A New Color Segmentation Method Based on Normalized RGB Chromaticity Diagram

by F. Yudi Limpraptono

A New Color Segmentation Method Based on Normalized RGB Chromaticity Diagram

Aryuanto [1)] **Komang Somawirata** [2)] **F. Yudi Limpraptono** [3)]
Department of Electrical Engineering, Faculty of Industrial Technology ITN Malang, Indonesia.
1) Email: aryuanto@fti.itn.ac.id

Abstract - *This paper presents the new color segmentation method based on normalized RGB chromaticity diagram by utilizing the line in the chromaticity diagram to separate colors. Parameter of the line is obtained automatically using the peak and valley analysis of the newly developed histograms. The method is simple, fast, and effective to overcome the problem of illumination changes. The method shows the promising results for color segmentation of the outdoor sign images.*

Keywords: *color segmentation, normalized RGB, chromaticity diagram, sign recognition.*

1. INTRODUCTION

Image segmentation plays an important role in the computer vision fields. It is usually used as the preliminary process for high level image processing. It extracts the meaningful object or object of interest from a whole image. Basically, image segmentation is to partition an image into non-overlapping regions [1]. A region is a homogenous group of connected pixels having a particular property, such as color, gray level, texture, motion, etc. In the color images, color segmentation is very popular method, since color is more meaningful property to the human perception. Hence, the task of color segmentation is to separate objects according to the colors.

Once objects are separated by color segmentation, further process such as object recognition could be performed to extract the meaningful information from the image. Many applications employ the color segmentation for understanding an image, such as for interactive robot [2,3,4], video retrieval [5], road sign recognition [6,7,8].

In outdoor environments, the illumination changes could not be controlled, hence color segmentation should be robust to this problem. Furthermore, the algorithm shoud be fast enough for real-time implementation. Due to the facts, color segmentation still becomes a challenging topic and offers the open area for improvement.

The existing color segmentation methods could be classified into several approaches : histogram-based method, boundary-based method, region-based method, Neural network-based method, Fuzzy-based method, and Genetic Algorithm (GA)-based method.

Histogram-based method is commonly used for monochrome image segmentation. Since color images are usually represented by three dimensional (3D) of RGB colors, the histogram-based color segmentation basically fuses the three thresholds obtained from each color channel. In [5], they employed a gray-level thresholding method in each of the color Red (R), Green (G), Blue (B), then used the generated threshold values as a base to produce a set of desired multiple threshold values for video image segmentation by means of an unsupervised clustering process.

In the boundary-based method, an edge detector is employed to find the boundary of an object. This method works by the fact that the the pixel intenstity values will change rapidly at the boundary of two regions. For color segmentation, at first edge detection is performed to each color channel R,G,B separately. Then the resulted edges are merged to obtain the final edge image.

In the region-based method, pixels are grouped according to the homogenity criteria. The region growing, and split and merge algorithms are the examples of the region-based method. In the region growing algorithm, pixels or subregions are grouped into larger regions based on predefined criteria [9]. The algorithm starts with a set of seed points and then grows regions by appending to each seed those neighboring pixels that have similar properties to the seed, such as gray level or color. On the contrary, the split and merge algorithm subdivide an image initially into a set of arbitrary, disjointed regions and then merge and/or split the regions in attemp to satisfy the predefined criteria [1]. These techniques have two main drawbacks [1]: They are both strongly dependent on global predefined criteria; while the region growing technique depends also on initial segments, which is the first pixel/segment to be scanned, and the order of the process.

The Artificial neural network that implements self-organizing map (SOM) is used for color segmentation as proposed by [10]. They use normalized RGB chromaticity as the data source of the neural network. During learning phase, sample points are taken from the image and submitted to the network. When the feature map has been formed, the main chromaticities present in the image are clustered. Then, each pixel is classified according to the identified class. The number of classes is a priory unknown and the SOM is used to determine the main classes.

In [11], the multilayer perceptron (MLP) network is adopted for adaptive color image segmentation. They use multisigmoid activation function for segmentation. The number of steps i.e. thresholds in the multisigmoid function are dependant on the number of clusters in the image, which are found automatically from the first order derivative of histograms of saturation and intensity in the HSV color space.

