.2})$. where, i=[1,2].

(2). The angle between each pair of adjacent lines is 90^o denoted as $pair(L_{perp\_i.1}, L_{perp\_i.1})$. where, i=[1,2].

The card position is consider to extract based on the geometry feature which are mentioned in the previous section. But in the scene situation, the shape of business card is distorted caused by the different position of camera. Some samples of different situations are shown in Fig. 3.

Fig. 3. Some samples of distorted situation.

According to this issue, the concept of ‘parallel’ and ‘perpendicular’ is re-defined and extended with a threshold T_{theta}. To practice, T_{theta} set as 25. Which that:

(1). For ‘parallel’: $|\theta_{para\_i.1} - \theta_{para\_i.2}| < T_{theta}$.

(2). For ‘perpendicular’: $|\theta_{perp\_i.1} - \theta_{perp\_i.2}| < T_{theta}$.

Where, θ_{para_i} and θ_{perp_i} are the angle between pair pair($L_{para\_i.1}, L_{para\_i.2}$) and pair($L_{perp\_i.1}, L_{perp\_i.2}$), respectively.

Also, the desired size of the business card is calculated as

$$\frac{Length(L_{para\_1.1} + L_{para\_1.2})}{Length(L_{para\_2.1} + L_{para\_2.2})} \approx \frac{1}{2} or \frac{2}{1}$$

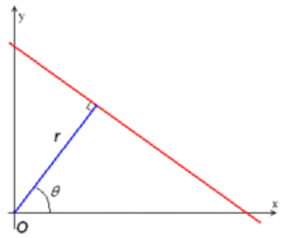
The card position is consider to extract based on the geometry feature which are mentioned in the previous section.

Next, the line detection procedure based on Hough transform applied to locate several candidates straight lines from the business card images. Generally, Hough transform is to transform an image from the Cartesian coordinates to Polar coordinates. [5] explain more details that any straight line *which is* $y = ax + b$ on the *xy coordinate plane* can be described in a new Polar coordinates as following:

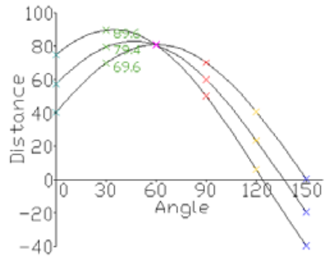
$$y = \left(-\frac{\cos\theta}{\sin\theta}\right)x + \left(\frac{r}{\sin\theta}\right)$$

Where, parameter r is the distance between the line and the origin O. Theta θis the angle of the vector from the origin to its corresponding point.

As being seen in the Fig. 4(a), a line in *x-y* coordinates is transformed to the Hough space in Fig. 4(b) based on the parameters (r, θ). The points which are lied on in the same red color line marked in Fig. 4(a) are matched in the same position in Fig. 4(b).



(a)



(b)

Fig. 4. (a) Straight line in x-y coordinates system; (b) Hough space based on parameter r and θ.

According to the major features of business card we described, there are four lines are detected as the final reference straight lines as shown in Fig.5.

Fig. 5. Line detection results and shape position localization results.

The proposed method successful detected the four reference straight lines from the sample images. But in this un-uniform situation, the desired reference lines can’t detect directly caused by losing some edge information of the card boundary. Fig. 6 shows one of the sample of the new issue. Caused by the low-contract between the foreground and background. A reference line in the vertical direction is lost marked as the green dashed rectangle.

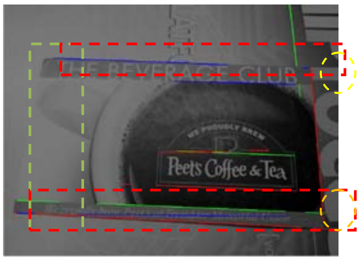


Fig. 6. The boundary lost in the left side.

