Automatic Segmentation of Natural Color Images in CIE Lab Space using Possibilistic Fuzzy C Means Clustering

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Abstract*: *Clustering is the most significant assignment in image processing. This work performs the segmentation of natural color images in CIELab space based on the Possibilistic fuzzy c means clustering (PFCM).*The basic principle of the proposed approach is t*he segmentation of natural color images based on the two-way approach of hill climbing (HC) and PFCM. In this work, RGB image is transformed into CIELab space for the efficient extraction of the secreted treasure in the images. The combined approach of local optimization search technique, HC and PFCM is applied for the segmentation of synthetic fiber images. This color histogram based technique works on the principle of identification of peaks in the color histogram of the natural color image. The identified peaks are considered as initial seed or clusters. These seeds are then applied to the PFCM to perform the final segmentation. Investigational outcomedemonstrates the competence of thetwo-way approach of HC and PFCMwhich presents the preeminentend result for less complexity color images.

Index Terms*: *Clustering, Color Image, Segmentation, CIELab Color Space, PFCM

I. INTRODUCTION

Our eye can discriminate only a maximum of 24 intensity (gray) levels in a complex scene due to its brightness adaptation. At the same time, it can distinguish thousands of intensities and shades of color information. This means that segmentation performed on color attribute presents much more significant information as compared to gray scale or binary segmentation.Color is the most precious aspect in the analysis of image segmentation or information retrieval. As per the literature survey, most of the image segmentation works have been done in RGB color space. However, the color intensity information is highly correlated in RGB. So it is very difficult to extract the necessary information from RGB color images. This is the main reason why many authors have employed different color space for the image segmentation and information retrieval [5]. They have proposed segmentation in color space other than RGB and some of them have investigated the segmentation using either more than one color model or a combination of color models.

Revised Manuscript Received on July 06, 2019.

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In this work, RGB image is transformed into CIELabspace for the efficient extraction of the hidden treasure in the images. The combined approach of local optimization search technique, HC and PFCM approach is applied for the segmentation of natural images. This color histogram based technique works on the principle of identification of peaks in the color histogram of the natural images. The identified peaks are considered as initial seed or clusters. These seeds are then applied to the modified PFCM algorithm to perform the final segmentation. The combined approach of HC and PFCM had provided the best result for less complexity images.

II. COLOR IMAGE SEGMENTATION

HC is a memory competent algorithm produces excellent result even at the cost of less memory.It is the frequently used local optimization approach for deciphering the intricate issues or problems. In this, the evaluation function is continuously evaluating the present status of the problem till the convergence is achieved [1].For instance, a typical objective function has 1D array values. It will fine-tune randomly selected element in X at all iteration and furthermore computes the modification to develop the value of the given function. This iterative procedure is repeated till convergence i.e., no further modification in thefunction [2]. If the algorithm starts with a poor location, the algorithm may be converging to the undesirable solution i.e., local maximum.PFCM clustering is a combination of fuzzy c-means (FCM) and possiblistic c-means (PCM) clusteing.PFCM provided answer to numerous issues of both FCM and PCM.The foremost inconvenience of FCM is that its noise sensitivity i.e., it treats noisy pixel as original one. PFCM has a solution for this noise sensitivity issue of FCM. Furthermore PFCM bestows solution to the clusters coincident problem of PCM. The idea of PFCM is to reduce its objective function as illustrated in (1)

$$\mathrm{PF_m}(T,V,U;X,\gamma) = \sum_{i=1}^{n}\sum_{k=1}^{c}\left(a\mu_{ik}^{m} + bt_{ik}^{\eta}\right)d_{ki}^{2} + \sum_{i=1}^{c}\gamma_i\sum_{k=1}^{n}(1-t_{ki})^{\eta} \quad (1)$$

