2015 International Conference on Industrial Instrumentation and Control (ICIC)
College of Engineering Pune, India. May 28-30, 2015

Color Image Segmentation using Edge Detection and Seeded Region Growing Approach for CIELab and HSV Color Spaces

Prachi R. Narkhede
PG Scholar
Department of Electronics Engineering
YCCE Nagpur, India
prachinarkhede@gmail.com

Aniket V. Gokhale
Department of Electronics Engineering
YCCE Nagpur, India
gokhale.aniket@gmail.com

***Abstract* — Image segmentation is one of the important tasks in image processing. The paper presents a simple and efficient method for segmentation of color images. Segmentation is performed for CIELab and HSV color spaces. The paper presents an integrated approach which uses edge detection and region growing for segmentation of color image. The proposed method involves automatic seed selection based on edge information. According to the selected seed pixels, region growing based on color similarity and connectivity of pixels is performed. This process is followed by region merging based on similarity and size to reduce over-segmentation. The proposed method provides efficient and effective results for many color images.**

Keywords— segmentation; edge detection; region growing; CIELab; HSV;

I. INTRODUCTION

Image segmentation is significant process used in many application areas involving image processing. The practical applications of image segmentation include object detection, video surveillance, medical imaging and machine vision.

The process of segmentation analyses an image into more meaningful form. Many times, only some object or part of image is necessary for further processing. These parts are referred to foreground. This foreground is separated from background by using segmentation techniques. Thus segmentation is used to identify object and boundaries in the image.

Image segmentation is performed based on similarity and discontinuity [1]. The methods for segmentation are categorized as boundary based methods and region based methods. Boundary based methods depend on discontinuities in the image while the region based methods [2] depend on similarities in the image. Hybrid methods for segmentation combine boundary based and region based methods [3]-[5].

In segmentation, all the pixels sharing common feature information are assigned with same labels. Different features like color, edge and texture are used for this purpose. The object recognition methods can be supervised or unsupervised. In the supervised method [6] [7], prior information about the object to be detected from the image is necessary. The unsupervised method [8], on the other hand, can detect object without need of any prior information. The proposed method use unsupervised methods for forming finite number of clusters based on color similarity as the feature of interest.

Section II of this paper describes the color spaces in brief. Section III describes the proposed algorithm used for segmentation process. The experimental results and conclusions are given in sections IV and V respectively.

II. COLOR SPACES

There are many color spaces used in image processing like RGB, CIELab and HSV color spaces. While processing the image, choice of color space is a critical element to be considered.

Generally the color images are in RGB color space. RGB color space is nonlinear with visual perception [9]. No transformations required to display information in RGB color space on the screen, for this reason it considered as the base color space for various applications [10]. Some disadvantages involved with RGB color space are device dependence and perceptual non-uniformity. RGB values are redundant and intensity dependent [11]. The RGB features fail to determine variations in color and intensity. Thus neighboring pixels with similar color but different shade are grouped into different clusters [12].

The CIELab is a perceptually uniform color space with dimension L for luminosity while a and b components for opponent dimension. The CIELab color space has three coordinates. The L component represents the luminosity of the color while a and b components represent chromatic information of that color [5]. Lab color space approximates human vision correctly. Lab color space includes all perceivable colors while RGB color space includes 90% of all perceivable colors.

In HSV (hue, saturation, value) color space, hue is defined as an angle in between 0 to 2π. Different angles correspond to different colors, for example angle 0 indicates red, and 2π/3 indicates green while 4π/3 represents blue color [12]. Saturation is depth and purity of color and is measured as a value between 0 and 1. Both the CIELab and HSV color spaces are illumination independent as the separate luminance components from chromatic information.

III. PROPOSED ALGORITHM

The proposed algorithm involves a hybrid method used for segmentation of color images. This method selects seed pixels automatically. Then seeded region growing approach is used followed by region merging based on similarity and size to achieve efficient segmentation results.

The process of segmentation is performed in CIELab and HSV color spaces. Thus the original image in RGB color space is converted to CIELab or HSV color space.

A. Initial Seed Selection

First consider that the image is converted into CIELab color space. The color component values at pixel (i, j) of the image are termed as L(i, j), a(i, j) and b(i, j). Mean values of color components (a_{mean}(i, j) and b_{mean}(i, j)) are computed for each pixel of the image by using 3×3 neighbourhood mask.

