Image Thresholding using Improved Bacterial Foraging Optimization in RGB decomposed Planes

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ABSTRACT

This paper addresses the problem of segmenting the image based on thresholding from its background by using combined approach of improved Bacterial foraging optimization approach and decomposed RGB planes. Three Thresholds are computed from three different RGB decomposed images. The summation of Threhold Values are applied on the image to perform segmentation. Image segmentation is the foundation process in many applications so authentic segmentation algorithm must be developed for successful execution of the image analysis applications. Motive behind image segmentation is to extract the information which is of interest for a particular application. This methodology will be able to separate three different colors of original image.

Keywords – *Modified BFO, RGB decomposed planes, Segmentation, Thresholding*

I. INTRODUCTION

Image segmentation is process of dividing the image according to either similarity or dissimilarity. It is an basic step in image analysis. Color is a perceptual phenomenon related to human response to different wavelengths in the visible electromagnetic spectrum [1].Color is the most prominent feature of any image. Extracting color information from any image has many applications related to computer vision algorithms. Color of an image can carry much more information than gray level [2]

In a broad sense the colored images segmentation are classified as follows:-

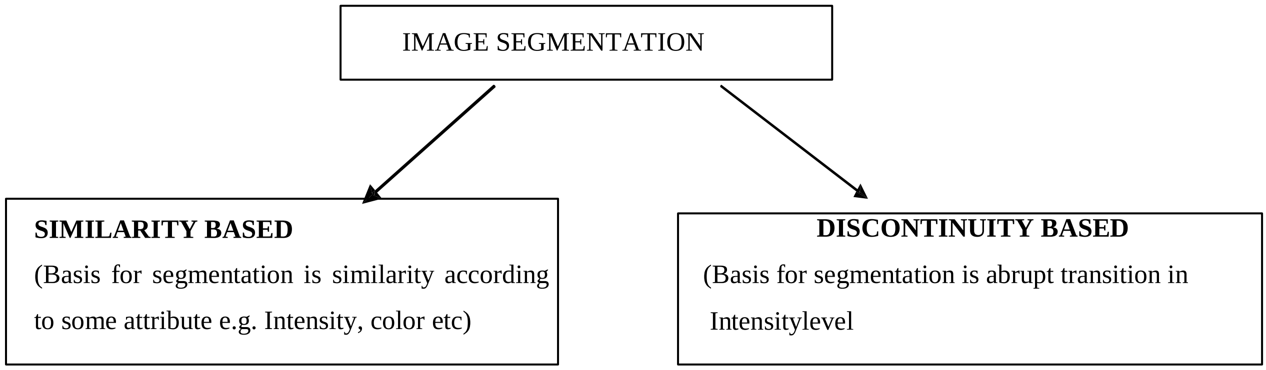

Figure 1:- Types of Image Segmentation

1.1 Similarity Based Segmentation Techniques

Similarity based segmentation techniques consists of Thresholding methods and region based methods. Thresholding methods convert grayscale image into binary image (Black and white) image by first choosing a gray level in the original image and then turning every pixel black or white according to whether its gray value is greater or less than T.[3]

A pixel = White if gray value >T

= Black if gray value <T

Region based methods **-**The main principle behind region growing method is a collection of pixels with similar properties (color, intensity level etc.) to form a region. Region growing method partitions an image into regions that are similar according to given criteria, such as gray character, color character or texture character.

1.2 Discontinuity Based Segmentation Techniques

Discontinuity based segmentation techniques consists of Edge detection, Line detection and Point detection methods. Edge is a boundary between two homogeneous regions. Edge detection refers to the process of identifying and locating sharp discontinuities in an image.

II. BACTERIA FORAGING OPTIMIZATION

This algorithm is one in class of nature inspired algorithm developed in order to solve number of optimization problems. It is a widely accepted algorithm for optimization based on social foraging behavior of E.coli bacteria. Bacteria move towards a particular direction in search of food based upon gradients of chemicals present in the environment. Foraging means locating, handling, and ingesting food [4].Bacterial foraging optimization algorithm (BFOA) has been widely accepted as a global optimization algorithm of current interest for distributed optimization and control The course(process) of natural selection tends to eradicate animals having poor foraging strategies and favor the propagation of genes of those animals that have flourishing foraging strategies, since they are more credible to enjoy reproductive success[5]. BFO is designed to tackle non gradient optimization problems and to handle complex and non differentiable objective functions. After many generations, weak foraging strategies are either eliminated or shaped into good ones. This stroke (action) of foraging led the researchers to use it as optimization process.BFO has been successfully applied on various applications like Option Model calibration [6], image processing [7], RFID Network scheduling [8] and many other applications. The four basic steps in BFOA are explained below [9]

1.Chemotaxis:- In the original BFO, a unit walk of the bacteria with random direction represents a "tumble" and a unit walk with the same direction in the last step indicates a "run." It can move in two different strategies. It can swim for a period of time in the same direction or it may tumble, and alternate between these two modes of operation for the entire lifetime.

2. Swarming: - A group of E.coli cells arrange themselves in a travelling ring by moving up the nutrient gradient when placed amidst a semisolid matrix with a single nutrient chemo- effecter. The cells when stimulated by a high level of succinate, release an attractant aspartate, which helps them to aggregate into groups and thus move as concentric patterns of swarms with high bacterial density.