To solve this issue, we try to predict the position of lost boundary based on the current information. Firstly, a pair of 'parallel' lines is located based on the current criterion which is marked as red dashed rectangle. Then, the adjacent angles between the pairs and single candidate line in the right side is calculated which is marked as yellow dashed circle and orange dashed circle. The adjacent angle in yellow circle bigger than 90 degree and the angle in orange circle smaller than 90 degree. Fig. 7 shows all the information we gather from the current situation. It is easy to figure out that the determined shape is a trapezoidal with upper-boundary a little shorter than the bottom boundary.

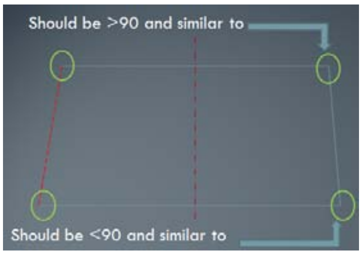


Fig. 7. Re-construction of desired shape based on current information

The desired boundary line will be located based on the feature analysis of the trapezoidal. The basic and key feature of a trapezoidal is that, the left side and right side of a trapezoidal is opposite to each other. It means that the two angles in the left side should be equal to the right side or almost. Based on this major feature, the prediction boundary line will be located at the position that the two adjacent angles equal to their corresponding angles in the right side. Fortunately, the degree of angles in the right side we already determined. The prediction procedure already briefly introduce in Fig. 8. Finally, based on the four reference boundary lines which are located in the previous section, a shape rectification method based on bilinear transformation applied to correct the distorted images. Some experimental results are shown in Fig. 9.

Fig. 8. The prediction boundary marked by the red dashed line.

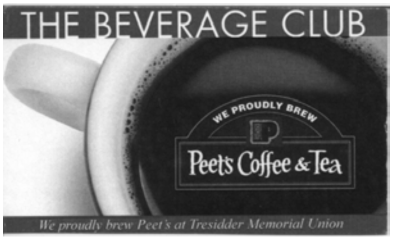


Fig. 9. Final shape detection result.

B. Text Region Extraction and Non-text Component removal

Fig. 10. (a)-(d) Various kind of text components; (e) A non-text connected-component.

Fig. 10(a)-(d) show various kind of text components such as Chinese, English, Korean and digit numbers. The most important difference between text component and non-text component is to analysis based on comparison of these text components in Fig.10(a)-(d) and the non-text component in Fig.10(e) .

The most important feature of the text component is that the stroke width in a the same text is uniform or almost. But the stroke width of non-text component such as a logo or a picture just like Fig.10 (e) are un-uniform.

The second most important feature of text defined as 'logical'. The meaning of 'logical' is that the ratio between width and height of a text component should be logical. Also, the size should be logical if the component belongs to a text component. Specially, in the business card, the text component lied on in the same line usually contained the same size. Based on the two major feature of a text component, the proposed method applied to estimate the stroke width and size of all the components in the business card to compare the relationship between each different components.

Fig. 11. Foreground contained different color information.

A big challenge of image binarization procedure is that the color information of each foreground component are not uniform and complex. In Fig. 11, the foreground components contained opposite color either white color or black color. To solve this kind of complex issue, a local binarization procedure is applied based on projection histogram and color segmentation.

First, the edge information is detected using a 'sobel' detector. Then, the whole image is separated into some local rectangle regions based on the projection histogram either in horizontal direction or in vertical direction. And, several local regions which are contained the possible text components are located and marked by green color and solid rectangle. The results are shown in Fig. 12.

Fig. 12. Local region localization based on projection histogram.

In each local possible text region, the color segmentation procedure based on mean-shift algorithm applied to segment each local region into several color clusters. Then, we need to determine which cluster or two clusters belongs to the foreground. A searching line is generated by passing through to detect some reference points of the possible text components. To practice, we use the searching line matched some reference points with the edge of boundary. A brief procedure is shown in Fig. 13.

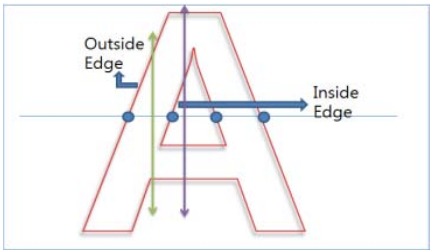


Fig. 13. Procedure of reference points searching.

