Color Segmentation for Extracting Symbols and Characters of Road Sign Images

by Aryuanto Soetedjo

Submission date: 04-Mar-2019 10:53PM (UTC-0800)
Submission ID: 1087976063
File name: 4.doc (633.5K)
Word count: 1954
Character count: 10593

Color Segmentation for Extracting Symbols and Characters of Road Sign Images

Aryuanto[1], Koichi Yamada[2], F. Yudi Limpraptono[1]
[1]*Department of Electrical Engineering, Institut Teknologi Nasional (ITN) Malang, Indonesia*
[2]*Department of Management Information Systems Science, Nagaoka University of Technology, Japan*
Email: aryuanto@gmail.com, yamada@kjs.nagaokaut.ac.jp, fyudil@yahoo.com

***Abstract*—This paper presents a color segmentation technique based on the normalized RGB chromaticity diagram for extracting symbols and characters of road sign images. The method separates blue color of the sign's background by utilizing the developed histogram on the RGB chromaticity diagram for selecting threshold automatically. The morphology operators are used to extract symbols and characters. From the experiments using real scene images with varying illumination, the proposed method could extract symbols and characters of road sign images properly.**

***Index Terms*—Color segmentation, RGB chromaticity diagram, objects extraction, guidance sign.**

I. INTRODUCTION

TRAFFIC signs are used to provide useful information to the drivers. In the driver assistance system, an automatic signs detection and recognition becomes an important aspect. Since colors are more useful information for the human perception, traffic signs are usually painted with colors contrast against the road environments. However, color information is sensitive to the lighting changes which occur frequently in the real scene. Therefore a robust algorithm is required to handle such problems.

There are many types of traffic signs, such as: a) regulatory signs (speed limit signs, no entry sign, etc); b) indication signs (pedestrian crossing sign, parking sign, etc); (c) warning sign (cross road sign, road work sign, etc); (d) guidance sign (destination and route information sign). Each type is characterized by the shape, color, and symbol or character contained on it. The interpretation of information contained in the regulatory, indication, and warning signs could be obtained by matching or classifying the sign to the reference signs. However, the scheme for the guidance signs is more difficult, because of the irregular symbols and the variation of characters. Thus it needs to extract the symbols and characters first before further process to interpret them.

Researches on extracting symbols and characters of the guidance signs were proposed in [1],[2]. In [1] they extracted characters (Japanese kanji and alphabets) and symbols (indicating road structure) by edge segmentation. To overcome the problem of illumination changes, they transformed the intensity image based on the intensity histogram of the image. The positions or regions of the characters are found by the histogram projection technique. Since symbols usually form a larger region, they use size information for separating symbols from characters. The similar approach was employed in [2] to extract Korean characters and symbols.

An edge-base detection method that integrates edge detection, adaptive searching, color analysis, and affine rectification was employed in [3] to detect text of the road sign. The method is divided into three stages, i.e. coarse detection of candidate text, color properties analysis, and geometry and alignment analysis. In the first coarse detection stage, a multi-scale Laplacian of Gaussian (LoG) edge detector was used to obtain an edge set for each candidate text area. Gaussian Mixture Model (GMM) is used to characterize color distribution of the foreground and background of road signs, more specifically, for each of the letters on the road signs. The text alignment is used to align characters, so that letters belong to the same context will be grouped together. The intrinsic features (font style, color, etc.) and the extrinsic features (letter size, text orientation, etc.) are used for text alignment.

In [4], a robust connected-component-based character locating was proposed to find characters in scene image from digital camera. First, color clustering technique based on the normalized RGB color space is used to separate the color image into homogeneous color layers. Then every connected component in color layers is analyzed, and the component-bounding box is computed. Then an aligning-and-merger analysis is proposed to locate all the potential characters. Finally, all potential characters will be identified by heuristic rules.

Another work for extracting characters in natural images was proposed by [5] to help visually impaired persons and blind persons recognize signs. They proposed an extraction method based on the Otsu's thresholding that is applied in all three-color channels. To filter out the false detections, they used selection rules based on the relative placement of connected-components.

Although color is sensitive to illumination changes, but since color contains more meaningful information, many researchers discussed above prefer to use the color segmentation as the initial process for extracting symbols and signs.