The difference between original color component values and mean color component values at pixel (i, j) is obtained and the distance ΔE and computed by using (3). The value of ΔE specifies similarity of neighbouring pixels.

$$\Delta a(i,j) = a_{mean}(i,j) - a(i,j) \quad (1)$$

$$\Delta b(i,j) = b_{mean}(i,j) - b(i,j) \quad (2)$$

$$\Delta \mathrm{E}(i,j) = \sqrt{\left(\Delta a(i,j)\right)^2 + \left(\Delta b(i,j)\right)^2} \quad (3)$$

Similarly, for HSV color space, the color component values at pixel (i, j) of the image are termed as H(i, j), S(i, j) and V(i, j). Mean values of color components (H_{mean}(i, j) , S_{mean}(i, j) and V_{mean}(i, j)) are computed for each pixel of the image by using 3×3 neighbourhood mask. The distance ΔE is computed by (7).

$$\Delta H(i,j) = H_{mean}(i,j) - H(i,j) \quad (4)$$

$$\Delta S(i,j) = S_{mean}(i,j) - S(i,j) \quad (5)$$

$$\Delta V(i,j) = V_{mean}(i,j) - V(i,j) \quad (6)$$

$$\Delta E(i,j) = \sqrt{\left(\Delta H(i,j)\right)^2 + \left(\Delta S(i,j)\right)^2 + \left(\Delta V(i,j)\right)^2} \quad (7)$$

For using both CIELab and HSV color spaces, the average and standard deviation (avg_E and std_E) are computed over ΔE. Then the edge threshold (T_E) is computed using (8).

$$\begin{aligned} T_E &= avg_E - 0.7 * std_E ; if \left(avg_E - 0.7 * std_E\right) > 0 \\ &= avg_E ; otherwise \end{aligned} \quad (8)$$

The threshold computed in equation (8) is used for selecting initial seed pixels. All the pixels for which the value of ΔE is more as compared to the edge threshold are the pixels on edge. All the non-edge pixels are considered as initial seeds. The connected seed pixels having same mean values of color components are assigned with same labels. Thus in this step, each of the different seed regions are labelled with unique and distinct labels.

The mean values of color components are calculated over the region having same label.

B. Region Growing

After selection of initial seed pixels, only the pixels which are on edges are unlabelled. The next task to be performed is labelling of these unlabelled pixels using region growing technique.

For the unlabelled pixel, its distance from the 4 connected neighbouring labelled pixels is computed by using equations (3) or (7) according the color space being used. The label of the neighbouring pixel with minimum distance is assigned to the unlabelled pixel. If the distance of the unlabelled pixel from all the neighbours is larger as compared to the threshold i.e. no similar region is observed, then new label is assigned to that pixel.

This process is repeated until all the pixels in the image get labelled. The mean values for the color components are then calculated for the updated regions.

In this process, the image is divided into a large number of small regions which results in over segmentation. This undesirable condition can be avoided by using region merging based on similarity and size in order to identify exact object boundaries.

C. Region Merging based on similarity

If distance between the mean color component values of the two neighbouring regions is less than the threshold, these two regions are merged together to form a single region.

Let the two neighbouring regions are l and k with color components ((L_l, a_l, b_l)/(H_l, S_l, V_l)) and ((L_k, a_k, b_k)/(H_k, S_k, V_k)) respectively. The distance between these regions is computed by using one following equations:

$$D(l,k) = \sqrt{(a_l - a_k)^2 + (b_l - b_k)^2} \quad (9)$$

$$D(l,k) = \sqrt{(H_l - H_k)^2 + (S_l - S_k)^2 + (V_l - V_k)^2} \quad (10)$$

If the distance D(l, k) is less than the threshold value calculated in equation (8), then the regions l and k are considered as similar and merged together and are assigned with updated label. The mean values of color components for the updated regions are computed.

The process is repeated till all the neighbouring similar regions get merged. The resultant number of regions formed is less as compared to the number of regions obtained in previous step.

D. Region Merging based on size

In this step, very small regions are merged with neighbouring most similar region. The size of region is considered with respect to the number of pixels in that region. The threshold size is considered as 1/100 of the original image size.

If any region has number of pixels less than the threshold size, it is merged with the neighboring region with minimum distance. This process eliminates the formation of very small regions, thus significantly reduces over segmentation.

IV. RESULTS

The experimental results are obtained for segmentation of image using both CIELab and HSV color spaces. The algorithm is tested on many color images in JPEG and bitmap format to obtain satisfactory results. The algorithm has been implemented in Matlab R2011b.

