PERFORMANCE ANALYSIS USING SINGLE SEEDED REGION GROWING ALGORITHM

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Abstract: Image segmentation is an important process and its results are used in many image processing applications. Color images can increase the quality of segmentation, but increase the complexity of the problem. This paper focuses on measurement of parameters that is RI,GCE,MMSE and time for segmentation using "Seeded Region growing algorithm". Image segmentation techniques using region growing requires initial seeds selection, which increases computational cost & execution time. To overcome this problem, a single seeded region growing technique for image segmentation is proposed, which starts from the center pixel of the image as the initial seed. It grows region according to the grow formula and selects the next seed from connected pixel of the region. The optimization is done with fuzzy logic to improve the value of parameters.

Keywords: Image segmentation, fuzzy logic, Single seeded region growing algorithm, Grow formula , Connected pixel, Random Index.

1. INTRODUCTION

Seeded region growing algorithm (SRG) is a new approach which is based on conventional postulate of region growing algorithms where the criteria of similarity of pixels is applied, but the mechanism of growing regions is closer to the watershed algorithm. Instead of controlling region growing by tuning homogeneity parameters, SRG is controlled by choosing a usually small number of pixels, known as seeds. These seed pixels are chosen by user according to his own opinion what should be regions to extract on the image[26].

This paper focuses on a new method for image segmentation and its improvements. This method is called "Seeded Region Growing" and it is introduced by Rolf Adams and Leanne Bischof[21].They proposed a new method for segmentation of intensity images, which is robust, rapid and free of tuning parameters. These characteristics allow implementation of one very good algorithm which could be applied to large variety of images. This method, however, requires selection of seed regions, what has to be done manually and it classifies this approach to the class of semiautomatic algorithms. The algorithm grows these seed regions until all of image pixels have been processed. Unfortunately, the algorithm is dependent on the order of pixel processing, what means that, for example, raster order and anti-raster order processing of the pixels on the image will lead to the different regions on the image. This problem is revisited by Andrew Mehnert and Paul Jackway in their improved version of algorithm. In this approach the process of segmentation is completely automatic, which is needed in many applications, as one of main disadvantages appears manual selection of the seed pixels or regions. This problem of manual selection of seed pixels or regions could be solved by automatic selection of the seed pixels. This paper is organised as follows; section 2 introduces the classical approaches for the segmentation of intensity images, section 3 introduce the basic of seed selection; Section4 fuzzy logic,section 5 discuss proposed algorithm work and measurement of parameters,section 6 shows result and we draw some conclusion in section 7.

II. CLASSICAL APPROACHES FOR THE SEGMENTATION OF INTENSITY IMAGES

There are three methods to classify intensity images

A. ***ThresholdTechniques***
Threshold techniques are based on the thresholds which are usually selected from the image histogram. It is said that all pixels whose value (gray intensity, color, or other) is between two values of thresholds belong to one region. The fact that the thresholds are derived from the histogram .this method have problems to cope well with the noise as well as with blurred edges on the image.

B. ***Edge-BasedMethods***
Edge based methods try to find the places of rapid transition from one to the other region of different brightness or color value. The basic principle is to apply some of the gradient operators convolving them with the image. High values of the gradient magnitude are possible places of rapid transition between two different regions, what we call edges. After this step of finding edges on the image they have to be linked to form closed boundaries of the regions.

C. ***Region-BasedMethods***
Region-based methods are complementary to the edge-based methods. Here the point is to group pixels of the

same or similar brightness or color to the regions according to the given criteria of homogeneity. Homogeneity criteria is based on some threshold value, the choice of which is problematic, because we have usually to play a lot with the right choice of the thresholds, and thresholds always depend on the image data. Also, results are sensitive to the noise.

D. ***Mixed, Hybrid Methods Which Combine Edge And Region Methods***

There are a lot definitions of such mixed methods. . Comparing with edge-based methods this method gives closed boundaries around the supposed regions, but it is sensitive to the noise in the regions and blurred edges between regions. The method is highly data driven with no scope to involve higher level knowledge. It is computationally very region growing method based on variable-order surface fitting. The method is highly data driven with no scope to involve higher level knowledge. It is computationally very expensive.