For the example of English character 'A', four reference points are located already marked by solid circles. We choose some points which are located between each reference points and search in the vertical direction. A very conservative but efficient standard suffices to estimate this point belong to foreground or background as following:

(1). If match the edge boundary odd times just like the point lied on the green double arrow straight line. This point should belong to the foreground. It means that all the other pixels which are in the same cluster also belong to foreground.

(2). If match the edge boundary even tomes just like the point lied on the purple double arrow straight line. This point should belong to the background. It means that all the other pixels which are in the same cluster also belong to background.

Until now, all the clusters are classified to foreground and background based on the previous standard. The foreground components set as binary value '1' and background components set as binary value '0', respectively. The final binarization results of some local regions are shown in Fig. 14.

Fig. 14. final binarization results of some local regions.

Based on the binarization results for each local region, A pixels grouping procedure based on the connected components labeling algorithm and projection histogram in vertical direction is applied to group the pixels into several components. Generally, the connected components labeling works well for grouping the pixels into each component. But there are some kind of situation that some small corners of two components connect and adjacent to each other just like the corners marked as red circle in Fig. 15.

Fig. 15. Some connected and adjacent corner marked by red rectangles.

To solve this issue, the projection histogram algorithm based to locate the break gap of two components. As the projection histogram values in the vertical direction shown in Fig. 16, it is very easy to figure out that the red circle is the desired break location.

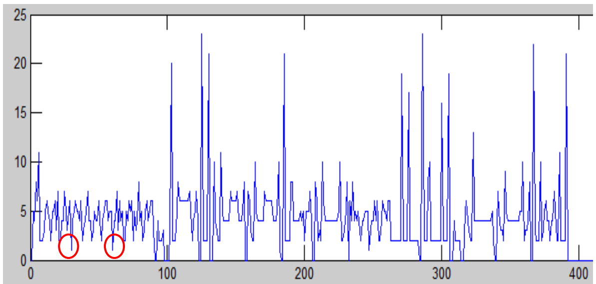


Fig. 16. The desired break location marked by red circle.

There are 17 CCs are generated based on the connected component labeling and projection histogram algorithm in the local region shown in Fig. 15.

The next step is to analysis the feature information such as size, ratio of width and weight of each CC, respectively. In Fig. 15, based on the size information of each CC, all the CCs separate to two groups with the '*Size 300*' and '*Size 25* '. '*Size 300*' group contained 15 CCs with mean size of 300, '*Size 25*' group contained 2 CCs with mean size of 25. Moreover, considered the whole size of our input image, if one component with size too small such as 25, it should be classify as non-text CC directly. For the 15 CCs with size of 300, until now tend to classify as text CCs. More information need to consider to determine the 15 CCs are text CC or non-text CC exactly.

Next, a stroke width estimation procedure is applied to analysis the stroke width information of each CC of the 15 possible text CCs. Fig. 17(a) shows a typical stroke of a text component, after edge detection procedure, the stroke with double side of edges. In one side of the edge, a pixel named 'p' selected as the seed point to calculate the gradient first. Following the direction of gradient in pixel 'p', another pixel named 'q' lies on the other side of edge to be search. The distance D_{p2q} from 'p' to 'q' is calculated. Then, the gradient of searched pixel 'q' is considers, if the gradient direction of 'q' is roughly opposite to 'p' and the distance D_{q2p} is equal to D_{p2q}. It means that 'p' and 'q' are lies on the same stroke. The procedure is shown in Fig. 17 (b) and (c), respectively. But the distance between 'p' and 'q' are not guaranteed as the stroke width yet.

