

Performance Evaluation of Biogeography Based Image Segmentation

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Abstract-Image Segmentation and its performance evaluation are very difficult but important problems in computer vision. Image segmentation, i.e., identification of homogeneous regions in the image, has been the subject of considerable research activity over the last three decades. Many algorithms have been elaborated for Colour Image Segmentation. This Paper elaborate a global optimization method Biogeography-based optimization for automatically grouping the pixels of an color image into disjoint homogenous regions. Biogeography is the study of the distribution of animals and plants over time and space. It generates different clusters from a desired input image that share certain visual characteristics such as colours, intensity or texture pattern. This proposed algorithm computes performance evaluation in terms of migration rate such as 0.4 as compared to other evolutionary algorithm (Generic algorithm). One Biogeography Based Optimization characteristic which makes it distinctive from Genetic Algorithm is its migration mechanism, which affects selection pressure. It has good optimization performance due to its migration operator. It also provides noise free image and compute fast computational speed as compared to other algorithm in terms of 1.28 seconds. Therefore, Biogeography Based Image Segmentation is more reliable and faster for Image Segmentation.

Keywords-Biogeography based optimization (BBO), RGB (Red, Green and Blue) model, Genetic Algorithm (GA), Migration, Mutation, Computational time.

I. INTRODUCTION

To understand the implementation of Biogeography Based Optimization, Firstly have to understand some terms that are discussed given below:

A. Image Segmentation

Image segmentation, i.e. identification of homogeneous regions in the image, has been the subject of considerable research activity over the last three decades [1]. "Segmentation" refers to the process of dividing a digital image into multiple segments such as sets of pixels, also known as super pixels. The main objective of segmentation is to simplify and/or change the representation of an image into meaningful image that is more appropriate and easier to analyze[2].

"Image segmentation" is an important aspect of digital image processing. Image segmentation may be defined as a process of assigning pixels to homogenous and disjoint regions which form a partition of the image that shares certain visual characteristics [3]. By partitioning an image into a set of disjoint segments to represent image structures, image

segmentation leads to more compact image representations and bridges the gap between the low-level and the higher-level structures[4].The segmentation process could be augmented by some additional knowledge about the objects in the scene such as geometric and optical properties as shown in Figure 1[5].

This paper contains an extensive survey of algorithms for colour image segmentation categorization of them according well defined list of attributes, suggestions for their improvements, and descriptions of few novel approaches.

B. Biogeography-Based Optimization

Biogeography Based Optimization (BBO) is a recently developed heuristic algorithm which has shown impressive performance on many well known benchmarks. Biogeography Based Optimization is based on the mathematical study of biogeography as shown in figure 2[7]. Each island has its characteristics such as food availability, rainfall, temperature, diversity of species, security, population of species etc. The quality of an island is measured by its suitability index (SI).

Islands with HSI are more suitable for living and therefore have large population while those with LSI have sparse population due to the fact that of suitability or friendly for living. HSI islands have low immigration rate λ and high emigration rate μ simply due to high population.HSI has less dynamic. By the same virtue, islands with LSI have high immigration rate λ , and low emigration rate μ , then accept more species from HSI islands to move to their islands, which may lead to increase in the suitability index of the island. The immigration and emigration rates depend on the number of species in the habitats [8].

Like other Evolutionary Algorithms, Biogeography Based Optimization operates probabilistically. The probability that an individual shares a feature with the rest of the population is proportional to its fitness. The probability that an individual receives a feature from the rest of the population is decreases with its fitness.

The values of emigration and immigration rates are given

$$\lambda = I(1-K/n)$$

$$\mu = E/n$$

Where I is the maximum possible immigration rate; E is the maximum possible emigration rate; k is the number of species of the k -th individual; n is the maximum number of

species.

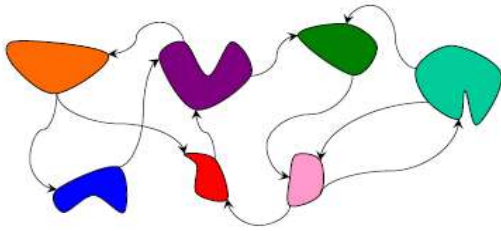


Figure 2:-Migration of spice

BBO basically depends upon following theory:-

a) Migration

The BBO migration strategy in which many parents can contribute to a single offspring, but it differs in at least one important aspect. BBO migration is used to change existing habitat Figure 2 shows the migration process [9].