In general, existing color segmentation methods could be classified into histogram-based method, boundary-based method, region-based method, and Artificial Intelligent (AI)-based method.

The histogram-based method basically fuses the thresholds obtained from the histogram of each color channel [6]. In the boundary-based method, edge detection is first performed to each color channel separately to find the boundary of objects. Then the resulted edges are merged to obtain the final edge image. The region-based method groups the pixels according to the homogeneity criteria. Examples of this method are region growing, split and merge algorithms [7]. AI-based method performs color segmentation by utilizing Artificial Neural Networks [8],[9], Fuzzy Logic [10], Genetic Algorithm (GA) [11].

In this paper, we propose a method to extract symbols and characters of road sign images based on the normalized RGB chromaticity diagram. The method is simple and effective for extracting particular colors usually used in the sign images. Furthermore the morphology operators are employed to extract symbols and characters of the sign images.

The organization of the paper is as follows. In section 2, the proposed method is presented. The experimental results and discussion are presented in section 3. Conclusion is described in section 4.

II. Proposed Method

A. Color Segmentation

In our previous works [12] [13], we proposed color segmentation based on the normalized RGB chromaticity diagram for detecting red color sign [12] and detecting human skin color [13]. Here we extend the approach to blue color thresholding for extracting symbols and characters of the guidance signs.

The normalized RGB chromaticity diagram is depicted in Fig. 1, where the chromaticity coordinates are r and g defined by

$$r = \frac{R}{R+G+B} \qquad (1)$$

$$g = \frac{G}{R+G+B} \qquad (2)$$

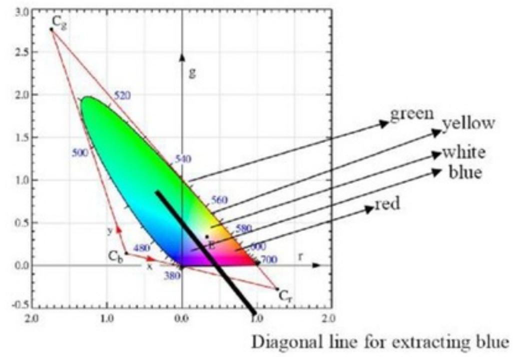


Fig. 1. Normalized RGB chromaticty diagram

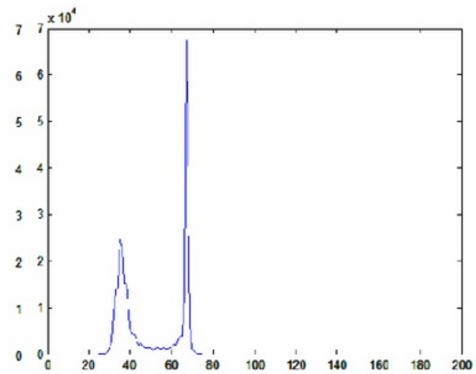


Fig. 2. *g_neg* histogram.

The diagonal line for extracting blue color is shown in the figure. This line is determined by the following equation

$$g = -r + TB \qquad (3)$$

where TB is the intersection of the line with g-coordinate. TB is calculated automatically by analyzing the peaks/valleys of the newly developed histogram called g_neg histogram [13]. The g_neg histogram is created by counting pixels with the value obtained by adding g value and r value (g + r). The effectiveness of the histogram is that it shows prominent peaks/valleys for easy threshold calculation. Thus by employing histogram peaks/valleys analysis, we may find the appropriate diagonal line for separating blue color. Fig. 2 shows the g_neg histogram with the prominent peaks, where the valley of histogram that determines the value of TB might be obtained easily.

From Fig. 1, it is clear that the blue color could be extracted by the following rule:

$$\text{If} \quad g + r < TB \quad \text{then} \quad \text{pixel is BLUE} \qquad (4)$$

B. Extraction of Symbols and Characters

The guidance sign used in the research contains three kind of information, i.e. characters (Japanese Kanji and/or Alphabet) indicating the city name or location; symbols indicating the road structure, and number indicating the route as illustrated in Fig. 3.

Fig. 3. *Guidance sign.*

As shown in Fig. 3, the symbols and characters are painted with white color in the blue background. Thus by employing the blue color segmentation as discussed above, we may separate the foreground (symbols and characters) from the background. The next step is to extract three kinds of objects (symbols of road structure, route number, and city name/location.

