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Color Image Segmentation Using Brightness and Color Fusion

A.Anuja Merlyn[1], Dr.C.Seldev Christopher[2]

Abstract - Image segmentation is an important technology in image processing. This paper presents a color image segmentation method aimed at detection of colors. To segment color objects in the RGB color image, a novel approach, namely brightness and color fusion framework is proposed which detecting colors from the background. Experimental results are reported to express the best accuracy level and efficiency of the proposed approach.

Index Terms* – *fusion, image processing, image segmentation

I. INTRODUCTION

In computer vision, segmentation refers to the process of partitioning a digital image into multiple segments (sets of pixels). In order to further process the color images, must do the image segmentation, and to detect images using brightness and color fusion. Applications of image segmentation include identifying objects in a scene for object-based measurements such as size and shape, identifying objects in a moving scene for object-based video compression (MPEG4), identifying objects which are at different distances from a sensor using depth measurements from a laser range finder enabling path planning for a mobile robot [1].

Color objects in a captured image are very difficult to separate out from the background utilizing traditional image segmentation methods due to the inhomogeneous background brightness and various types of color objects in different colors and shapes [2]. Most of the color objects detection techniques, multiple objects cannot be detected from the color images. The threshold for image segmentation is experimental values. So this image segmentation is relatively complex and time consuming.

The aim of this paper is to develop a method which can be uses in the multiple objects to be detected from the color images precisely and quickly. Segmentation for every color and gray object detection has better flexibility.

***Ms. A. Anuja Merlyn, B.E.* [1]**, *PG Student, St. Xavier's Catholic College of Engineering, Chunkankadai, Nagercoil, India..*
***Dr. C. Seldev Christopher, M.E., Ph.D.* [2]**, *Professor, St. Xavier's Catholic College of Engineering, Chunkankadai, Nagercoil, India.*

II. RELATED WORK

The methods of color image segmentation based on clustering, edge detection and region splitting and merging. In color image segmentation using K-Means clustering classifies the input data points into multiple classes based on their inherent distance from each other. For each data point the distance from the data point to each cluster is calculated and simple validity measures based on the intra cluster and inter cluster distance measures which allows the number of clusters to be determined automatically [3]. The K-Means method is to minimize the sum of squared distances between all points and the cluster centre. This clustering method which gives a minimum value for the validity measure and described about what the ideal value of K is in the K-Means procedure. It has a problem of all initial centroids will not bring the same results [4].

The generalization of K-Means clustering algorithm is to include spatial constraints and to account for local intensity variations in the image. Spatial constraints are included by the use of a Gibbs random field model. Local intensity variations are accounted for in an iterative procedure involving averaging over a sliding window whose size decreases as the algorithm progresses. The eight-neighbor Gibbs random field model applied to pictures of industrial objects, buildings, aerial photographs, optical characters, and faces. The segmented images are caricatures of the originals which preserve the most significant features, while removing unimportant details. They can be used in image recognition and as crude representations of the image. The caricatures are easy to display or print using a few grey levels and can be coded very efficiently [5]. The main drawback of adaptive clustering algorithm is difficult to detect boundaries of image.

In Fuzzy C-Means (FCM) clustering algorithm has a general principle is to incorporate the neighborhood information into the clustering algorithm during the classification process by using the RML estimator. The Rank M-type L (RM-L) and L-estimators are used to obtain the spatial information of the pixels. These estimators are involved into the FCM algorithm to provide robustness for segmentation schemes [6]. It is caused by the cost of computation is increased. This algorithm is to reduce the number of iteration; the algorithm selects the peak value of gray histogram as the initial centroid. To enhance the noise immunity, the clustering of centre pixel is influenced by the neighbor mean value and median value. The algorithm reduces the time of each iteration step by the gray histogram of image [7]. The main drawback of this algorithm is to

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enhance the noise immunity the clustering of center pixel is influenced by the neighbor mean value and median value.

The unsupervised color image segmentation for border finding algorithm uses color as the basis for segmenting the tumor images into meaningful regions. A skin tumor may be distinguished from surrounding skin by features such as color, brightness or luminance, texture and shape, and any combination thereof. The border finding algorithm involves a series of preprocessing steps to remove noise from the image, followed by color image segmentation, data reduction, object localization, and contour encoding [8]. It is caused by shadows and reflections from the image. The detection of faces in color images works by detecting areas of skin color then it applies a top down and bottom up analysis to the skin colored areas. It is important for many multimedia applications [9]. It is infeasible to determine the complex background.