For $i=1$ to NP **do**

Select I_i with probability based on

λ_i

If I_i is selected **then**

For $j=1$ to NP **do**

Select I_j with probability based on

μ_j

If I_j is selected

Randomly select a SIV v from I_j

Replace a random SIV in I_i with v

End if

End for

b) Mutation

The implemented mutation mechanism is problem dependent. In which a new region are created by hybrid others region [9].

For $j=1$ to length (SIV) **do**

Use λ_i and μ_j to compute the probability P_i

Select a variable I_i (SIV) with probability based on P_i

If I_i (SIV) selected **then**

Replace I_i (SIV) with a randomly generated SIV

End if

End for

II. DESIGN AND IMPLEMENTATION:-

To implement Biogeography Based Optimization for image segmentation, some stages are widely used. The main stages are converting image, calculate CMC distance and apply Biogeography Based Optimization strategy.

The image first considered is a color image; color image is taken because this image is further divided into different color spaces. RGB colors are widely used for every research. RGB is an additive color system from which other color models are derived. These Color models are computed with the help of euclidean distance between the neighboring pixels [11]. Biogeography based Optimization strategy applied into an image according to the CMC distance that produced distance between two pixels.

The steps of the complete process used in the present work are shown in Figure 3.

A. Proposed Algorithm

Image Segmentation is one of the important aspects of Digital image processing. Colour Image Segmentation is a process of extracting the image domain from one or more connected regions satisfying uniformity criterion which is based on features derived from spectral components [12]. The image first considered is a color image; color image is taken because this image is further divided into different color spaces. Lab color model are widely used in this algorithm. Fabric.png RGB image is taken as an input, which is an image of colorful fabric that consists of five different colors. The L*a*b* color space enables to

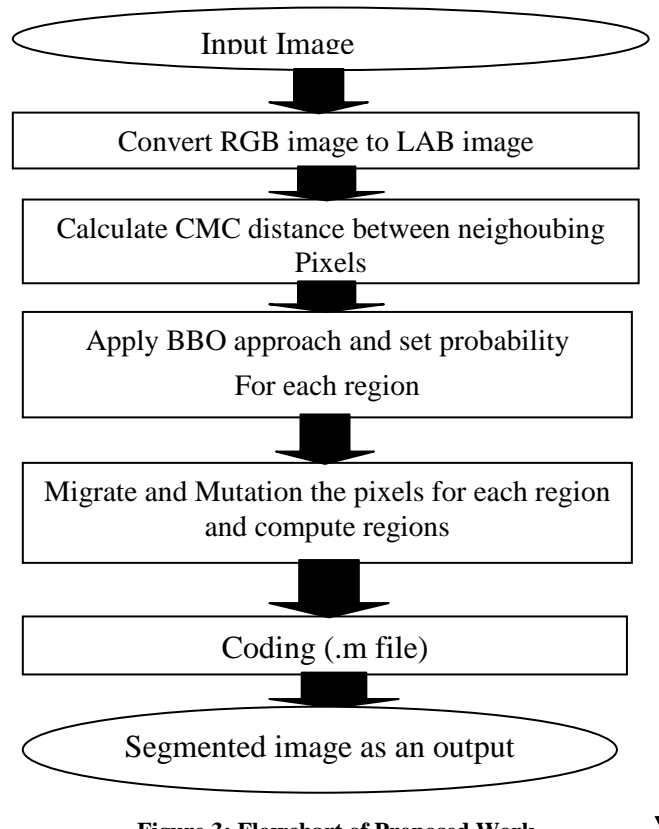


Figure 3: Flowchart of Proposed Work

visual stimulus. Fabric.png RGB image is taken as an input, which is an image of colorful fabric that consists of five different colors. The L*a*b* color space enables to quantify these visual colors. The L*a*b* space consists of a luminosity

'L*' or brightness layer, chromaticity layer 'a*' indicating where color falls along the red-green axis, and chromaticity layer 'b*' indicating where the color falls along the blue-yellow axis. Each color marker has an 'a*' and a 'b*' value. To classify each pixel in the image by calculating the Euclidean distance between that pixel and each color marker. The smallest distance tells that the pixel most closely matches that color marker.

The Proposed algorithm can be summarized as follows:

Step 1: Convert a RGB image into LAB image.

Step 2: Using Region Growing based Image Segmentation criteria selecting a seed point. After selecting, then examine their neighboring pixels of seed points based on some predefined criteria.

Step 3: Classify Each Pixel Using the Nearest Neighbor Rule. Calculate CMC color distances are used between pixels that compute the distance between two pixels that have same characteristics.