III. Basic of Seed Selection Method

The first step in region growing is to select a set of seed points. Seed point selection is based on some user criterion (for example, pixels in a certain gray-level range, pixels evenly spaced on a grid, etc.). The initial region begins as the exact location of these seeds.The regions are then grown from these seed points to adjacent points depending on a region membership criterion. The criterion could be, for example, pixel intensity, gray level texture, or color.

Since the regions are grown on the basis of the criterion, the image information itself is important. For example, if the criterion were a pixel intensity threshold value, knowledge of the histogram of the image would be of use, as one could use it to determine a suitable threshold value for the region membership criterion[25].

A. Some important issues:

Then we can conclude several important issues about region growing are:

1. The suitable selection of seed points is important.
2. More information of the image is better.
3. The value, “minimum area threshold”.
4. The value, “Similarity threshold value“.

B. Properties of SRG algorithm

SRG method may not be applied to high textured images or to range images. It may be applied to images affected by light variation but only after initial preprocessing (i.e. removal of the background). SRG also can be extended for color and multispectral images. This method can be implemented on any number of dimensions as well as on any shape grid (or graph). Two very important problems which segmentation algorithm should overcome are:

- robustness in the presence of unwanted small round object on the image
- robustness in the presence of noise

SRG algorithm doesn't depend on position where initial seed pixels are put. This choice is left to the end-user. Evaluation of the segmentation results is also made by user. This fact classifies SRG to the group of semiautomatic algorithms. It is possible that user makes mistake selecting seed pixels. That can lead to less or more regions on the images. SRG algorithm is semi automated, but is it possible to automatize the whole process of segmentation? Generally it is possible, but it depends on what is your goal and on which images you want to apply that. Usually you can start with some simple method of segmentation, for example, based on thresholding. Than you can use results of this segmentation as starting point for SRG.

IV. Fuzzy Logic

Fuzzy systems are mappings from the family of fuzzy sets to the family **of** fuzzy sets. In other words, they are operators transforming fuzzy sets to fuzzy sets. The fuzzy sets may be onedimensional as well as multidimensional.In practice, often the input of the fuzzy system as well as the output are crisp numbers. But a fuzzy system requires a fuzzy set as input and generates a fuzzy set as output. Therefore schemes
like the one displayed are normally used.

Fig 1. Fuzzy Logy

A. Advantages and disadvantages of the use of fuzzy systems

i. Advantages:

- Fuzzy logic sometimes uses only approximate data, so simple sensors can be used.

- The algorithms can be described with little data, so little memory is required.
- The algorithms are often quite understandable.
- Fuzzy algorithms are often robust, in the sense that they are not very sensitive to changing environments and erroneous or forgotten rules.

ii. Disadvantages:

- In areas that have good mathematical descriptions and solutions, the use of fuzzy logic most often may be sensible when computing power (i.e. time and memory) restrictions are too severe for a complete mathematical implementation.
- Proof of characteristics of fuzzy systems is difficult or impossible in most cases because of lacking mathematical descriptions.

V. Proposed Algorithm

After studying the various approaches we find that there is no unique method or approach for image segmentation. Conventional image segmentation techniques using region growing requires initial seeds selection, which increases computational cost & execution time.
To overcome this problem,and to calculate values of stastical parameter like MMSE and Time, a single seeded region growing technique for image segmentation is proposed, which starts from the center pixel of the image as the initial seed. It grows region according to the grow formula and selects the next seed from connected pixel of the region.Then the result of segmentation is optimized using fuzzy logic

Brief review of region growing

A. Seeded Region Growing

Basic function of region growing technique is partition of an image into non overlapped regions. It takes seed.s as input, and then merge pixels with similar property and produce a region correspond to each seed. Result of region growing must follow following constraints:

1

$$\bigcup_{i=1}^{L} R_i = I$$

Here L is total no. of regions. It means, all regions should form whole image.