The segmentation results obtained by using CIELab and HSV color spaces are shown in fig. 1 to fig. 8. The binary images shown in figures represent the initial seeds selected using edge threshold as pixels with value 1.

It is observed that if there are very small objects in the image to be segmented, the smaller threshold size should be used for merging in order to accurately separate them. Also, the edge threshold can be reduced for images where foreground and background are not well distinguished. The precise segmentation of color image is a troublesome issue but as we see from the segmentation results obtained using HSV color space that the object boundaries can be recognized more precisely and close to the human perception.

V. CONCLUSION

The hybrid method for segmentation of color images using automatic seed pixel selection using edge information and seeded region growing is proposed in this paper. Region merging technique based on color similarity and size is utilized in order to reduce over segmentation. The algorithm is developed for CIELab and HSV color spaces to obtain reasonably good results producing meaningful regions. It is observed that segmentation results obtained by using HSV color space are more precise as compared to the results obtained using CIELab color space. The accuracy of the segmentation results can be enhanced if the information about object size in image is available according to which the threshold can be set.

REFERENCES

[1] Nikita Sharma, Mahendra Mishra, Manish Shrivastava, “Colour Image Segmentation Techniques and Issues: An Approach”, International Journal of Scientific & Technology Research Volume 1, Issue 4, May 2012.

[2] Rolf Adams and Leanne Bischof, “Seeded Region Growing”, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 16, No. 6, June 1994.

[3] Yashpal G. Mul, A.V. Gokhale, “Color Image Segmentation Based on Automatic Seed Pixel Selection”, IJCEM International Journal of computational Engineering & Management, Vol. 15, Issue 3, May 2012.

[4] M.Mary Synthuja Jain Preetha, L.Padma Suresh, “An Integrated approach for Color Image Segmentation using Edge and Color Information”, IOSR Journal of Computer Engineering (IOSR-JCE), e-ISSN: 2278-0661, p- ISSN: 2278-8727, Volume 14, Issue 6 (Sep. - Oct. 2013), PP 07-13

[5] Payal P. Mundhada, Smita M. Naphade, Komal Bondre and Aniket V. Gokhale, “Color Image Segmentation Based on Automatic Seed Selection, Region Growing and Region Merging using CIELab Color Space”, International Conference on Computer & Communication Technologies, March 28-29, 2014.

[6] Rishav Chakravarti and Xiannong Meng, “A Study of Color Histogram Based Image Retrieval”, Sixth International Conference on Information Technology: New Generations, 2009

[7] Peng Chang and John Krumm, “Object Recognition with Color Cooccurrence Histograms”, IEEE Conference on Computer Vision and Pattern Recognition, Fort Collins, CO, June 23-25, 1999

[8] Luis Garcia Ugarriza, Eli Saber, Sreenath Rao Vantaram, Vincent Amuso, Mark Shaw, and Ranjit Bhaskar, “Automatic Image Segmentation by Dynamic Region Growth and Multiresolution Merging”, IEEE transactions on Image Processing, Vol. 18, No. 10, October 2009.

[9] Max Mignotte, “Segmentation by Fusion of Histogram-Based K-Means Clusters in Different Color Spaces”, IEEE Transaction on Image Processing, Vol. 17, No. 5, May 2008.

[10] Noor A. Ibraheem, Mokhtar M. Hasan, Rafiqul Z. Khan, and Pramod K. Mishra, “Understanding Color Models: A Review”, ARPN Journal of Science and Technology, ISSN 2225-7217, Vol. 2, No. 3, April 2012

[11] Patel Janakkumar Baldevbhai and R. S. Anand, “Color Image Segmentation for Medical Images using L*a*b* Color Space”, OSR Journal of Electronics and Communication Engineering, ISSN: 2278-2834, Vol. 1, Issue 2 (May-June 2012)

[12] Shamik Sural, Gang Qian and Sakti Pramanik, “Segmentation and Histogram Generation using the HSV Color Space for Image Retrieval”, in IEEE ICIP 2002.