Fuzzy logic model that follow the human intuition for color classification is proposed in [12]. In this approach, fuzzy sets are defined on the H, S, and V components of the HSV color space and divides the color space into segments based on linguistic terms. The fuzzy rules are defined based on human observation to classify the color produced by the tree components of the HSV color space.

Genetic Algorithm (GA) is adopted in [13] to optimise the color segmentation. The process evolves in a sequence of steps, where at each step a GA optimises the previous segmentation results until a satisfactory segmentation is achieved. The GA starts from an initial random population of N individuals, then it performed N segmentations of the image according to the parameters of each individual. Then a fitness is evaluated for each resulting image, and the GA cycles, i.e. genetic operators (selection, crossover, mutation) are applied on the processing parameters of these individuals until the fitness does not exceed a given threshold or a maximum number of iterations is reached.

This paper presents a new technique for color segmentation based on normalized RGB chromaticity diagram. The proposed method is intended to segment the particulars colors usually used in the outdoor sign images, such as road traffic signs (traffic signs, information signs, guidance signs). Road signs are usually painted with colors contrast against enviroments, i.e. blue, yellow, red, green, and white colors, in order to attract and make it easy to be seen by people on the road. By considering these particular colors, our algorithm extracts the information contained in the sign effectively, even when the sign image is under the problem of illumination changes.

The paper is organized as follows. In section 2, the proposed method is presented. The experimental results are presented in section 3. Finally, conclusion is described in section 4.

2. PROPOSED METHOD

2.1. Existing color segmentation methods for extracting road sign images

A guidance sign as illustrated in Fig. 1 is used to give traffic information to the users (drivers or pedestrian). Since they are installed in outdoor environments, they appear with shape and color contrast against environments. In Fig. 1, a guidance sign is characterized by its rectangular shape and blue color with white characters and symbols. Since color contains useful information, many researchers [6,7,8] prefer to use color segmentation to extract the symbols and character from the sign images. The vision systems to recognize the traffic signs from the camera automatically is primary used in the driver assistance systems, a system to assist the human driver when driving on the road to provide safety and comfortable driving. In some cases, a similar system is useful to help the blind people recognize such signs installed on the road.

Fig. 1: A guidance sign.

In [6], a blue color segmentation using LUV (L is luminance, U and V are chrominance components) color space is taken to extract the blue color from an image and then finds the edge of rectangular shape to identify the guidance sign. To overcome the problem of illumination changes, they employ a multiple-thresholds approach. The thresholds are determined by analyzing the actual distribution of data in the LUV color space taken in various weather and lightning conditions.

After blue color segmentation, candidates are screened using shape information. In [6], four boundary line segments are detected using a histogram projection technique. The detected sign (guidance sign) consists of two colors (blue and white), results in two clusters having the highest value in the intensity histogram. Then, characters and symbols are extracted by transformation of intensity histogram using the following equation :

 ISSN 2085 – 9732

$$I_{new} = \begin{cases} 255\dfrac{I_{org} - I_{min}}{I_{max} - I_{min}} & if \quad I_{min} \le I_{org} \le I_{max} \\ 0, & otherwise \end{cases} \quad (1)$$

where I_{min} and I_{max} are the minimum and maximum intensity of the cluster in the histogram, respectively. I_{org} is intensity of the original image and I_{new} is the intensity of transformed image. Using this intensity transformation, characters and symbols could be extracted fairly stably using one threshold in various lightning conditions [6]. This similar approach is also employed in [7].

In [8], to localize road sign (road sign that contains text) from an image, *H* component of HSI color space is used for color modeling and *k*-mean algorithm is applied for clustering. Using this method, all red points (pixels) are in one cluster, the same for blue, green and yellow ones. Then, for extracting texts in the sign, color modeling of background and foreground (text) of detected road sign is applied.

2.2. Proposed color segmentation method for extracting road sign images

The multiple-thresholds proposed in [6] requires many times thresholding processes. It might not be the efficient method in the memory space and computation time. Since *k*-mean algorithm is an iterative method, the color clustering technique used in [8] consumes much time. Moreover, HSI color space used in [8] requires additional computation time for conversion from RGB color, which is commonly used in the computer system.