The detailed step by step procedure for the proposed approach is elucidated as follows. As an initial step, the test image (RGB) is gathered from database. The test image is transformed into CIELch space for the efficient extraction of the hidden treasure in the images. In the

next step, peaks in the 3D color histogram of the natural images are computed. These identified peaks are considered as initial seed or clusters. These seeds are then applied to the PFCM algorithm to perform the final segmentation [3]. HC method formulates a mounting task in the direction of that adjacent bin [4]. The procedure enlightened in the preceding step is carried ontill the entire non zero bins are mounted. Now every peak is considered as primary seeds. These seeds are then applied to the modified KMC algorithm to perform the final segmentation.The combined approach of local optimization search technique (HC) and PFCM is applied for the segmentation of natural colorimages. This color histogram based technique works on the principle of identification of peaks in the color histogram of the synthetic fiber images. The identified peaks are considered as initial seeds or clusters. The seeds then applied to KMC to perform the final segmentation. The combined approach of HC and PFCM had provided the best result for less complexity images.

III. EXPERIMENTAL RESULTS AND DISCUSSION

Figure 1 depicts the test image 1which is utilized for evaluating the proposed approach. The primary seeds are generated depending on the number of histogram bins. In the proposed approach, image is initially translated to CIE lab space and a three dimensional histogram is constructed based on the information. HC isapplied to compute the histogram's local maxima. It is facilitated to involuntarilymake a decisionabout the number of cluster and the primary seeds for PFCM. The segmentation outcome for the image 1 is displayed in fig 1. The outcome mainly depends on the histogram bins and primary seeds.

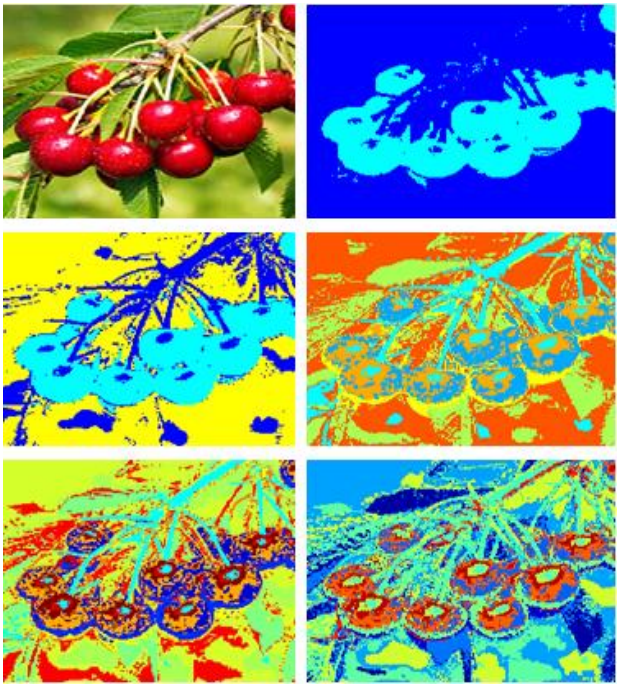

Fig. 1. Segmentation outcome for image 1

The histogram of image 1 is illustrated in fig 2. From the histogram, the statistical features of image is computed and tabulated in table 1.

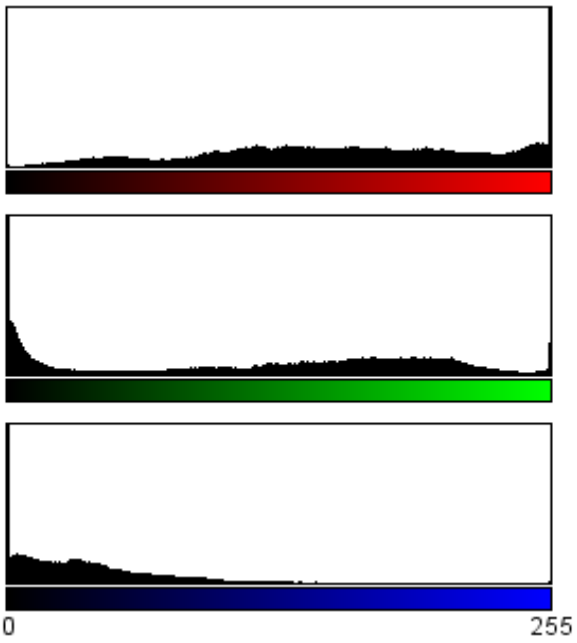

Fig.2. Histogram of image1

Table 1. Statistics for image 1

Component	Mode	Mean	SD
Red	255	154.65	65.28
Green	0	120.71	78.75
Blue	0	47.28	48.38

The three dimensional histogram is constructed based on theimage information as illustrated in fig 3. HC is applied to compute the histogram's local maxima.