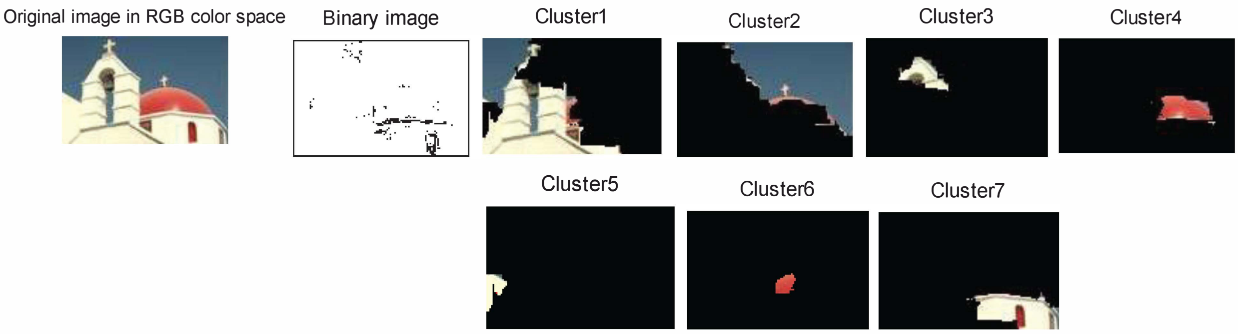

Fig. 1 Segmentation results obtained using CIELab color space

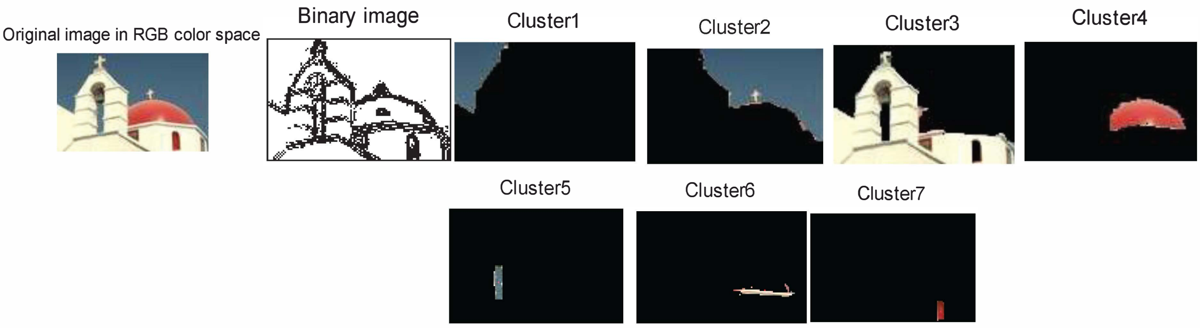

Fig. 2 Segmentation results obtained using HSV color space

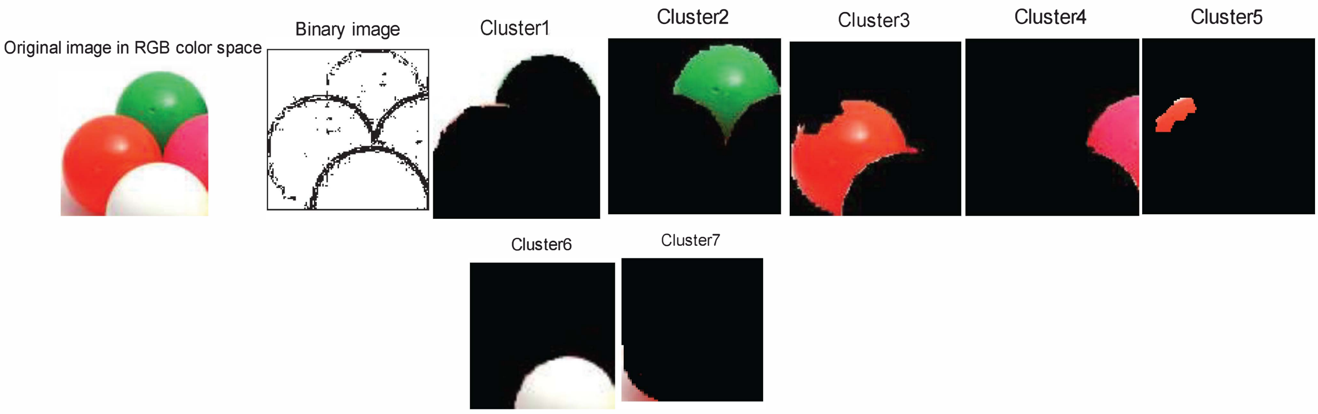