The unsupervised segmentation of color-texture regions in images and video has mainly deals with JSEG algorithm. The JSEG consists of two steps: color quantization and spatial segmentation. In the first step, colors in the image are quantized to several representative classes that can be used to differentiate regions in the image. The image pixels are then replaced by their corresponding color class labels, thus forming a class map of the image. In the second step, good segmentation is used by the class map. Applying the criterion to local windows in the class map results in the J image, in which high and low values correspond to possible boundaries and interiors of color texture regions. A region growing method is then used to segment the image based on the multi scale J-images. A similar approach is applied to video sequences. An additional region tracking scheme is embedded into the region growing process to achieve consistent segmentation and tracking results, even for scenes with non-rigid object motion. The JSEG algorithm caused by varying shades due to illumination and it is difficult to select a good parameter. [10]

The Seeded region growing (SRG) is one of the hybrid method starts with assigned seeds, and grow regions by merging a pixel into its nearest neighboring seed region. The input RGB color image is transformed into YCbCr color space. Then the initial seeds are automatically selected. Next the color image is segmented into regions where each region corresponds to a seed. Finally, region-merging is used to merge similar or small regions [11]. It has a main problem of the initial seeds are over generated.

III. PROPOSED SYSTEM

The main aim of color image segmentation method is to detect color images using brightness and color fusion. This paper organized as follows:

A. Framework of Proposed System

In image with color objects, color is the most important feature. In an image with brightness feature of color objects, gray object is the most important feature. So color objects are detected by color, while can detect the gray object by brightness. From the brightness feature is easy to separate objects from the background in a live images. Finally, the color and gray objects have been obtained; the final objects are obtained by a fusion of them. Framework of proposed work is given in the following Fig.1.

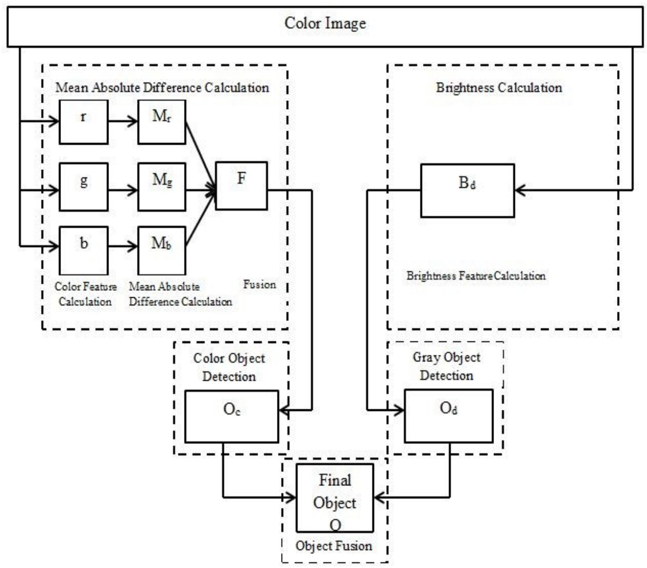

Fig. 1: Block Diagram of Proposed System

B. Mean Absolute Difference Calculation

The input I is a RGB color image of dimension $M \times N \times 3$, where M and N are the number of rows and columns respectively. Let R, G and B be the red, green and blue components of I, respectively. Color components of red, green and blue can be expressed as the following formulas:

$$r = R - (G + B) / 2 \quad (1)$$

$$g = G - (R + B) / 2 \quad (2)$$

$$b = B - (R + G) / 2 \quad (3)$$

Let m_r, m_g and m_b be the mean absolute difference of the color features of red, green and blue respectively. The mean absolute differences of color feature dimensions are also equal to $M \times N$ using the formulas:

$$m_r = \frac{1}{M \times N} \sum_{x=1}^{M} \sum_{y=1}^{N} r(x,y) \quad (4)$$

$$m_g = \frac{1}{M \times N} \sum_{x=1}^{M} \sum_{y=1}^{N} g(x,y) \quad (5)$$

$$m_b = \frac{1}{M \times N} \sum_{x=1}^{M} \sum_{y=1}^{N} b(x,y) \quad (6)$$

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The mean value of a pixel based on one color feature can be obtained by computing the difference of its color feature with the mean value of this color feature. Then use the square of the differences to make the color object as following formulas:

$$M_r = (r - m_r)^2 \quad (7)$$

$$M_g = (g - m_g)^2 \quad (8)$$

$$M_b = (b - m_b)^2 \quad (9)$$

After calculating the mean absolute difference of red, green and blue color features, the final color object F can be obtained by a fusion of these three independent color features using the formula.

