Image segmentation of Dermatitis Images Using Differential Evolution

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Abstract
Color-based region segmentation of skin lesions is one of the key steps for correctly collecting statistics that can help clinicians in their diagnosis. This study describes the use of differential evolution algorithm for segmentation of dermatitis that is formed on the skin. The abilities of differential evolution optimization algorithm is easiness, simple operations using, effectiveness and converging to global optimum reflected to dermatitis image segmentation by using differential evolution algorithm in image segmentation. The system does not have the disadvantages of classical systems such as K-means clustering algorithm and the results obtained from different dermatitis images have been discussed.

Keywords
Differential evolution, image segmentation, dermatitis

1. Introduction

The appearance of the dermatitis has important clues that can help with the diagnosis, determination of severity, and the prognosis for healing. Image analysis tools are spreading in dermatology since the introduction of dermoscopy (epiluminescence microscopy), in the effort of algorithmically reproducing clinical evaluations.

Dermatitis is a general term that describes an inflammation of the skin. There are different types of dermatitis, including seborrheic dermatitis and atopic dermatitis (eczema). Although the disorder can have many causes and occur in many forms, it usually involves swollen, reddened and itchy skin and skin lesions and sometimes oozing and scarring. A sample dermatitis image caused by Seborrheic keratoses is given in Figure 1. Normal practice of dermatitis care includes weekly check-up of a patient at which an image is acquired. A clinician draws a contour around the dermatitis and assesses its size by comparing contours in subsequent images. This is a time consuming and subjective work. Digital image processing of dermatitis may provide a technique that is objective, reliable and reproducible, compared with what the human eye sees.

In this paper automatic segmentation of dermatitis images by differential evolution algorithm is presented. The rest of the paper is organized as follows: An overview of image segmentation is given in Section 2. Differential Evolution(DE) algorithm and the DE based image segmentation is presented in Section 3. Section 4 presents experimental results. Section 5 concludes the paper and outlines future research.

Figure 1: Dermatitis Image

2. IMAGE SEGMENTATION

Image clustering is the process of identifying groups of similar image primitives [1]. These image primitives can be pixels, regions, line elements and so on, depending on the problem encountered. Many basic image processing techniques such as quantization, segmentation and coarsening can be viewed as different instances of the clustering problem [1]. Some of them partitions the data set into a specified number of clusters. These algorithms try to minimize certain criteria (e.g. a square error function); therefore, they can be treated as an optimization problem [2]. Partitioning of an image into several constituent components is called segmentation. Image segmentation [3,4] plays an important role in scene analysis and image understanding. Many techniques, which have been proposed in this area, can be coarsely classified into the following categories:

- Histogram based segmentation [5,6],
- Neighborhood based segmentation [7,8,9,10],
- Surface Fitting based segmentation [11].

The focus of this paper is on the unsupervised approach based on Differential Evolution. The aim of using DE for clustering is to overcome the problems of classical algorithms such as K-means. K-means suffers from the following problems:

- The algorithm is data dependent.
- The algorithm depends on the initial conditions which may cause the algorithm to converge to suboptimal solutions.
- The algorithm is unable to handle the outliers.

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3. DIFFERENTIAL EVOLUTION ALGORITHM

Differential evolution (DE) [12] is a population-based search strategy very similar to standard evolutionary algorithms. The main difference is in the reproduction step where offspring is created from three parents using an arithmetic cross-over operator. DE is defined for floating point representations of individuals. Differential evolution does not make use of a mutation operator that depends on some probability distribution function, but introduces a new arithmetic operator which depends on the differences between randomly selected pairs of individuals.

For each parent, $x_i(t)$, of generation t, an offspring, $x'_i(t)$, is created in the following way: Randomly select three individuals from the current population, namely $x_{i1}(t)$, $x_{i2}(t)$ and $x_{i3}(t)$ with $i1 \neq i2 \neq i3 \neq i$ and $il,i2,i3 \sim U(1,..., s)$, where s is the population size. Select a random number $r \sim U(1,.....,N_d)$, where N_d is the number of genes (parameters) of a single chromosome. Then, for all parameters $j = 1, N_d$, if

$U(0,1)< P_r$ $U(0, 1)< P_r$, or if $j=r$ j=r, let

$$x'_{ij}(t)=x_{i3,j}(t)+ \gamma(x_{i1,j}(t)-x_{i2,j}(t))$$

Otherwise , let

$$x'_{ij}(t)=x_{i,j}(t)$$

In the above, P_r is the probability of reproduction (with $P_r \in (0,1)$), γ is a scaling factor with $\gamma \in (0,\infty)$, and $x'_{i,j}(t)$ and $x_{i,j}(t)$ indicate respectively the j-th parameter of the offspring and the parent.

Thus, each offspring consists of a linear combination of three randomly chosen individuals when $U(0,1)< P_r$; otherwise the offspring inherits directly from the parent. Even when $P_r=0$, at least one of the parameters of the offspring will differ from the parent (forced by the condition $j=r$).