Step 4: Set probability for each region. Probability is like a threshold values. The probability P_s the region contains exactly S pixels. P_s changes from time to time as follows:

$$P_s(t+\Delta t) = P_s(t)(1-\lambda_s \Delta t - \mu_s \Delta t) + P_{s-1} \lambda_{s-1} + P_{s+1} \mu_{s+1} \Delta t$$

Step 5: HSI (highly suitability index) that contain pixels which have more similar properties. Low suitability index (LSI) that contain pixels which contain pixels that not so familiar that depends upon the probability produced. Region modification can loosely be described as follows: **H** is a probabilistic operator that adjusts habitat **H** based on the ecosystem **H**ⁿ. The probability that is **H** modified is proportional to its immigration rate λ , and the probability that the source of the modification comes from **H**_j is proportional to the emigration rate μ_j .

Region modification can loosely be described as follows:

Select H_i with probability $\alpha \lambda_i$

If H_i is selected

For $j=1$ to

Select H_j with probability $\alpha \mu_j$

If H_j is selected

Randomly select an SIV from H_j

Replace a random SIV in H_i with $\alpha \mu_i$

end

end

end

$\lambda=0$ for the p best habitats, where is a p user selected elitism parameter.

Step 6: Segmented Image is produced as an Output.

III. Result and Discussion:-

For Image Segmentation, a PNG Fabric color image is taken as an input image. Color image gives detailed information about the fabric image and an attractive way of producing an image. PNG are the image compression standard that define procedures for compressing and decompressing images for reducing the amount of data needed to represent an image. PNG images consist of 680 * 500 pixels with bit depth 48. An image basically consists of five color objects. Biogeography Based optimization applied into image to extract red, green, purple, magenta and yellow color objects. The histogram of corresponding image is generated with intensity levels in the range [0, L-1] is a discrete function $h(r_k) = n_k$, Where r_k is the kth intensity value and n_k is the number of pixels in the image with intensity r_k . As Biogeography Based Optimization Image Segmentation, taking RGB fabric image then converting it into Lab fabric image as shown in Figure 4. Following results are generated:

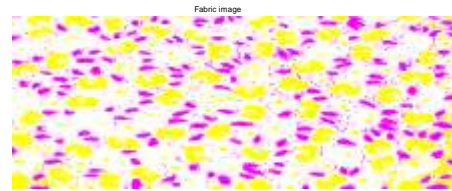


Figure 4: Lab Image

After generating Lab image, applying Biogeography Based Optimization into desired image and obtain segmented objects of different colors. As shown in Figure 5, red object that contain red color are segmented from input image.



Figure 5: Cluster of Red Objects

Histogram for red objects cluster are shown in Figure 6, which has two axis, horizontal axis corresponds to intensity values and vertical axis corresponds to number of pixels.

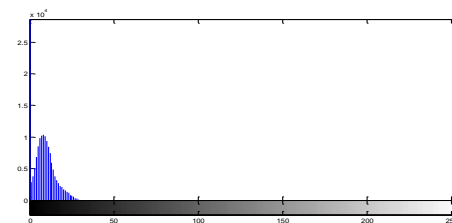


Figure 6: Histogram of red cluster

The Green object cluster are shown in figure 7. These cluster contain green color. Histogram of green cluster are shown in Figure 8.

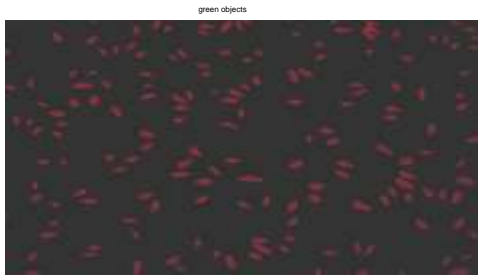


Figure 7 : Cluster of Green Object

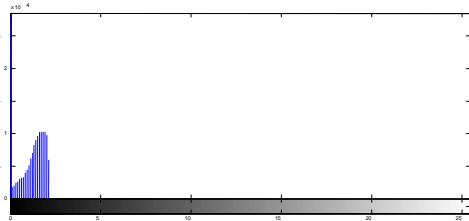


Figure 8: Histogram for green Object

Cluster of Segmented Purple Object are shown in Figure 9. These Objects contain purple color.



Figure 9: Cluster of Purple Objects

Corresponding histogram of an purple objects as shown in Figure 10, describe the number of pixels that are contained by purple object with their intensity scale.