$$F = M_r + M_g + M_b \quad (10)$$

C. Brightness Feature Calculation

Some objects in the image can be black or white. They are not salient in color but in brightness. So detect these objects by their brightness feature. Then get the brightness feature map B_d by transforming the RGB image to a gray object using the formula.

$$B_d = 0.299 \times R + 0.587 \times G + 0.114 \times B \quad (11)$$

D. Color Object Detection

The objects in an image may be color objects or gray objects. Color objects can be easily recognized in the mean absolute difference calculation while gray object can be figured out in the brightness feature calculation. Then use an empirical threshold T_c to distinguish whether a pixel at (x, y) is a color object pixel or not. If the mean absolute difference fusion of each pixel (x, y) is greater than T_C, then this pixel is recognized as a color object pixel, otherwise not.

$$O_c(x,y) = \begin{cases} 0 & F(x,y) \le T_C \\ 1 & F(x,y) > T_C \end{cases} \quad (12)$$

In the brightness feature calculation,if the brightness of pixel (x, y) is less than T_B, then this pixel referred to as a black object pixel; and if the brightness of pixel (x, y) is greater than T_W, then this pixel should be a white object pixel. Both T_B and T_W are empirical values:

$$O_d(x,y) = \begin{cases} 1 & B_d(x,y) < T_B \text{ or } B_d(x,y) > T_W \\ 0 & \text{otherwise} \end{cases} \quad (13)$$

E. Object Fusion

The final objects are obtained by a fusion of the color objects and gray objects using, bit OR operator.

$$O(x,y) = O_c(x,y) \mid O_d(x,y) \quad (14)$$

IV. SIMULATION RESULTS

The processing results of a RGB image with color objects obtained by the proposed method were shown in the figure below. Through object fusion, a perfect final object was obtained. The existing system was based on the color saliency which was complex and time consuming. Hence mean absolute difference calculation was used.

Due to threshold T_c being designed for color object detection in the color saliency map, when it was used for gray object detection in the same color saliency map, unsatisfactory results were obtained. Fortunately, brightness calculation was fitted for gray object detection whether it was a black object or white object. In proposed method, empirical thresholds T_B and T_W were used for black and white object pixel. Both the color objects O_c and gray objects O_d were obtained. These detected objects were segmented and fused together to get the final object.

The experimental results and accuracy of testing images were shown below. Proposed method works well for all captured live images.

V. EXPERIMENTAL RESULTS

Fig.2 and Fig.3 illustrates the effectiveness of color image segmentation using brightness and color fusion method to detect objects from color images.

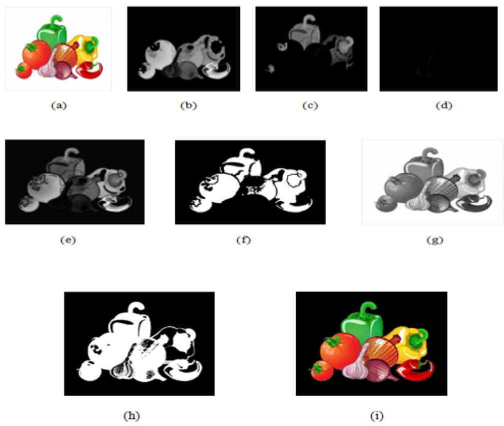

Fig. 2: Experimental Results of Color Object Segmentation

(a)Original image (b) Color feature of red (c) Color feature of green (d) Color feature of blue (e) Fusion of RGB color features (f) Color object detection (g) Brightness feature (h) Gray object detection (i) Final object

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Table 1: Summary of Color Object Segmentation Result of Fig. 2

Number of Objects	Number of Detected Objects	True Positive	False Positive	True Negative	False Negative	Accuracy
8	8	8	0	0	0	100%

Table1 illustrates the accuracy of color object segmentation result of Fig.2. This figure has where out of 8 color objects 8 were correctly detected and there were false positive is 0, true positive is 0 and false negative is also 0. But true positive of the given image is 8. So, the accuracy of the given image is 100%.

Fig. 3: Experimental Results of Color Object Segmentation

(a)Original image (b) Color feature of red (c) Color feature of green (d) Color feature of blue (e) Fusion of RGB color features (f) Color object detection (g) Brightness feature (h) Gray object detection (i) Final object

Table 2: Summary of Color Object Segmentation Result of Fig. 3

Number of Objects	Number of Detected Objects	True Positive	False Positive	True Negative	False Negative	Accuracy
4	4	4	0	0	0	100%

Table2 illustrates the accuracy of color object segmentation result of Fig.3. This figure has where out of 4 color objects 4 were correctly detected and there were false positive is 0, true positive is 0 and false negative is also 0. But true positive of the given image is 4. So, the accuracy of the given image is 100%.