Here, we propose the color segmentation based on the normalized RGB chromaticity diagram using "a diagonal line" . Fig. 2 illustrates chromaticity diagram of the normalized RGB color space. In the figure, a diagonal line for extracting the blue color is shown. The chromaticity coordinates of the diagram are *g* and *r* defined by

$$r = \frac{R}{R+G+B} \quad (2)$$

$$g = \frac{G}{R+G+B} \quad (3)$$

Then to extract blue color, the following rule is employed :

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

where *TB* is a blue color threshold.

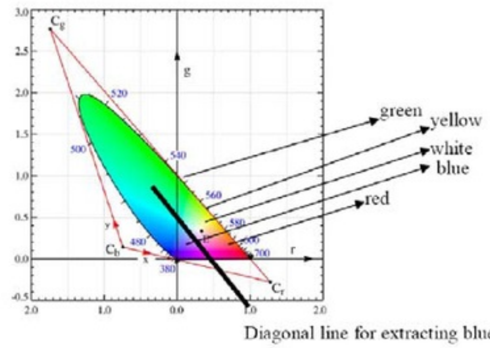


Fig. 2: Blue color segmentation.

The threshold *TB* is obtained automatically by analyzing the peak and valley of the "new developed histogram". The developed histogram is developed by representing the value of $g + r$ (adding *g* and *r* values) as "interval" and counting pixels for each interval. Using the method, the color segmentation could be computed fast, while the problems of illumination change could be overcome (minimized), due to the fact that the normalized RGB color space is more robust to the illumination changes.

To extract the green and red colors, similar methods to the blue color might be employed. While to extract yellow color, two lines are needed.

Furthermore, our method extracts white color by utilizing "a circle" on the normalized RGB chromaticity diagram. The rule for extracting white color is expressed as

$$If \quad (r - 0.33)^2 + (g - 0.33)^2 \le TW \quad then\ pixel\ is\ WHITE \quad (5)$$

where *TW* is a white color threshold.

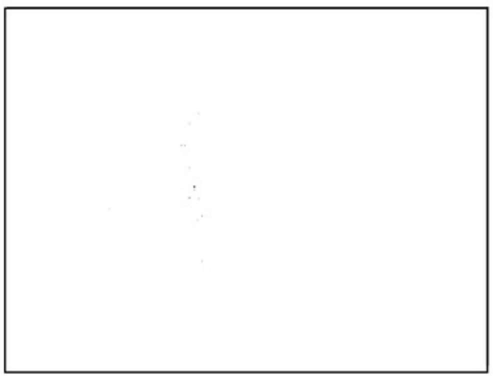
3. EXPERIMENTAL RESULTS

To verify our proposed method, we tested our algorithm to extract the symbols and characters of the guidance signs taken from a digital camera. We implemented our algorithm using MATLAB running on a Personal Computer (PC).

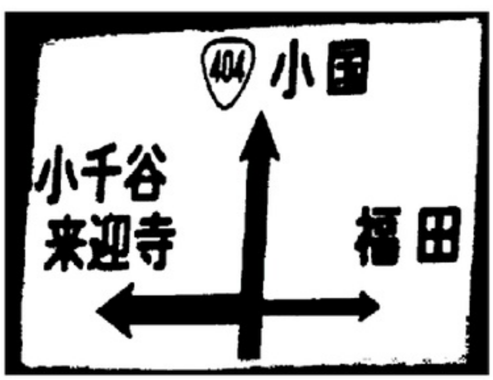
Fig. 3,4,5 depict the guidance sign images, where in each figure, figure (a) shows the original image, figure (b) shows the new intensity image obtained using Eq. (1) as proposed in [6,7], and figure (c) shows the extracted image obtained by our proposed algorithm. Sign image in Fig. 4 is the same as the one in Fig. 3, but the intensity is darker.