By observing Fig.3, the area of blue color of background inside the "small box" of route number is the largest one among the others, i.e. the ones inside the numbers or characters (Kanji and Alphabet). Thus, we may use the size information to find the region containing the route.

If we perform the connected component analysis to the extracted symbols and characters, i.e. the white color, we could find that the area of the symbols indicating road structure is the largest one. Thus we may use this restriction to extract the symbols. Finally, the remaining objects after the above two rules employed will be the characters.

III. Experimental Results and Discussions

To verify our proposed method, we tested our algorithm using real scene sign images taken from a camera. The algorithm is implemented using MATLAB running on a Personal Computer (PC).

Fig. 4(a) shows the result of applying color segmentation of image in Fig. 3 using our proposed method as defined by Eq. (4). The histogram shown in Fig. 2 is the g_neg histogram of image in Fig. 3. Hence the threshold TB is obtained automatically by peaks/valleys analysis, i.e. 0.51. The method is able to separate blue color of the background from the foreground properly.

Fig. 4(b) shows the extracted boundary of route numbers, where all five boundary regions of the route numbers could be extracted from image successfully. The result of symbols extraction is shown in Fig. 4(c), where three arrows indicating route are extracted. Fig. 4(d) shows the extracted characters consist of Japanese Kanji and Alphabet.

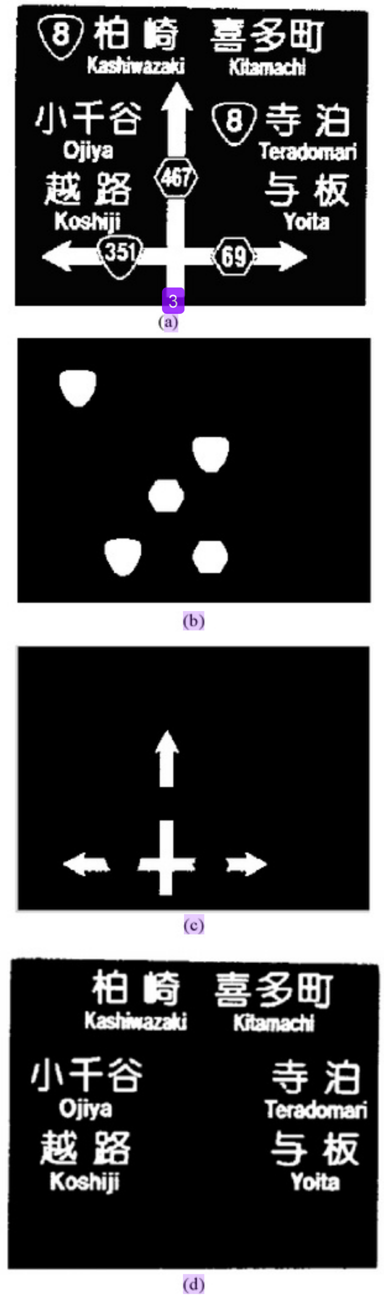


Fig. 4. (a) Extracted symbols and characters; (b) Extracted boundary of route number; (c) Extracted symbol of road structure; (d) Extracted Japanese Kanji and Alphabet.

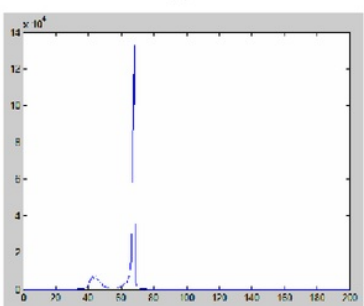
Fig. 5(a) shows the different image with the different illumination condition. The g_neg histogram of the image is shown in Fig. 5(b), where the value of obtained TB (TB=0.55) differs from the one in Fig. 2 as indicated by the different location of the valley. The symbols and characters are extracted properly as shown in Figs. 5(c), (d), (e), (f).

Compared to the existing method proposed in [1], our color segmentation method has two advantages: a) It could extract symbols and characters directly from the image without locating the road sign first; b) It could extract route number, while in [1], they do not extract the route number, but extract them as symbols together with the arrow indicating road structure.