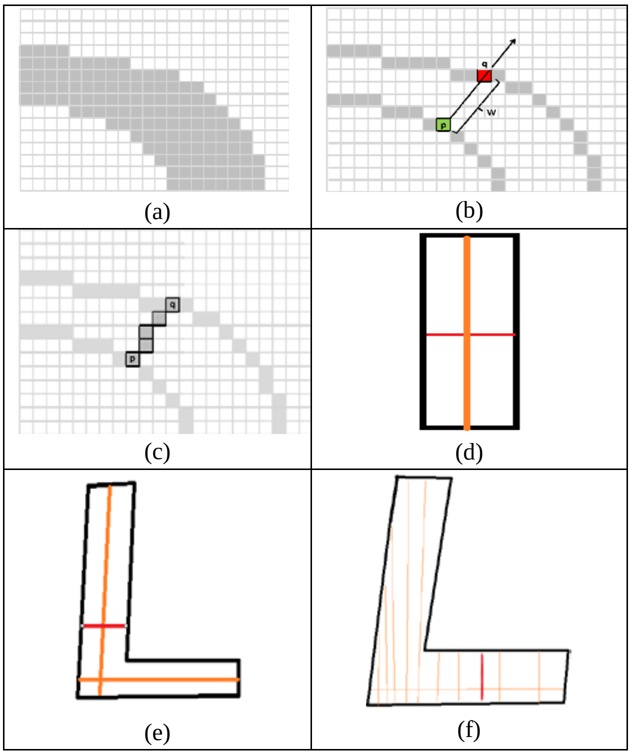


Fig. 17. (a) a typical stroke; (b) following gradient direction, searching the corresponding pixel (c) the stroke width after estimation.

Simply, the text component classified as 'circle', 'giant', and extended transformed style or combination of 'giant'. Fig. 17(d) and (e) show some situations of two pixel lies on the same stroke but the distance between two pixels are not the stroke width. Even through, confirmed that there are two pixels lies on the same stroke still provided enough information to estimate the exactly stroke width. Suppose that the distance between 'p' and 'q' are not the stroke width, select one point lies on this distance. Then, search to the perpendicular direction of D_{p2q}. In both up and down direction, another two edge pixels should be match. Calculate the distance between the two new matched points. Loop this procedure until all the points lies on D_{p2q} is considered. If there is one distance D_{new} is smaller than D_{p2q}. D_{new} will be the exactly stroke width. Otherwise, D_{p2q} itself is the stroke width yet. The procedure is shown in Fig. 17(f).

One key issue need to mention that the possible stroke width need to be calculate for couple of times and in different position of each CC. Fig. 17(f) shows the procedure of exactly stroke width estimation.

Then, the mean variance of stroke width for each CC are calculated as following:

(1) Compute all the stroke width for the whole CCs, respectively.

(2) Compute a mean value of all stroke widths for each CC.

(3) Compute the variance of stroke width for each CC based on the mean value.

(4) Compute a mean variance of all the stroke width for each CC.

Table 1 shows all the 15 mean variance values for each CC. From this table, one key information can be easily to figure out that for each single CC, the stroke width is almost uniform compare with different position.

Table 1. Mean variance of all the stroke width for each CC.

2.3	**2.1**	**1.8**	**1.9**	**2.3**
2.4	**2.4**	**1.8**	**1.8**	**2.6**
2.7	**2.1**	**2.7**	**2.6**	**2.4**

Based on Table 1, the mean variance stroke width of all 15 CCs are computed compare to each other as shown in Table 2. Another key information generated based on Table 2 is that in the same local region, the stroke width is almost uniform to each other.

Table 2 . Mean variance of all the stroke width compare with each other.

4.3	**5.0**	**4.9**	**5.2**	**4.9**
4.8	**4.7**	**5.1**	**5.3**	**5.3**
4.8	**4.7**	**4.6**	**4.7**	**5.2**

Finally, there are three feature information are estimated that:

(1) Uniform and logical size for the 15 CCs.
(2) Uniform stroke width for each CC.
(3) Uniform stroke width between each other.

Fig. 18. Another possible text region.

Based on these three feature information, the 15 CCs can be classify as the text CCs.