 ISSN 2085 – 9732

(a)



(b)

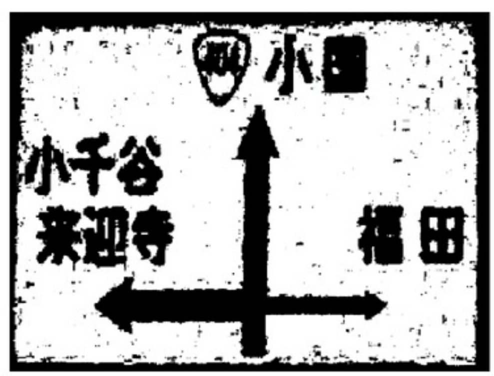


(c)

Fig. 3: (a) Original image; (b) Intensity image obtained by method proposed in [6,7]; (c) Extracted image obtained by our proposed algorithm.

(a)

(b)

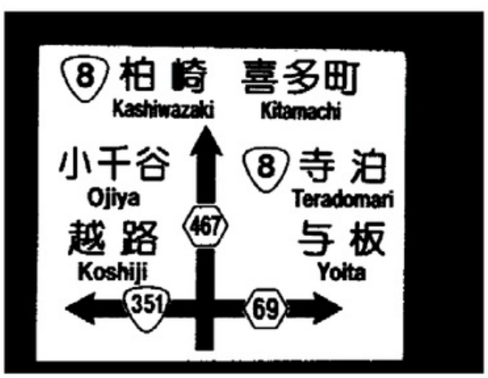


(c)

Fig. 4: (a) Original image; (b) Intensity image obtained by method proposed in [6,7]; (c) Extracted image obtained by our proposed algorithm

(a)

(b)



(c)

Fig. 5: (a) Original image; (b) Intensity image obtained by method proposed in [6,7]; (c) Extracted image obtained by our proposed algorithm.

The method proposed in [6,7] could be used to extract the symbols and characters of the sign of Fig. 4(a) and 5(a) properly as shown in Figs. 4(b) and 5(b), but it fails to extract the image of Fig. 3(a) as shown in Fig. 3(b). Our method could extract all three cases properly as shown in Figs. 3(c), 4(c), 5(c).

The extracted symbols and characters in Fig. 3(c) and 5(c) is clear enough, but they are not so clear in Fig. 4(c). We could improve the result in Fig 4(c) by refining the result, thus we might get the proper symbols and characters. For instance, we may apply the edge operation followed by filtering and connected component analysis.

4. CONCLUSIONS

In this paper, a new color segmentation method based on the normalized RGB chromaticity diagram is presented. The method is simple, fast and effective to overcome the problem of illumination changes. The thresholds are obtained automatically, thus when illumination changes, the threshold will be adjusted automatically.

The proposed methods work for extracting the particular colors, such red, yellow, blue, green, and white. For future work, the research for developing more general colors segmentation will be conducted.

REFERENCES

[1] E. Navon, O. Millier, A. Averbuch, " Color Image Segmentation Based on Adapative Local Thresholds", *Image and Vision Computing*, Vol. 23, pp. 69-85.

[2] J. Bruce, T. Balch, M. Veloso, "Fast and Inexpensive Color Image Segmentation for Interactive Robots" , *Proc. of International Conference on Intelligent Robots and System*, Takamatsu, Japan, Oct 2000, pp. 2061-2066.

[3] B. Browning, M. Veloso, " Real-time, Adaptive Color-based Robot Vision", *Proc. of International Conference on Intelligent Robots and System,* Edmonton, Canada, Aug 2005, pp. 3871- 3876.

[4] B. Li, H. Hu, L. Spacek, "An Adaptive Color Segmentation Algorithm for Sony Legged Robots". *Proc. of the 21st IASTED International Conference Applied Informatics*, Innsbruck, Austria, Fe 2003, pp. 126 -131.

[5] Y. Z. Du, C. Chein-I, T.P. David, " Unsupervised Approach to Color Video Thresholding", *Optical Engineering*, Vol. 43, No. 2, pp. 282-289.

[6] J. Miura, T. Kanda, Y. Shirai, "An Active Vision for Real Time Traffic Recognition", *Proc. of IEEE Conference on Intelligent Transportation Systems*, Dearborn, MI, pp. 52-57, 2000.