The mutation process above requires that the population consists of more than three individuals. After completion of the mutation process, the next step is to select the new generation. For each parent of the current population, the parent is replaced with its offspring if the fitness of the offspring is better; otherwise the parent is carried over to the next generation.

DE is easy to implement, requires little parameter tunning [13], can find the global optimum regardless of the initial parameter values and exhibits fast convergence [14].

DE- BASED CLUSTERING ALGORITHM

The steps of Differential Evolution Algorithm for image segmentation are given below:

Step 1: Randomly create a population where the values where offspring is created from three parents using an of the individuals are equal to class centers.

Step 2: Assign the pixels to the class of nearest center. For quality measurement calculate the distance between the class center and each individual.

Step 3: Generate an offspring from 3 different randomly selected parents.

Step 4: Compare the performance- of- the- offspring vector-and-its-parent ,-select-the-better-one.

Step 5: Repeat from step 2 until termination criteria (generation number or acceptable error) are met.

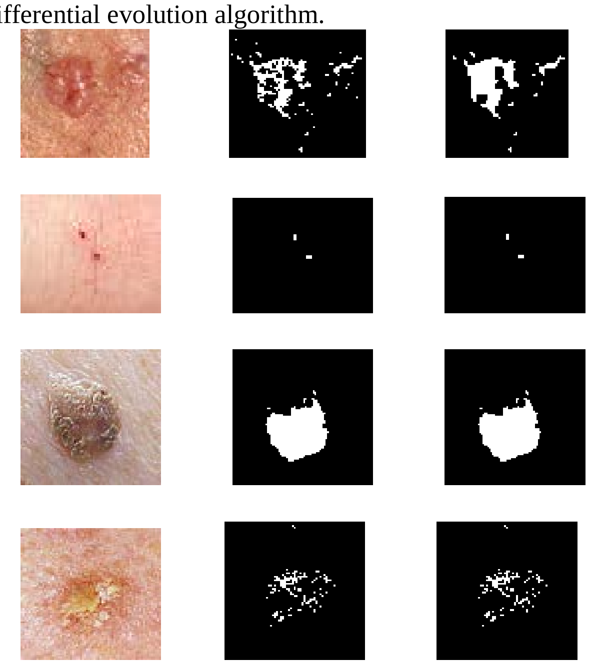
In this paper inverse of Euclidian distance given in Formula below is used for measuring the quality.

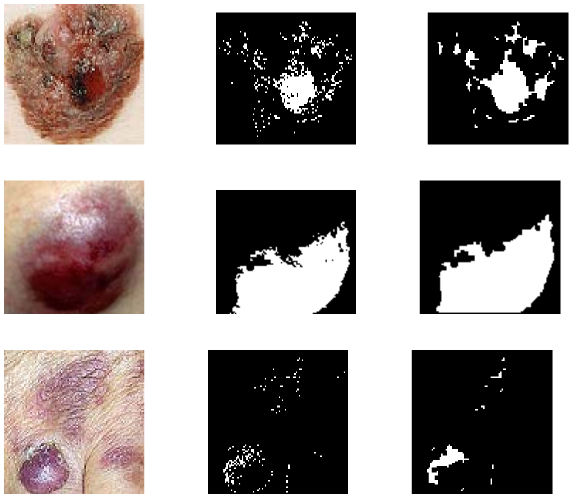
$$\sqrt{\sum_{i=1}^{N}(x_i - M_j)^2}$$

An advantage of using DE is that a parallel search for an optimal clustering is performed. This population-based search approach reduces the effect of the initial conditions, compared to K-means, especially for relatively large population sizes.

4. EXPERIMENTAL RESULTS

For evaluating the performance of the system, 3 different dermatitis images were used. Dermatitis on patients were photographed at approximately 10cm away from the dermatitis site using a digital video camera. For the differential evolution algorithm in all cases 8 individuals were trained for several iterations. According to [15] γ is in the range of 0.5-1 and P_r was set to 0.8. After several attempts the best results were achieved when the γ is 0.5. 3 classes are needed for segmenting the dermatitis from the skin. Figure 2 demonstrates a sample dermatitis image and Figure 3 demonstrates the result of segmentation by using differential evolution algorithm.





(a) (b) (c)

Figure: (a)Input image,(b)Differential Evolution Segmented Dermatitis Image ,(c) Enhanced Dermatitis Image

5. Conclusion and future work

This paper presents a clustering approach using DE. The DE clustering algorithm has as objective to simultaneously minimize the quantization error and intra-cluster distances. The future work will study a modified DE that cares the pixel neighborhood relations. The experimental results suggest that the proposed approach is flexible and is able to generate an acceptable segmentation result automatically. However it can not produce a dermatitis contour which is as fine as manual one drawn by clinician. The aim of future research will be aimed for these processing methods: DE segmentation and contour detection.

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