POLLINATION BASED OPTIMIZATION FOR COLOR IMAGE SEGMENTATION

Gaganpreet Kaur¹, Dr. Dheerendra Singh²

¹Assistant Professor, Department of CSE, Sri Guru Granth Sahib World University, Fatehgarh Sahib, India
²Professor & Head, Department of Computer Science & Engineering, SUSCET, Tangori, Mohali, India
E-mail: ¹gagan1492003@yahoo.com, ²professordsingh@gmail.com

ABSTRACT

Color image segmentation is a process of partitioning an image into disjoint regions, i.e. into subsets of connected pixels which share similar color properties. Region extraction in color images is a difficult process. I have proposed a new optimization method Pollination Based Optimization (PBO) to select best optimal clusters in color images. The methodology consisted of four steps: color space conversion, generation of candidate color cluster centers using Fuzzy K Means, pollination based optimization method to select optimum color cluster centers, image segmentation. Pollination in flowers is used for selecting optimal clusters in colored image. The optimization method worked well on images used. The total elapsed time used to compute segmentation also reduced considerably.

Keywords: Segmentation, Clustering, Pollination Based Optimization (PBO)

INTRODUCTION

Segmentation involves partitioning an image into a set of homogeneous and meaningful regions, such that the pixels in each partitioned region possess an identical set of properties [1]. Image segmentation is one of the most challenging tasks in image processing and is a very important pre-processing step in the problems in the area of image analysis, computer vision, and pattern recognition [2]. In many applications, the quality of final object classification and scene interpretation depends largely on the quality of the segmented output [3]. In segmentation, an image is partitioned into different non-overlapping homogeneous regions, where the homogeneity of a region may be composed based on different criteria such as gray level, color or texture. [1]. Image segmentation is a complex and hard task in color images, but also it is the one of the important and curial problems in color image analysis. Because high performing segmentation algorithms lead effective image recognition and retrieval systems [4]. In this paper, PBO approach is used for color image segmentation by using clustering is used. The paper is organized as follows. In section 2, pollination based Optimization (PBO) is discussed. In section 3, the design and implementation of PBO is discussed. Experimental results on images are presented in section 4. Finally, in Section 5, some conclusions and directions for future work are discussed.
A. Image Segmentation

The segmentation procedures analyze the colors of pixels in order to distinguish the different objects which constitute the scene observed by a color sensor or camera. It is a process of partitioning an image into disjoint regions, i.e. into subsets of connected pixels which share similar color properties [5]. Segmentation schemes can be divided into two main approaches with respect to the used predicate [2]. The first one assumes that adjacent regions representing different objects present local discontinuities of colors at their boundaries. The second one assumes that a region is a subset of connected pixels which share similar color properties. The methods associated with this assumption are called region construction methods and look for subsets of connected pixels whose colors are homogeneous [5]. These techniques can be categorized into two main classes, whether the distribution of the pixel colors is analyzed either in the image plane or in the color space [5].

B. Region construction based on a color space analysis

The color of each pixel can be represented in a color space, it is also possible to analyze the distribution of pixel colors rather than examining the image plane. In the (R,G,B) color space, a color point is defined by the color component levels of the corresponding pixel, namely red (R), green (G) and blue (B). It is generally assumed that homogeneous regions in the image plane give rise to clusters of color points in the color space, each cluster corresponding to a class of pixels which share similar color properties [5]. The classes of pixels are constructed by means of a cluster identification scheme which is performed either by an analysis of the color histogram or by a cluster analysis procedure. When the classes are constructed, the pixels are assigned to one of them by means of a decision rule and are mapped back to the original image plane to produce the segmentation. The regions of the segmented image are composed of connected pixels which are assigned to the same classes. When the distribution of color points is analyzed in the color space, the procedures generally lead to a noisy segmentation with small regions scattered through the image. Usually, a spatial-based post-processing is performed to reconstruct the actual regions in the image [6, 7].

C. Clustering-based segmentation

Clustering is the process of identifying natural groupings or clusters, within multidimensional data, based on some similarity measure (e.g. Euclidean distance) [8], [9]. Clustering algorithms are used in many applications, such as data mining, compression, image segmentation, machine learning etc. A cluster is usually identified by a cluster center (or centroid) [10]. Data clustering is a difficult problem as the clusters in data may have different shapes and sizes [9]. Most clustering algorithms are based on two popular techniques known as hierarchical and partitional clustering [9]. In hierarchical clustering, the output is "a tree showing a sequence of clustering with each clustering being a partition of the data set". Partitional clustering aims to optimize cluster centers, as well as the number of clusters [11]. Most clustering algorithms require the number of clusters to be specified in advance [10]. Finding the "optimum" number of clusters in a data set is usually a challenge since it requires a priori knowledge, and/or ground truth about the data, which is not always available. The problem of finding the optimum number of clusters in a data set has been the subject of several research efforts [10], however, despite the amount of research in this area, the outcome is still unsatisfactory.

II. POLLINATION BASED OPTIMIZATION

Optimization is a natural process embedded in the living beings [12]. Pollination is a process of transfer of pollen from male parts of flower called anther to the female part called stigma of a flower. Some flowers will develop seeds as a result of self-pollination, when pollen and pistil are from the same plant, often (but not always) from the same flower. Other plants require cross-pollination: pollen and pistil must be from different plants. Plants benefit from pollinators because the movement of pollen allows them to
reproduce by setting seeds. However, pollinators don’t know or care that the plant benefits. They pollinate
to get nectar and/or pollen from flowers to meet their energy requirements and to produce offspring. In
the economy of nature, the pollinators provide an important service to flowering plants, while the plants
pay with food for the pollinators and their offspring. The floral display, fragrance and nectar lure
pollinators and leads to pollination. Some species of plants optimize their nectar, display and fragrance
producing resources. If pollination process is proceeding smoothly the plants spend average resources. If
pollination process is above normal the plants reduce expenditure on resources for producing nectar,
floral display and fragrance in the flowers. If the pollination success goes below normal, plants increase
the resource expenditure such that more floral display, fragrance and nectar to attract pollinator. As more
pollinators and their number of visits increase the pollination success rate increases [12].