Fig. 18 shows another local region contained possible text CC. Similarly, the size of this CC and mean variance of stroke width are estimated. Table 3 shows the size and stroke information of Fig. 18 compare with the information of Fig. 15.

Table 3. Size and Mean variance compare with Fig. 17 and Fig. 19.

	Size	Mean variance
Fig. 18	24435	300
Fig. 15	625.4	2.2

It is very easy to figure out that the CC in Fig. 18 contained un-logical size and un-uniform stroke width compare with the text CCs which are already determined. According to this, the CC in Fig. 18 should be classified as non-text region.

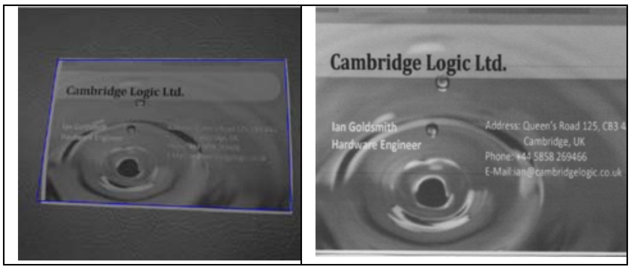
Based on the analysis and estimation procedure in the above sections, there are three final decision are generated as the classify standard to determine a component is text or not. The standard one is shown as follows:

(1) Reject the component which the variance of the stroke width is too big.
(2) Reject the component whose size is too big or too small.
(3) Reject the component with the reasonable stroke width but the ratio of height and width is not logical.

Fig. 19 shows the final text region extraction results of Fig. 11.

Fig.19 . Final results of text region extraction.

4. EXPERIMENTAL RESULTS



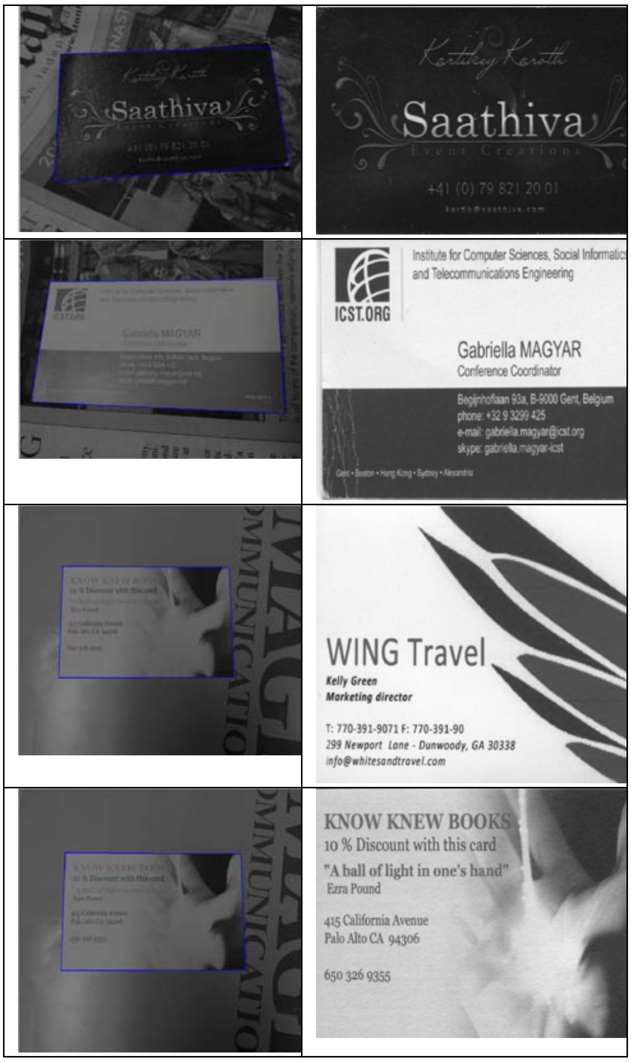


Fig. 20. Some results of card position localization of business cards.