3. Reproduction:- The least healthy bacteria eventually die while each of the healthier bacteria (those yielding lower value of the objective function) asexually split into two bacteria, which are then placed in the same location. This keeps the population of bacteria constant.

4. Elimination and Dispersal: - The chemotaxis provides a basis for searching the local best solution

And reproduction process speeds up the convergence which has been simulated by the classical BFO. The bacteria with the best positions are kept and the remaining bacteria population is killed. The bacteria with best positions are then moved to another position within the environment.

III. METHODOLOGY

The proposed bacterial foraging algorithm is implemented on the input image in the following steps:

1.The input image is first decomposed into RGB componenets using suitable matlab command. In result we will get three different subimages.

2. Initialize Threshold for each subcomponent image as TR = 0, TG = 0 and TB = 0

3. Take the red component image. compute size of image.

Bacterial Search area= Size of image(Row* Column)

4. Assign Nc = 1 and Ns=1; Chemo tactic and swim length.

5.Compute the health status of every pixels from the image histogram. The health status of ith color pixel Hi is given by:

Hi = Ci / (Size of image), where Ci is the no. of pixels of ith color.

6. Compute the Euclidean distance ED between the adjacent pixels as

Euclidean Distance = C(r,c) – C(r,c+1)

Where C(r,c) and C(r,c+1) are the pixel color value of two adjacent pixels.

7.If ED is less than some threshold ED, then replace the C(r,c) by C(r,c+1), which will reduce number of colours in the image.

8. Now compute the difference of health status of two adjacent pixels . If health status are less than the defined threshold health status, then the pixels under consideration are the unpopular colors and can be replaced by a new color.

9. Keep on adding the color value to TH, TG or TR

10. Do this for all the pixels.

11. Repeat above steps for all subcomponent images.

12. Compute the individual thresholds as given by:

TH = TH/Row*Column, TG = TG/ Row*Column TB = TB/ Row*Column

13. Compute the final threshold as given by: T = (TH + TG + TR)

14. Apply the final threshold over the original image and compute the performance indices as standard deviation, entropy, PSNR and class variance.

V RESULTS

The proposed algorithm is implemented on different images using matlab code. Table1 depicts the values of the performance indices for colored pattern image and its comparison with existing algorithms. Threshold, Standard Deviation, Class Variance and Entropy is being calculated and shown.

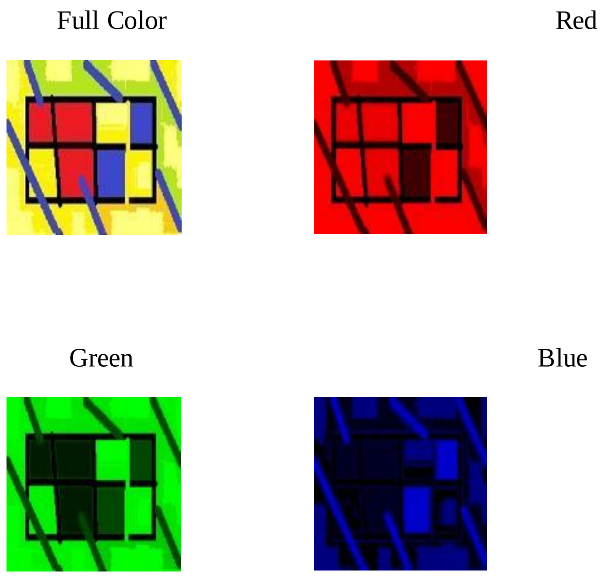

Figure 2:- Original and subcomponent image

Final Segmented Image

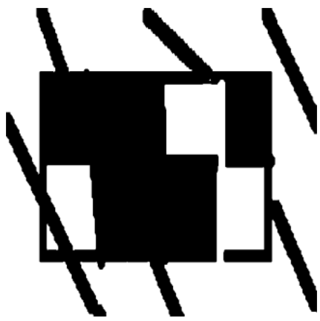

Figure 3:- Output of proposed algorithm

Table 1: Comparison with Other Techniques for Colored Pattern Image

COLORED PATTERN IMAGE (512X512)			
TECHNIQUE	OTSU	BFA	MBFA
THRESHOLD	0.5569	0.3164	0.59701
SD	0.4939	0.3541	0.495
ENTROPY	0.9823	0.6024	0.984
CLASS VARIANCE	0.0014	0.0111	0.00143
PSNR	39.593	53.740	58.267

V1 CONCLUSION

In the presented work, the final threshold has been computed by taking the summation of thresholds Tr, Tg and Tb. The threshold Tr, Tg and Tb are computed by decomposing the input image into its Red, green and blue component images and by applying the modified BFA. The result table shows drastic improvement in the thresholded images as PSNR is highest in all previously discussed algorithms. Further, as the images are decomposed into R, G and B components, each color in all components contribute in computing the threshold and finally to one single threshold. The proposed algorithm finds some limitation at the end of time of computation. This is because the algorithm runs three times on the input image in R, G and B components. Further if the size of the image increases, the time may again increase. However, the speed of algorithm can be optimized when running the same on high performance machine. The final threshold value has been computed by taking the mean of the three components thresholds. Further work may be carried out in order to integrate the three thresholds to fine tune the application.

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