# A Medical Image Selection and Evaluation Based on Canny Edge Detection

Nathari.Sheela
Pg student , VGSE,
Karimnagar,India

R. Naraiah
Assoc.prof, VGSE,
Karimnagar,India

## ABSTRACT

**Region growing method is largely used in medical image segmentation. However, there are still some difficulties that have not been well solved as the medical image is complicated. Especially, some of the segmentation methods do well in one kind of image segmentation, but it is poor when it is applied to another image. In order to improve this condition, the article involves an improved method to select the best segmentation methods. It uses three kinds of region growing methods to segment the origin medical image. Canny edge detection is adopted to evaluate the performance of edges locating and decide which is the most suitable. Experiment result proves that this method is very effective. It not only expands the region growing method's applying, but also makes the segmentation result more precisely.**

*Keywords-region growing; canny edge detection; medical image segmentation.*

## I. INTRODUCTION

With the development of society and the improving of life, people begin to concern their health more than ever before. So people require more precisely diagnose and cancer predicted possibility. When the medical image data is introduced to the cancer diagnose, more precisely diagnose and predicted become truth. And medical image segmentation technology is one of the most important operations in medical image that are developed very rapidly. As a main branch of the segmentation method, the region growing segmentation is widely used in real-time practices.

Many researchers devoted to study this method, and they applied it to some of the organ's segmentation. They filtered the image firstly to enhance the edge, and then adapt one-dimensional maximum variance between clusters to obtain the optimal threshold. Compared with the previous threshold choosing methods, the segmentation result is better. An used region growing method to inspect foreign substance.

Not only they select required seeds automatically, based on X-ray image's histogram, but also they get segmentation threshold by analyzing the probability and statistics of grown regions. Although much effort has been down to make it perfect, there are still some dissatisfaction depending on the characters of region growing.

It is that it can gain a good region, but its locating for the small edges is no so precise. And this is very important in segmenting. To solve this problem, we develop a new method considering both the region and edges information. Canny edge detection is used to obtain the small edges, and then applying the edge information to compare different region growing methods to choose the suitable one. In comparing stage, we propose a similarity function. This method improves the small edges' locating and promotes the last segmentation result.

## II. QUESTIONS IN REGION GROWING METHOD

Region growing methods mainly consider the similarity of neighborhood pixels. If two pixels have the same grey or topology, it thought to belong to the same region . The main steps show as Fig. 1.

First, choosing a pixel as the seed and then searching neighborhood pixels to see whether it satisfies the growing condition. If it satisfies this kind of growing rule, combine it to the region. If not, search other pixels. Repeat this step constantly until no pixel satisfying. At last, obtain the segmentation result.

From Fig. 1 we can find the key problems in implementing region growing segmentation that are seed's selection and growing rule's choosing. Two separated methods are applying in determining the seed. They are manual selection and automatic selection. Manual selection requires the operator have special knowledge, and the result is sensitive to personal select. The automatic selection depends on the grey statistical properties and histogram. Comparing to the manual selection, the obtain seed is not so reliable and easy to affected by noise. Another difficulty is the selection of growing rules. It is so important that it can determine the segmentation result directly. And also, one growing rule that works well in one kind of image's segmentation may be very poor in another image's segmentation which mainly depends on the complicate of medical image. In order to get a more precisely segmentation result,

we must adopt some strategy to evaluate the growing rules. Edge detection is by far the most common approach for detecting meaningful discontinuities in intensity values. Edge models are classified according to the intensity profiles. The edge is the boundary between two different regions with relatively distinct grey level properties. It is assumed that the transition between these two regions can be determined on the basis of grey level discontinuity. Edge detection technique is one of the most commonly used object detection method in image analysis. An edge is defined by a discontinuity in gray level values. In other words, an edge is the boundary between an object and the background .
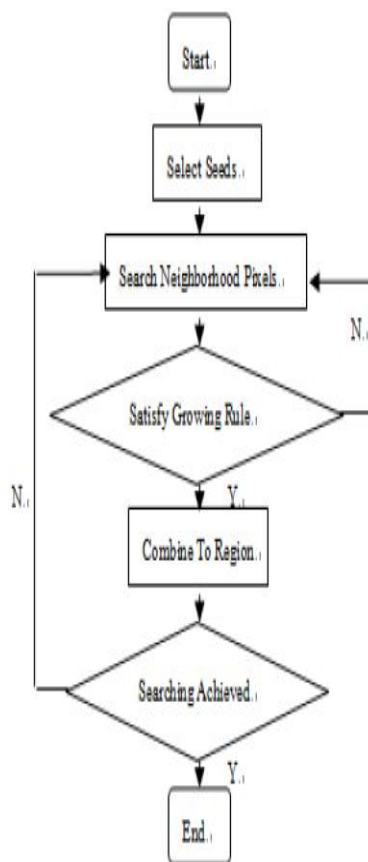


Figure 1.Main steps of region growing method

## III. CANNY EDGE DETECTION

There are many classic edge detection operators, such as Prewitt, Sobel, Kirsch and Robinson etc [6]. Compared with others operators, canny operator have very well adaptability to noise and very precisely locating. It can makes up the shortage of region method.

Canny operator is developed by John F Canny in 1986. It introduces a two-dimension Gauss function, and using its first order derivation as filter to process image. Canny edge detection

can detect all the small edges when we set appropriate parameters. While it will appears some edges that is not included in region segmentation result, which will be discussed in the following chapter.

## IV. METHOD IMPLEMENTATION AND EXPERIMENT RESULT

The article uses three kinds of region growing method, confidence connected threshold, connected threshold and neighborhood connected threshold, to segment brain CT image. To evaluate the segmentation result, we consider the edge's locating without concerning the region characters. In order to better understand the main process, we give some of explanation on concept.