Fig. 3 Segmentation results obtained using CIELab color space

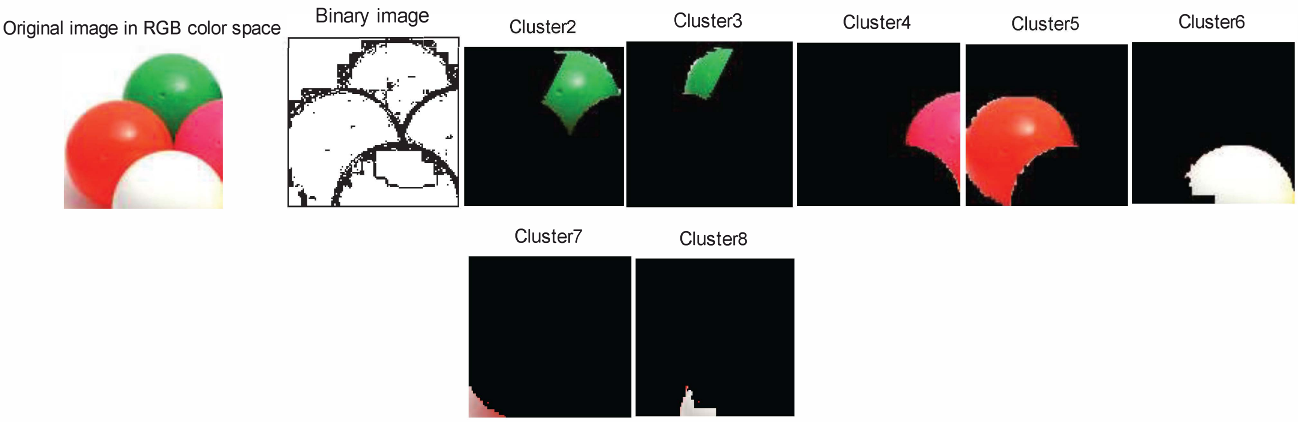

Fig. 4 Segmentation results obtained using HSV color space

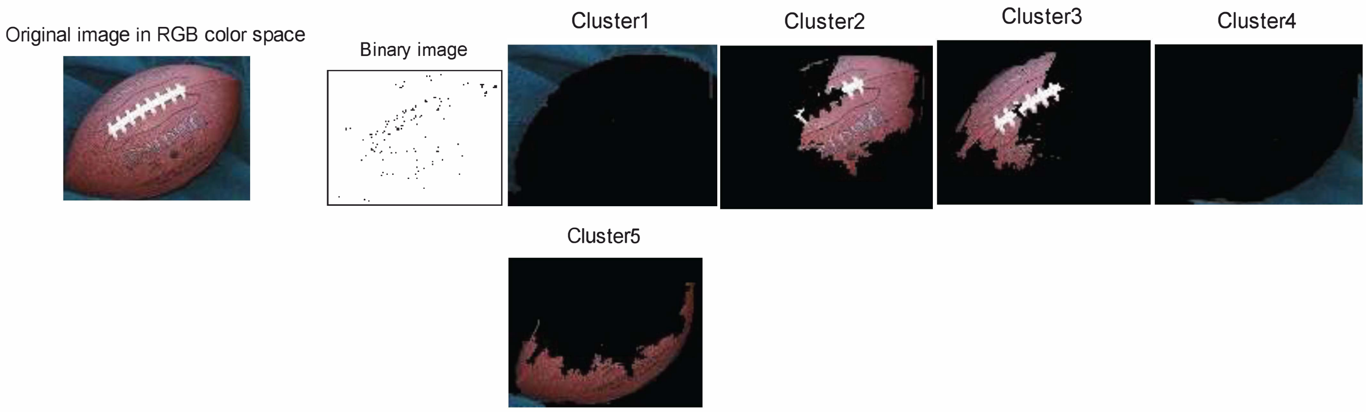

Fig. 5 Segmentation results obtained using CIELab color space

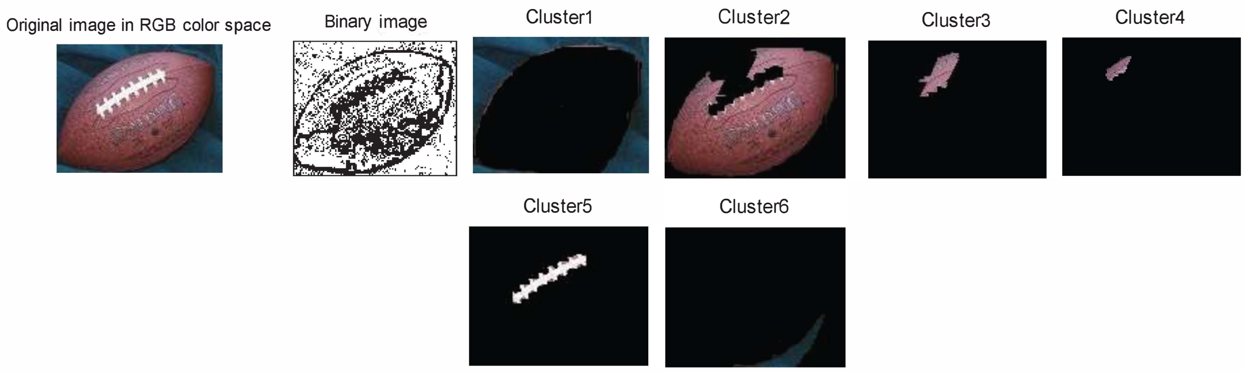