The first advantage of our method is cleary shown from Fig. 5. If we apply the method in [1] to the Fig. 5(a), it yields a wrong result as shown in Fig. 6, since the algorithm in [1] requires that image should be contained only two colors (background and foreground). Therefore, method in [1] needs to locate road sign first before extracting the symbols and characters.

The second advantage of our method could be shown in Fig. 4(b) and Fig. 5(d). Hence all route numbers, inside and outside the arrows are extracted. In contrast, since method in [1] do not extract the route number, but extract them together with the arrow instead, then the route numbers outside the arrows will be considered as characters.

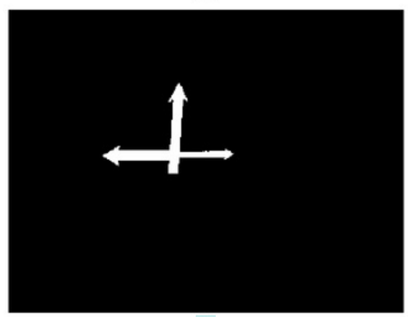
(a)



(b)

(c)


(d)


(e)

(f)

Fig. 5. (a) Original image; (b) g_neg histogram; (c) Extracted symbols and characters; (d) Extracted boundary of route number; (e) Extracted symbol of road structure; (d) Extracted Japanese characters.

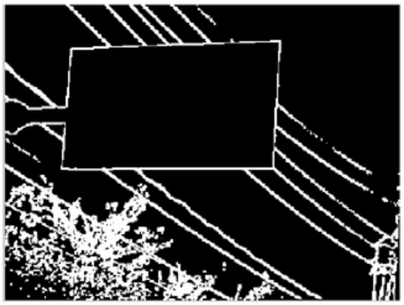


Fig. 6. Extraction of Fig. 5(a) using method in [1].

IV. Conclusion

In this paper, a color segmentation technique for extracting symbols and characters of road sign image is presented. The proposed method is based on the normalized RGB chromaticity diagram. From several experiments conducted, the proposed method shows a good result in extraction the symbols and characters.

In future, we will extend the work to perform the recognition process for recognizing or interpreting extracted symbols and characters. Further, the real implementation will be developed.

Color Segmentation for Extracting Symbols and Characters of Road Sign Images

ORIGINALITY REPORT

13%	%	13%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Jie Yang. "Incremental detection of text on road signs from video with application to a driving assistant system", Proceedings of the 12th annual ACM international conference on Multimedia - MULTIMEDIA 04 MULTIMEDIA 04, 2004 Publication	5%
2	Kongqiao Wang, Jari A. Kangas. "Character location in scene images from digital camera", Pattern Recognition, 2003 Publication	2%
3	"Computer Analysis of Images and Patterns", Springer Nature America, Inc, 2005 Publication	2%
4	"Advances in Multimedia Information Processing – PCM 2013", Springer Nature America, Inc, 2013 Publication	1%
5	Y. Shirai. "An active vision system for real-time	1%

traffic sign recognition", ITSC2000 2000 IEEE Intelligent Transportation Systems Proceedings (Cat No 00TH8493) ITSC-00, 2000
Publication

6 Honggang Zhang, Kaili Zhao, Yi-Zhe Song, Jun Guo. "Text extraction from natural scene image: A survey", Neurocomputing, 2013 — 1%
Publication

7 X. Shi, R. Manduchi. "Invariant operators, small samples, and the bias-variance dilemma", Proceedings of the 2004 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 2004. CVPR 2004., 2004 — 1%
Publication

8 Youn, Junhee, and Kyusoo Chong. "Automatic Extraction of Route Information from Road Sign Imagery", Journal of the Korean Society of Surveying Geodesy Photogrammetry and Cartography, 2015. — <1%
Publication

9 Patel, S., and K.S. Patnaik. "Analysis of Clustering Algorithms for MR Image Segmentation using IQI", Procedia Technology, 2012. — <1%
Publication

10 Hsuan T. Chang, Chang-Sian Chen, Chun-Wen Hung, Day-Fann Shen. "Frequency Domain — <1%

Analysis of Human Motions in Surveillance Video", 2010 International Conference on Broadband, Wireless Computing, Communication and Applications, 2010
Publication