I have used the model suggested by Thakar et al. [13]. The model suggests that the reproductive
success for every plant can be modelled by the following expression.

\[
R = \left( \frac{A \times D}{(a + A \times D)} \right) + \frac{a}{A^2 + N^2} - C (N + D) \quad (1)
\]

Where
\( a \) =variable denoting average display at a given average nectar content. (a = optimum D = 1.2)
\( A \) = Average Investment in Nectar Content of a species (A= optimum N = 0.9. its range is 0.8 -
1.4)
\( D \) = individual investment in display (0 - 1.2 typical 1.2)
\( N \) = individual investment in nectar (0.8 - 1.5 typical 1.2 at A = 0.9)
\( P \) = parameter related to pollinators learning efficiency \( P = m \times a + c \) here m and c are
Constants. (Range 0.1 – 25, typical value.2)
\( C \) =proportionality constant relating investment to reproductive cost (1)

A. PBO ALGORITHM

Initialize a=1.2, A=0.9, D=1.2, N=1.9, P=2,
number of plants = 6;
number of weeks =6;
number_of_seasons =20 (number of iterations)
pollination_weekly_goal = [0.10 0.25 0.50 0.75 0.90 1.00]
Randomly generate Investment Vector (IV)*
For season = 1 to number of seasons (iterations)
  For week = 1: number of weeks
    For k = 1: number of plants
      Evaluate R using equation 1
      Based upon R, update IV
      Evaluate Error = Goal - R
      Based upon error update N, D, A
    End
  Exit, if Error acceptable
End
End

III. DESIGN AND IMPLEMENTATION OF POLLINATION BASED OPTIMIZATION FOR
COLOR IMAGE SEGMENTATION

From the literature, it has been found that there is a need to develop a new optimization for selecting
optimum clusters in colored image for image segmentation. The proposed model focuses on following
steps:

a) New optimization method based on pollination in flowers to select best clusters.
b) The total time used to compute segmentation is reduced.

This is practically implemented using MATLAB 7.11.0 environment.

A. System Level Design

The work is implemented on three images-

1. Hestain.png
2. Fabric.png
3. Lion.jpg.

Figure 1 shows the original test images used in the work.

B. Algorithm Level Design

To segment image into regions, our method operates some successive tasks step by step. First, segment the image into clusters using fuzzy K means clustering method. Then, pollination based optimization algorithm is run to select optimum cluster points over candidate cluster center points set. Finally, pixels are classified according to their closest cluster center point, and image is segmented into homogeneous regions.

The Image Segmentation using PBO algorithm can be described with the following algorithm.

**Step 1** Take an image and convert it into Lab image.

**Step 2** Segment the image into clusters using Fuzzy K Means. **Step 3** Select the optimum cluster points call PBO algorithm discussed in 2.1. This loop can be terminated after a predefined number of generations or after an acceptable problem solution has been found.

**Step 4** Segmented image is obtained.

![Fig.1 Original Test Images (a) “Hestain.png” (b) “Fabric.png” (c) “Lion.jpg”](image)

IV. RESULTS

The implementation was done on original images of hestain.png, fabric.png and lion.jpg for color image segmentation using PBO approach shown in Figure 1. Clusters of the objects obtained from the original images are shown in Figure 2, Figure 4 and Figure 6. Finally segmented homogeneous regions of the original image are shown in Figure 3, Figure 5 and Figure 7. The implementation was done in Matlab 7.11.0. The time elapsed by new algorithm to identify the clusters and further segment the regions of interest is in seconds as shown in Table1.
Fig. 2 (a) Objects in Clusters 1 (b) Objects in Clusters 2 (c) Objects in Clusters 3 for image 1 (a)

Fig. 3 (a) Segmented Red Colored Region obtained from Image 1(a) (b) Segmented Purple Colored Region (c) Segmented Magenta Colored Region

Fig. 4 (a) Objects in Clusters 1 (b) Objects in Clusters 2 (c) Objects in Clusters 3 for image 1 (b)

Fig. 5 (a) Segmented Red Colored Region obtained from Image 1(b) (b) Segmented Purple Colored Region (c) Segmented Magenta Colored Region
Fig. 6 (a) Objects in Clusters 1 (b) Objects in Clusters 2 (c) Objects in Clusters 3 for image 1 (c)

Fig. 7 (a) Segmented Red Colored Region obtained from Image 1(c) (b) Segmented Purple Colored Region (c) Segmented Magenta Colored Region (d) Segmented Green Colored Region (e) Segmented Yellow Colored Region

TABLE I: TIME TAKEN BY PBO BASED COLOR IMAGE SEGMENTATION

<table>
<thead>
<tr>
<th>Optimization Technique used/ Time taken to segment an image (in seconds)</th>
<th>POLLINATION BASED OPTIMIZATION (PBO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hestain.png</td>
<td>1.34</td>
</tr>
<tr>
<td>Fabric.png</td>
<td>1.59</td>
</tr>
<tr>
<td>Lion.jpg</td>
<td>3.66</td>
</tr>
</tbody>
</table>
V. CONCLUSION

This paper derives new optimization technique based on pollination of plants to segment the color images. This new optimization algorithm has been implemented in Matlab for extraction the optimal clusters from the colored images. The new algorithm worked accurately on the colored images and the time required to segment the images into distinct homogeneous regions was considerably reduced as compared to other optimization algorithms.

REFERENCES