2 R_i is connected region, $i = 1, 2, 3…n$, where n is the number of regions.

$R_i \cap R_j = Null$ for all $i \neq j$,

3 mutual exclusion of region.

To perform region growing we need to address following steps:

1. Selection of initial seeds

Selection of initial seeds plays a prominent role in the process of image segmentation. Seeds should have some similar feature with respect to their neighbors. There should be a seed for every expected region in image. No seeds should be connected to each other.

2. Growing formula based on stopping criterion

Growing formula decides the homogeneity between seed and neighbors of it based on similarity index. Stopping criteria should be efficient to discriminate neighbor elements in non homogeneous domain.

B Otsu's Method For Adaptive Threshold

In 1979, N. Otsu proposed the maximum classes' variance method (known as the Otsu method) . For its simple calculation, stability and effectiveness it has been widely used.It is a well-behaved automatic threshold selection method, and its consumed time is significantly less than other thresholding algorithms. This method regards the largest inter-class variance between target and background as a principle to choose the best segmentation threshold. Otsu method chooses the optimal threshold t by maximizing the between-class variance, which is equivalent to minimizing the within-class variance, since the total variance (the sum of the within-class variance and the between-class variance) is constant for different partitions.

In the proposed single seeded region growing algorithm Seed selection is the first step of the region growing technique. Instead of selecting seeds initially we select center pixel of the image as initial seed.For the grow formula we use the intensity based similarity index between the seed and the 8-neighbour pixels of the seed.The similarity index between two neighborhood pixels of RGB intensities (x, y) and $(x+i, y+j)$ respectively is calculated by Euclidean distance as follows:

$$DIST = \sqrt{D_r + D_g + D_b}$$

$$\text{Where } D_r = (f(x+i, y+j, 1) - f(x, y, 1))^2$$

$$D_g = (f(x+i, y+j, 2) - f(x, y, 2))^2$$

$$D_b = (f(x+i, y+j, 3) - f(x, y, 3))^2$$

The stopping criterion for the grow formula is determined from the Otsu's adaptive thresholding method. If the distance between labeled pixel and non labeled pixel is less than the threshold, then we label both pixels as belonging to same region. In the proposed algorithm we input no of pixel to be grown and the maximum color difference with this algo check the number of pixel which is given as input from center point and the pixel whose threshold is whine the maximum color difference is belonging to region otherwise it considered to be belonging to next region.

C Optimization Of SSRGA Using Fuzzy Logic.

For optimization we are using Fuzzy interference system where we select two input that is region and color and output is area. With the given input one fuzzy threshold is calculated and pixel whose intensity or threshold is whine the range is belonging to region otherwise it form next group. Same parameter is calculated with optimized algo then we find that MMSE is slightly increase but time for segmentation is reduced much. We use the concept of Quantization and aggregation, in which input imge is first quantize and then aggregate to its nearest value. Quantize image then apply as input to the optimized algorithm.