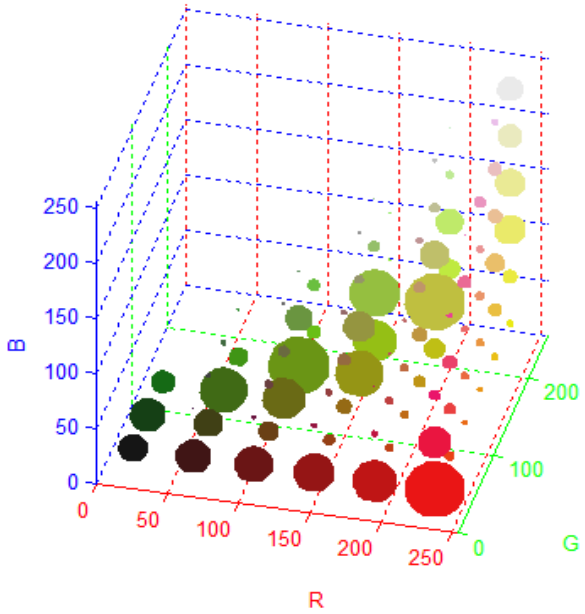

Fig.3. Three Dimensional Histogram of image1

The outcome of the proposed work for the segmentation of the natural color image 1 is portrayed in table 1.

Table 2. End result of the proposed method for image 1

Hist. Bins	Prime Seeds	Execution time (sec)
5	2	1..84
10	3	5.03
15	9	14.91
20	26	31.78
25	45	54.67

The segmentation outcome for the image 2 is displayed in fig 4. The outcome mainly depends on the histogram bins (5, 10, 15,20, 25) and primary seeds (2,3,9,26 and 45).

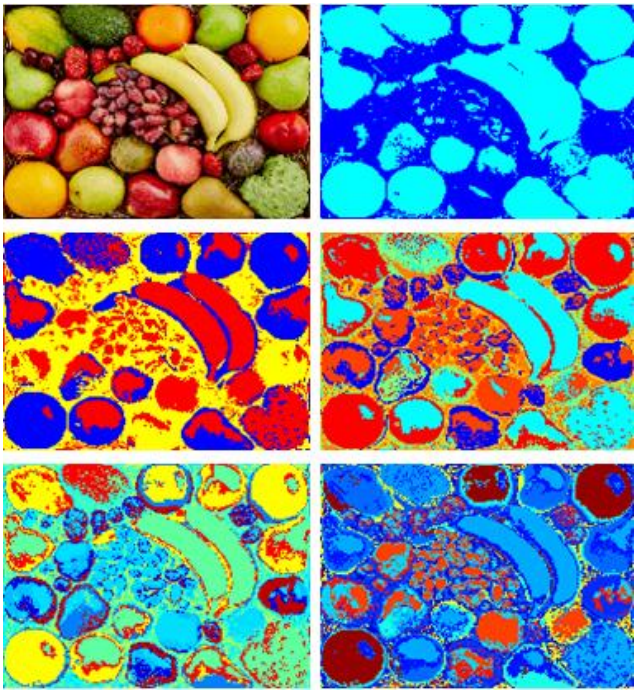

Fig. 4. Segmentation outcome for image 2

The histogram of image 2 is illustrated in fig 5. From the histogram, the statistical features of image is computed and tabulated in table 3.