Fig. 6 Segmentation results obtained using HSV color space

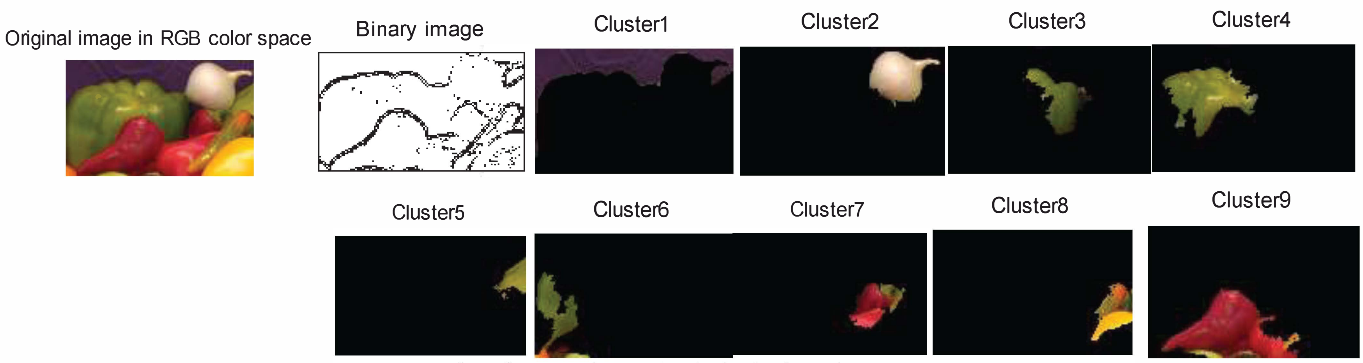

Fig. 7 Segmentation results obtained using color space

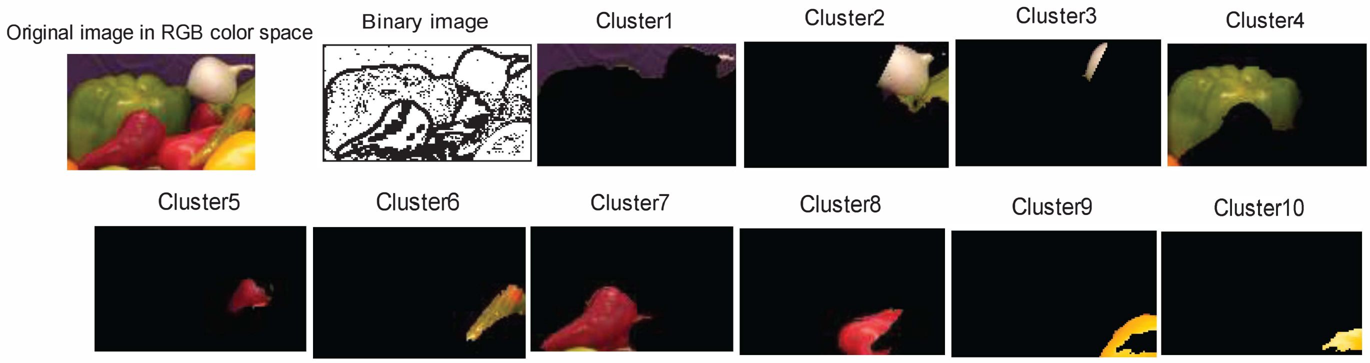

Fig. 8 Segmentation results obtained using HSV color space