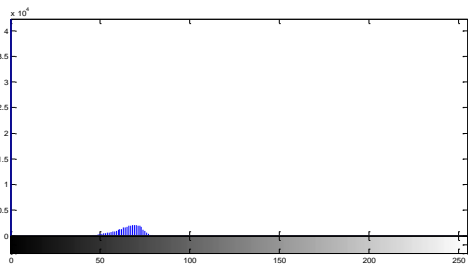


Figure 10: Histogram of purple Objects

Cluster of Segmented magenta Object are shown in Figure 11. These Objects contain magenta color.

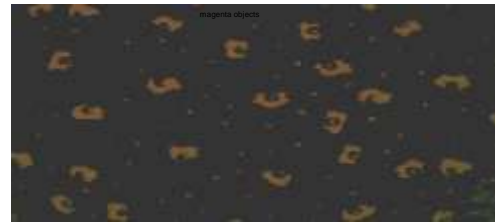


Figure 11: Cluster of Magenta Objects

Corresponding histogram of an Magenta objects as shown in Figure 12, describe the number of pixels that are contained by magenta object with their intensity scale.

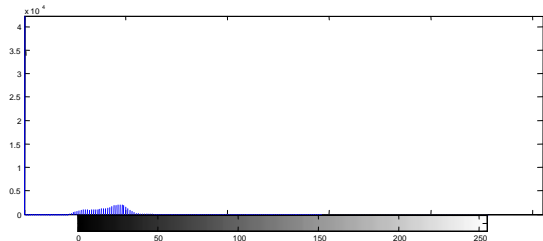


Figure 12:- Histogram for Magenta Object

Cluster of Segmented yellow Object are shown in Figure 13. These Objects contain yellow color .Histogram of Yellow Cluster are in Figure 14



Figure 13: Cluster of Yellow Objects

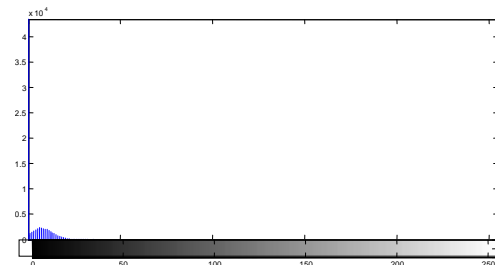


Figure 14:- Histogram of yellow Objects

A. Comparisons between BBO and Evolutionary Algorithm:-

In BBO, a solution is represented by an island. Islands consist of solution features named suitability index variables (SIV), equivalent to GA's genes. The aim of optimization is to optimal solution in terms of the variables of the problem. An array of variable values to be optimized is formed. In GA terms, this array is called "chromosome", but in BBO the term "island" is used for this array. In GA terminology these SIVs are called 'genes' as shown in Table 1.

Table 1: Comparison between GA and BBO Terminology:-

GA	BBO
Gene	SIV
Chromosome	Island
Crossover	Migration

The performance of implementing color image segmentation using BBO approach is compared with Existing evolutionary algorithm (genetic algorithm) in terms of computational speed and migration rate. The computational time of above used image is much faster than the genetic algorithm [13] as shown in following Table 2.

Table 2: Comparison of Calculated Total Computational Time for Segmented Colored Objects of Image

Segmented Images	COMPUTATIONAL TIME (sec.) (For each image)				
	RED	Green	Yellow	Purple	Magenta
BBO	1.26	1.27	1.31	1.24	1.63
GA	9.25	11.5	13.1	10.1	9.1

Migration in BBO is an adaptive process. It is used to change the existing island. BBO has low migration rate. As Compared to genetic algorithm crossover are used in terms of migration as mentioned in Table 3.

Table 3:-Comparison Based on Migration rate (BBO) and Crossover Probability (GA)

METHODS	Migration rate	Crossover Probability
GA(Genetic Algorithm)		0.9
BBO(Biogeography Based optimization)	0.4	

Thirdly, the main comparison between GA and BBO is that BBO approach evaluate more accurate and noise free image as compared to Genetic algorithm.

IV. CONCLUSION AND FUTURE SCOPE:-

Colour images allow for more reliable Image Segmentation than for gray scale images. As concluded, Biogeography Based Optimization is more reliable and fast search algorithm for Image Segmentation purposes. Biogeography Based Optimization generally results in better optimization results than the Genetic Algorithm for the problems that we

investigate. Biogeography based Image Segmentation produce different cluster of different color at low migration rate with higher computational time. Biogeography Based Optimization is therefore a generalization of Genetic Algorithm. Due to its non-uniform immigration rate, Biogeography Based Optimization can be viewed as including additional “selection pressure” that is missing from Genetic Algorithm. For the future work the Image Segmentation techniques or noise removal methods can be improved, so that the input image to be extracted could be made better which can improve the final outcome.

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