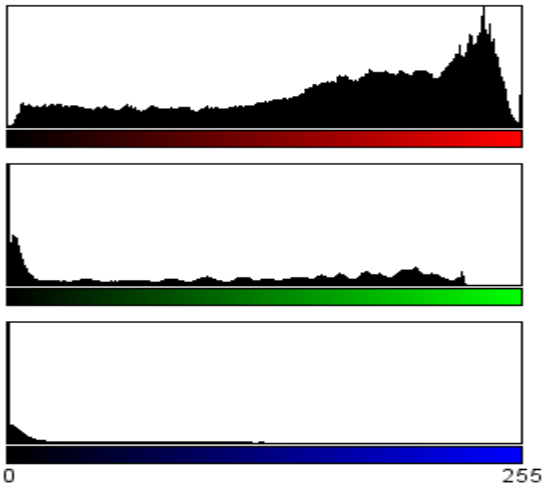

Fig.5. Histogram of image 2

Table 3. Statistics for image 2

Component	Mode	Mean	SD
Red	237	162.13	69.14
Green	0	108.52	77.94
Blue	0	40.27	47.63

The three dimensional histogram is constructed based on theimage information as illustrated in fig 6. HC is applied to compute the histogram's local maxima.

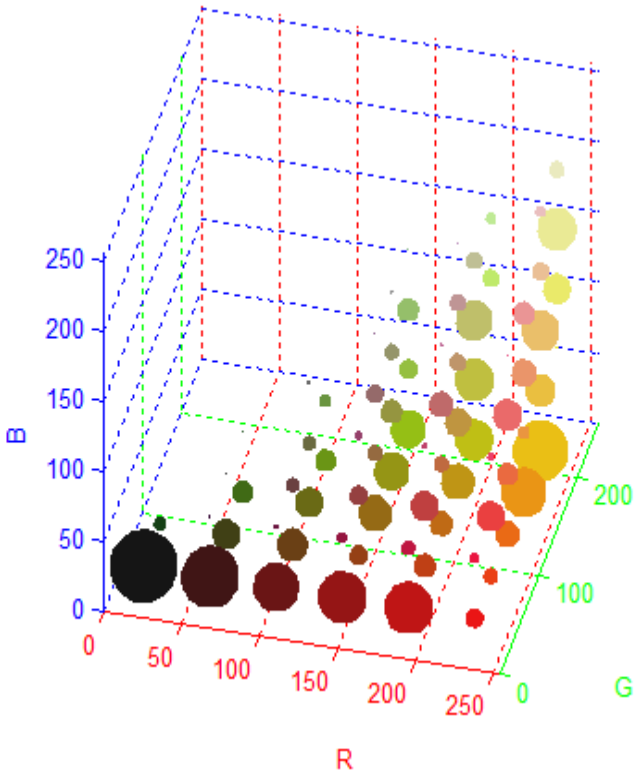

Fig.6. Three Dimensional Histogram of image 2

The outcome of the proposed work for the segmentation of the natural color image 2 is portrayed in table 4.

Table 4. End result of the proposed method for image 2

Hist. Bins	Prime Seeds	Execution time (sec)
5	3	2.72
10	7	4.91
15	18	9.06
20	34	29.28
25	58	37.75

The segmentation outcome for the image 3 is illustrated in fig 7. The outcome mainly depends on the histogram bins (5, 10, 15,20, 25) and primary seeds (3, 7, 18, 34 and 58).

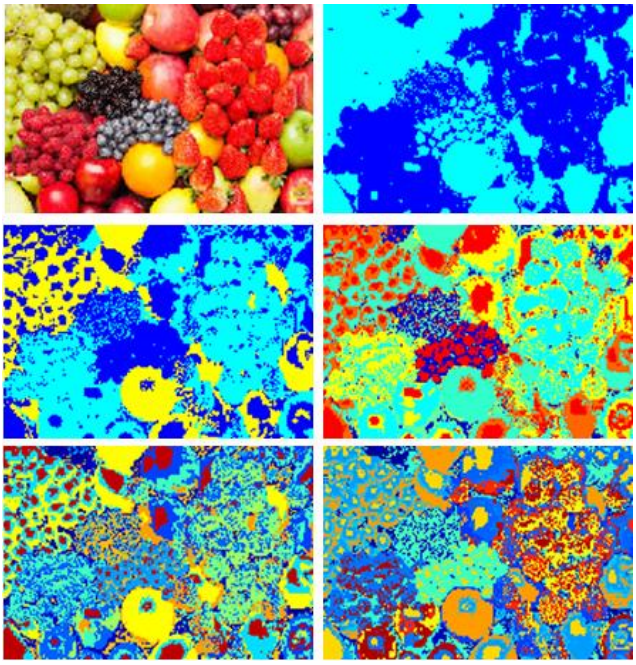

Fig.7. Segmentation outcome for image 3

The histogram of image 3 is illustrated in fig 8. From the histogram, the statistical features of image is computed and tabulated in table 5.