[7] J.H. Lee, K.H. Jo, "Traffic Sign Recognition by

Division of Characters and Symbols Regions", *Proc. of the 7th Korea-Russia International Symposium*, KORUS 2003.
[8] W. Wu, X. Chen, J. Yang, "Incremental Detection of Text on Road Signs from Video with Application to a Driving Assistant System", *Proc. of ACM Multimedia 2004*, New York, USA, 2004.
[9] R.C.Gonzalez, R.E. Woods, *Digital Image Processing,* Prentice Hall, 2002.
[10] J. Moreira; L. da F. Costa, "Neural-based Color Image Segmentation and Classification Using Self-Organizing Maps", *Anais do IX SIBGRAP,* Caxambú, Brazil, Oct 1996, pp. 47-54.
[11] G.N. Shinde, K.S. Deshmukh,"An Adaptive Color Image Segmentation", *Electronic Letter on Computer Vision and Image Analysis*, Vol. 5, No. 4, pp. 12-23.
[12] L. Shamir, "Human Perception-based Color Segmentation Using Fuzzy Logic", *Proc. of International Conference on Image Processing, Computer Vision and Pattern Recognition (IPCV 2006)*, Ls Vegas, USA, Jun 2006, pp. 496-505.
[13] P. Zingaretti, G. Tascini, L. Regini, "Optimising the Colour Image Segmentation", *Workshop sulla percezione e visione nelle machine*, Siena, Italy, 2002.

A New Color Segmentation Method Based on Normalized RGB Chromaticity Diagram

ORIGINALITY REPORT

24%	%	24%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Ety Navon, Ofer Miller, Amir Averbuch. "Color image segmentation based on adaptive local thresholds", Image and Vision Computing, 2005 Publication	3%
2	J. Miura, T. Kanda, Y. Shirai. "An active vision system for real-time traffic sign recognition", ITSC2000. 2000 IEEE Intelligent Transportation Systems. Proceedings (Cat. No.00TH8493), 2000 Publication	2%
3	"Advances in Neural Networks – ISNN 2007", Springer Nature, 2007 Publication	2%
4	Victor Wiley, Thomas Lucas. "Computer Vision and Image Processing: A Paper Review", International Journal of Artificial Intelligence Research, 2018 Publication	2%
5	Jie Yang. "Incremental detection of text on road	2%

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

6 Chein-I Chang. "Unsupervised approach to color video thresholding", Optical Engineering, 2004
Publication
2%

7 M. Udin Harun Al Rasyid, Bih-Hwang Lee, Amang Sudarsono. "Wireless body area network for monitoring body temperature, heart beat and oxygen in blood", 2015 International Seminar on Intelligent Technology and Its Applications (ISITIA), 2015
Publication
1%

8 I. El-Feghi, M. Galhoud, M.A. Sid-Aadhmed, M. Ahmadi. "Three-Level Gray-Scale Images Segmentation using Non-extensive Entropy", Computer Graphics, Imaging and Visualisation (CGIV 2007), 2007
Publication
1%

9 Wei-Ta Lai. "Reconstruction of typhoon path and cloud image from descriptors", 2007 IEEE International Conference on Systems Man and Cybernetics, 10/2007
Publication
1%

10 Konstantinos N. Plataniotis, Anastasios N. Venetsanopoulos. "Chapter 6 Color Image Segmentation", Springer Nature, 2000 — 1%
Publication

11 Deshmukh, Kanchan Subhash, and Yi Xie. "", Second International Conference on Digital Image Processing, 2010. — 1%
Publication

12 Lecture Notes in Computer Science, 2006. — 1%
Publication

13 "MICAI 2005: Advances in Artificial Intelligence", Springer Nature America, Inc, 2005 — 1%
Publication

14 A. Beghdadi, M.-C. Larabi, A. Bouzerdoum, K.M. Iftekharuddin. "A survey of perceptual image processing methods", Signal Processing: Image Communication, 2013 — 1%
Publication

15 P. Amnuaykanjanasin, S. Aramvith, T.H. Chalidabhongse. "Face Tracking Using Two Cooperative Static and Moving Cameras", 2005 IEEE International Conference on Multimedia and Expo, 2005 — 1%
Publication

16 Gudigar, Anjan, Shreesha Chokkadi, and

Raghavendra U. "A review on automatic detection and recognition of traffic sign", Multimedia Tools and Applications, 2016. 1%

Publication

17	"Big Data Analysis and Deep Learning Applications", Springer Nature, 2019 Publication	1%

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		