VI. EXPERIMENTAL ANALYSIS

Fig.2 and Fig.3 illustrates the effectiveness of color image segmentation using brightness and color fusion method to detect objects from color images. In Fig.2 (a) is the original image which is given as input. The input I is a RGB color image of dimension, $M \times N \times 3$, where M and N are the number of rows and columns respectively. (b) represent the red color feature of image I which is calculated from the R component. Here, the red object pixels are represented using white color, (c) represent the green color feature of image I which is calculated from the G component, (d) represent the blue color feature of image I which is calculated from the B component. (e) represent the fused object which is obtained by the fusion of mean absolute difference of three independent color features. Then the fused object is segmented to get the color object which is represented in (f). Brightness feature is obtained by transforming the RGB image to a gray object that is represented in (g). Then the objects in dark black or bright white are segmented out using a threshold method from the brightness feature of color and gray object is obtained which is represented in (h). Then the final output is obtained by fusing color object and gray object using bit OR operator which is shown in (i). Here 8 objects that were manually present in the input are also available at the output after segmentation.

Another example of our process is shown in Fig.3. Here 4 objects that were manually present in the input are also available at the output after segmentation.

Thus the proposed system the brightness feature is easy to separate objects from the background in a live images. The color objects can be easily segmented out from fusion of color features. This color image segmentation method is to detect the objects precisely and quickly.

VII. PERFORMANCE ANALYSIS

Table 3:Accuracy of Images

Figure Number	Figure	Number of Objects	Number of Detected Objects	Accuracy
1.		8	8	100%

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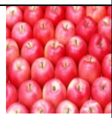
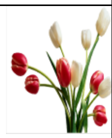
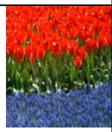
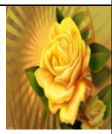
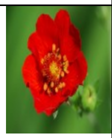
2.		31	25	80.65%
3.		78	68	87.18%
4.		1	1	100%
5.		123	98	85.4%
6.		20	17	85%
7.		31	25	81%
8.		20	16	80%
9.		4	4	100%
10.		11	9	81.82%
11.		7	6	85.7%
12.		30	29	96.7%
13.		7	5	71.4%
14.		15	12	80%
15.		28	20	71.43%
16.		40	29	72.5%
17.		26	21	80.77%
18.		124	116	93.5%
19.		12	9	75.0%
20.		13	9	69.23%
21.		5	3	60.0%
22.		12	8	66.67%
23.		31	24	77.42%
24.		34	26	76.5%
25.		14	10	71.43%

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From table 3, the accuracy of total image is 86.06% (2151.59/25). In Fig.1, Fig.4, Fig.9 were correctly detected and to give the 100% of accuracy.

VIII. CONCLUSION AND FUTURE WORK

In Proposed system, the color objects can be recognized in the color image by their mean absolute difference of color components or brightness feature of colors or both. The independent color components of red, green and blue can be calculated from the red, green and blue feature matrix respectively, and the final color object can be obtained by a fusion of these three independent color components. Color components can be easily segmented from the final color objects. Brightness is the most salient feature for black or white color objects, and can be easily recognized from the gray scale image transformed from the original RGB color image. So the fusion performance is better and very effective. In future, supervised method can be used which can improve the quality of segmentation.

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Ms.A.Anuja Merlyn received the B.E. degree in Computer Science from the Anna University, Tamil Nadu, India, in 2012 and is currently pursuing the M.E degree in Computer Science at St.Xavier's Catholic College of Engineering, Tamil Nadu, India. Her research interests cover image processing.

Dr.C.Seldev Christopher received his B.E. degree in Electronics and Communication Engineering from Manonmaniam Sundaranar University, India in 1997 and M.E. degree in Communication Systems from Madurai Kamaraj University, India in 1999. He is in the teaching field since January 2000. He is completed his Ph.D. from Manonmaniam Sundaranar University, India, in 2010. He is a professor in St.Xavier's Catholic College of Engineering, Tamil Nadu, India. His research interests covers image processing, signal processing and speech processing. He is the peer reviewer for international journals and approved supervisor for guiding PhD students under Anna University of technology, Tirunelveli.

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