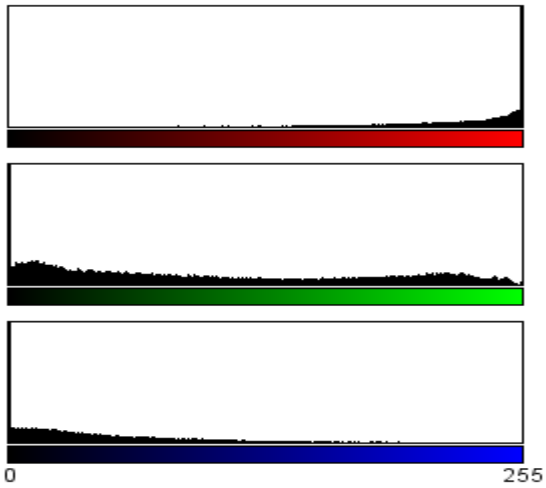

Fig.8. Histogram of image 3

Table 5. Statistics for image 3

Component	Mode	Mean	SD
Red	255	196.16	66.90
Green	0	102.08	79.31
Blue	0	54.49	52.29

The three dimensional histogram is constructed based on theimage information as illustrated in fig 9. HC is applied to compute the histogram's local maxima.The outcome of the proposed work for the segmentation of the natural color image 3 is portrayed in table 6.

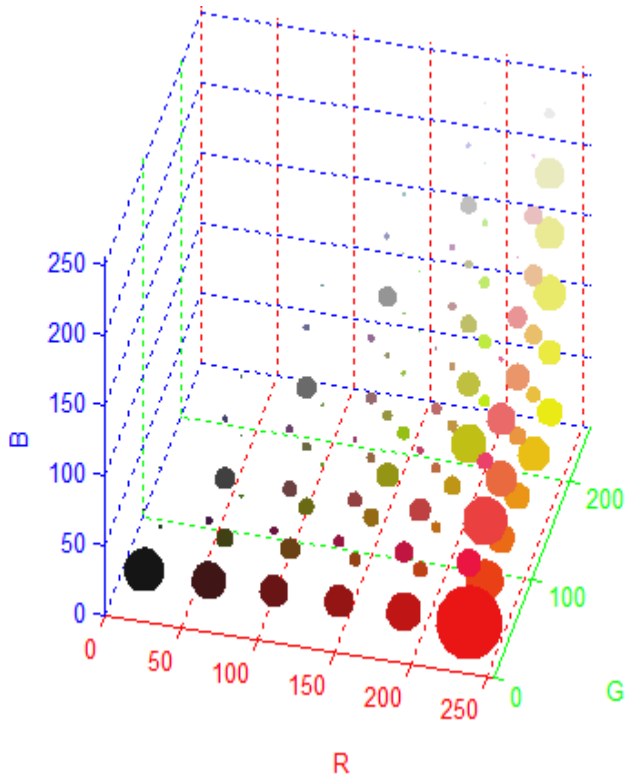

Fig.9.Three Dimensional Histogram of image 3

Table 6. End result of the proposed method for image 3

Hist. Bins	Prime Seeds	Execution time (sec)
5	2	1.05
10	4	2.92
15	19	5.81
20	38	15.07
25	65	26.74

IV. CONCLUSION

The proposed work enlightened the natural color imagesegmentation using the two-way approach of local optimization (HC) and clustering (PFCM). RGB image is transformed into CIELab space for the efficient extraction of the hidden treasure in the synthetic fiber images. HC is applied to select the initial seeds for the combined process. This color histogram based technique worked on the principle of identification of peaks from the histogram of the natural image. The identified peaks are considered as initial seed or clusters. These seeds are then applied to PFCM to perform the final segmentation.The investigational outcome clearly exposed the effectiveness of the combined approach of HC and PFCMwhich provided the best segmentation result for the natural color images.

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