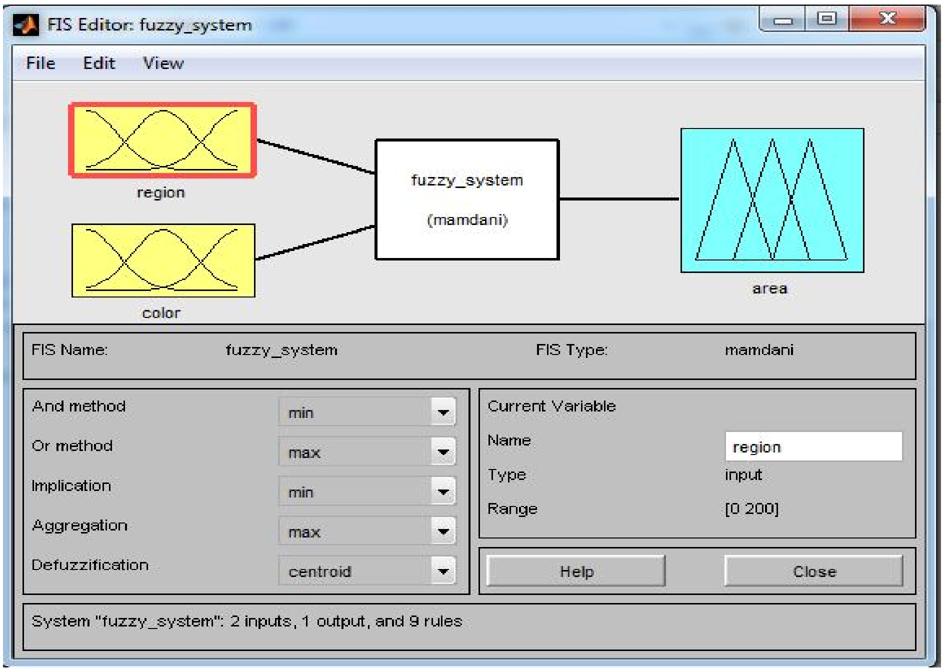


Fig 2. FIS Editor

VI. RESULTS:

The proposed algorithms have been implemented using MATLAB. The performance of various image segmentation approaches are analyzed and discussed. The measurement of image segmentation is difficult to measure. There is no common algorithm for the image segmentation. The statistical measurements could be used to measure the quality of the image segmentation .The following parameters are used to measure the quality of the image segmentation. The rand index (RI), global consistency error (GCE), MMSE and time for segmentation. The detailed description of parameters are explained in detail as follows,

i. ***Minimum mean square error(MMSE):*** Minimum mean square error is the average of the difference between predicted and actual value . MMSE indicates that higher the values of error mean the image is of poor quality**.** MMSE=mse_num/(mse_den*N)

ii. RI(Random index):

RI counts the fraction of pairs of pixels whose labeling are consistent between the computed segmentation and the ground truth averaging across multiple ground truth segmentations. The Rand index or Rand measure is a measure of the similarity between two data clusters.

- a, the number of pairs of elements in S that are in the same set in X and in the same set in Y
- b, the number of pairs of elements in S that are in different sets in X and in different sets in Y
- c, the number of pairs of elements in S that are in the same set in X and in different sets in Y
- d, the number of pairs of elements in S that are in different sets in X and in the same set in Y

The Rand index (RI) is, RI= a+b /(a+b+c+d)

iii. GCE(Global consistency error):

GCE measures the extent to which one segmentation can be viewed as a refinement of the other. Segmentations which are related are considered to be consistent, since they could represent the same image segmented at different scales

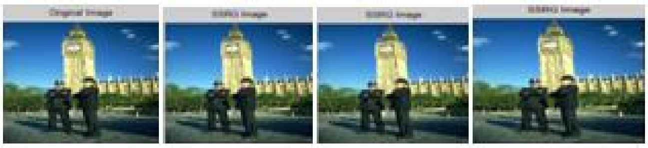
Output for SSRGA, OSSRGA and QOSSRGA

Enter growing area:8

Enter maximum color difference:20

Algorithm	MMSE	GCE	RI	TIME
SSRGA	0.03	0.0078	0.9609	115.88 S
OSSRGA	0.03	0.0078	0.9609	27.86 S
QOSSRGA	0.03	0.0078	0.9609	37.96 S
SSRGA	0.81	0.0078	0.9805	207.27 S
OSSRGA	3.60	0.0078	0.9805	55.78 S
QOSSRGA	0.61	0.0078	0.9805	52.13 S
SSRGA	43.51	0.0117	0.9649	125.35 S
OSSRGA	43.72	0.0017	0.9649	54.27 S
QOSSRGA	43.41	0.0017	0.9649	6.47 S

Table 1.Parameters values for 3 images

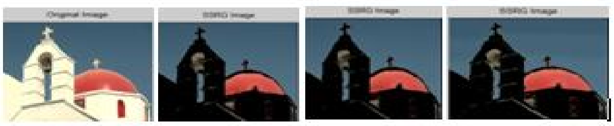


(a) (b) (c) (d)