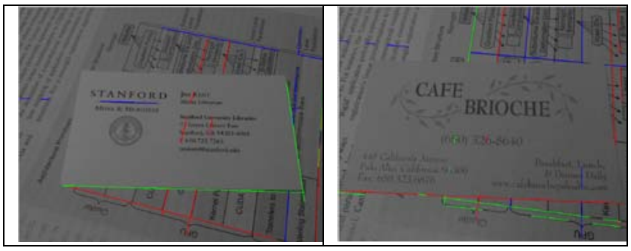


Fig. 21. Some failure results of card position localization of business cards.

Fig. 20 shows the results on the business card localization with some failure cases in Fig. 21. In the failure cases, the intensity information of environment contained too low contrast compare to the foreground. More than two boundary lines are lost that the geometry feature algorithm is not offered to works well in this kind of situation. Fig. 22 shows text detection results. Table 4 shows the accuracy rate of the card position localization procedure.

Table 4. Accuracy rate of the card position localization procedure.

Amounts of dataset	Amounts of accuracy results	Accuracy rate
100	91	91%

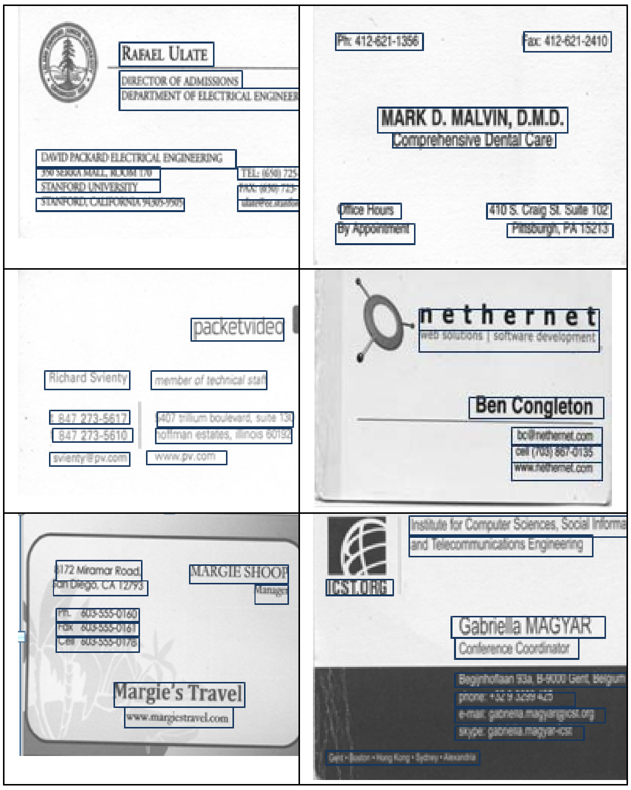


Fig. 22. Some experimental results of text extraction of business cards.

Fig. 23. Some partial correct experimental results of text extraction of business cards.

In Fig. 23, there are two kinds of miss-classification issues remained. The first situation marked by red dashed rectangle is that the text region contained with WordArt style. Each connected components connect to each other lead to the size estimation results far from the other text components. The second situation marked by yellow dashed rectangle is that caused by extremely terrible reflection, all the information of this limited region such as colour and edge are lost. The feature analysis and estimation procedure can be works without these kinds of major feature information.

Table 5 shows the accuracy rate of the text extraction procedure.

Table 5. Accuracy rate of the card position localization procedure.

Amounts of local regions	Amounts of accuracy results	Accuracy rate
723	672	92.95%

5. CONCLUSIONS

In this paper, the card position localization procedure based on straight line detection and card geometry feature analysis is applied to extract the exactly shape of the business card. Then, the card separated into several local regions based on the projection histogram. In each local region, all the pixels are grouped into several connected components based on the connected-component labeling and projection histogram. The feature information of each CC in each local region is analyzed and estimated to determine if each CC is a text component or not.

The contribution of the paper is on the presentation of detecting card boundary from arbitrary images and the usage of text stroke analysis.

According to experimental results, the proposed method is efficient and stable for the assumed situations. Also, there are some issues remained as mentioned in experimental results session. These issues will be our major concern in the future research.

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