Fig 3.Output for image 368078

(a) (b) (c) (d)

Fig 4. Output for image 118020



(a) (b) (c) (d)

Fig 5. Output for image 118035

Methods	RI	MMSE	GCE
QOSSRGA	0.9687	14.68	0.0091
OSSRGA	0.9687	15.78	0.0091
SSRGA	0.9687	14.75	0.0091

Table 2. Average Performance Calculation

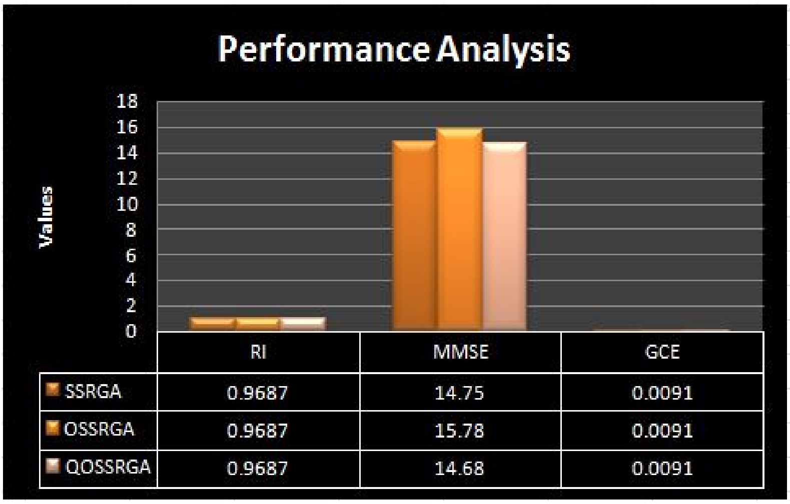


Fig 5. Performance Analysis

SSRGA	OSSRGA	QOSSRGA
149.32 S	45.9366 S	32.1866 S

Table 3. Average Time Analysis

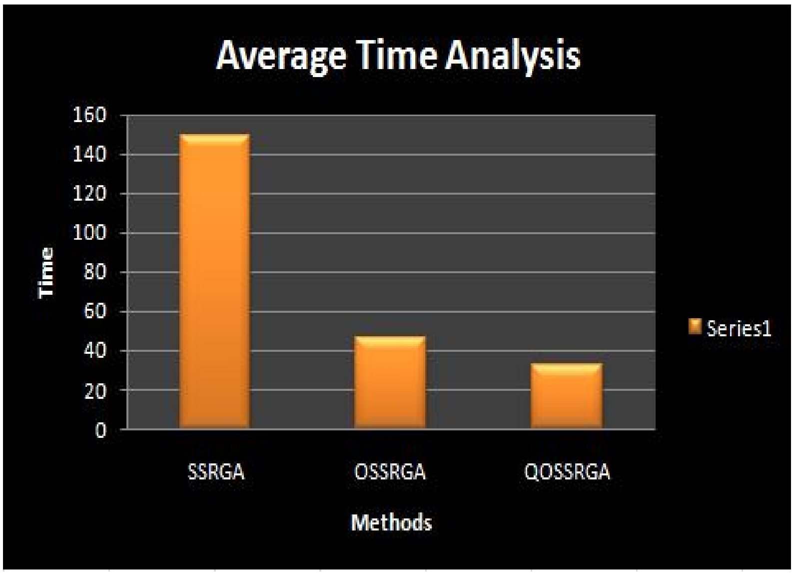


Fig 5. Average Time Analysis

VII. Conclusion

A new approach to segment an image using a single seed based region growing algorithm has been proposed in this paper. In this method the center pixel of the image is selected as the initial seed and the region is grown according to growing formula with the stopping criterion determined by Otsu's. Parameters values are calculated using proposed algorithm and optimized algorithm, we found that with optimized algorithm the value for MMSE is slightly increase but time for segmentation is decrease more than half. When image quantized and aggregated and given as input to optimize algorithm, we found that MMSE is reduced and time for segmentation is also reduced.

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