### A. Three Kinds of Region Growing Methods

Confidence connected threshold method calculates all the pixels mean and standard deviation in the feature region, then multiply the standard deviation with multiplication factor defined by user to form a data interval closed to mean. The formulation is $R(x) \in [m\text{-}T\sigma]$, where m is mean of grey and $\sigma$ is standard derivation. T is the multiply factor we define. If no more neighborhood pixels satisfy this rule, it finishes the first iteration.

Then calculate new mean and standard derivation to form a new interval. Repeating it until it reaches the maximum iteration. Connected threshold method justify whether a pixel satisfy the growing rule is to see the grey values of present pixel. If it locates in the interval we define, we combine it to the region. It can be descript as J(x) [lower, upper]. X shows the position of operation. In this operation, we need to define two parameters named lower and upper to form a selecting interval. Neighborhood connected threshold method is the same as connected threshold except that its neighborhood region's radius is determined by user. It avoids small structure to be obtained to region. The whole process equivalent to adding corrosion in mathematical morphology on connected threshold method.

In the first method, we should set the number of maximum iteration and multiply factor. While in the last two, a threshold is needed. The common operation is that select a suitable seed. The related parameters show as TABLE 1.

TABLE1. SEGMENTATION PARAMETERS

| Structure | Seed | Low Threshold | Upper Threshold |
|-----------|------|---------------|-----------------|
| White Matter | (60,116) | 150 | 180 |
| Ventricle | (81,112) | 210 | 250 |
| Grey Matter | (107,69) | 180 | 210 |

The segmentation result shows as Fig. 2. From left to right, they are the origin image, confidence connected threshold image, connected threshold image and neighborhood connected threshold image. It can be seen from the figure that neighborhood connected threshold segmentation result is much smoothing than the connected threshold segmentation. Confidence connected threshold segmentation has some holes in region.



Figure 2.Region Growing Segmentation Result

### B. Methodology and Implementation
#### 1) Image Filtering

As we all know, medical image contains much noises. If we use this image to execute segmentation directly, the result is very bad. So we should filter the image. Another question is that the edge information should be reserved while removing the noise. The curvature flow image filter satisfies all the requirements, so we use it to filter origin medical image. The maximum iteration sets to be 5, and time step sets 0.125. The filtered result shows as Fig. 3. A
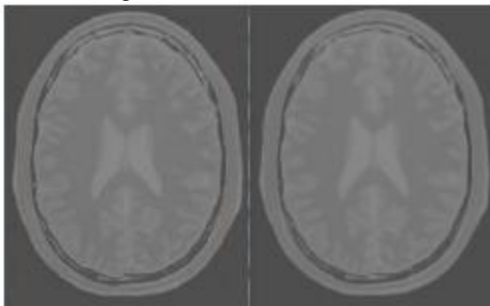


A Origin image B Filtered imageFigure 3.Image smoothing.

From the figure we can see that filtered image becomes much smoother than origin image, as much of noises are filtered out.

#### 2) Edge Detection

Edge detection method is used for two different purposes. First, we use it to deal with the origin image to get all the small edges, especially for the feature region. The process needs a small threshold so that small edges are precisely detected, and we set it to be 0.08 to 6.7. The variance sets to be 2.0. Another purpose of edge detection is to get edge information of segmented image. We use it to process segmented image, and obtain the edge pixels of the image. It adopts the same parameters as the first one to avoid introducing unexpected disturbs. The result shows as Fig. 4.
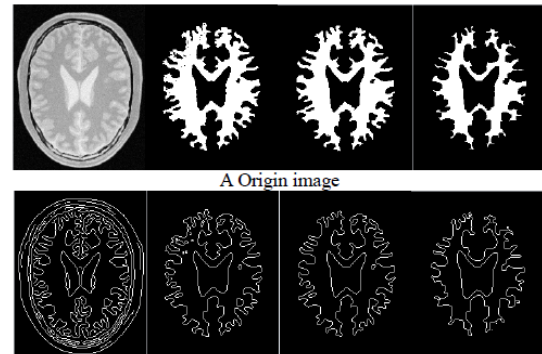


A Origin image

B Edge detected image Figure 4.Edge detection

Fig. 4 shows the origin images which are origin CT brain image, confidence connected threshold segmented image, connected threshold segmented image and neighborhood connected threshold segmented image form left to right. And b shows the edge detected images corresponding to a one by one. From it we can see that all the edge pixels are show out, and others pixels similar to background. This is very important in the following process.

#### 3) Selection and Evaluation

Edge locating is one of the standards evaluating the segmented result. Using this information to choose the best segmentation method is a good choice. The article adopts the same theory to evaluated three kinds of region growing methods. We compare the edges of origin CT brain image to the segmented ones, and select the maximum similar one as the last result.

From upper description we know that there is a question that has not been well solved. It is that the edge detected image of origin CT image has many redundant edges. These redundant edges are helpless in comparing. Some strategies should be adopted to get rid off the edges. Our strategy is that searching 8 neighborhood pixels of present edge pixel in segmented image to see if they are all zeros. If so, the pixel marks as zero. The processed results show as Fig. 5.

Outer edges which are not included in segmented region are taken off. The next step is that compare processed edge detected image to the segmented edge detection image, and get the collaborative edges. The method is that we introduce a parameter

(num) to record the number of mutual edges. The initial value of num is 0. If one pixel can be found in both the edge detected image and segmented edge image, the num add 1. Search all the pixels and get the last number of num. We apply this method to three region growing methods, and the statistic result show in TABLE2.

TABLE2. STATISTICS OF MUTUAL PIXELS

| Method | CCM | CM | NCM |
|--------|-----|-----|-----|
| sum | 827 | 846 | 142 |

Where CCM represents the confidence connected threshold method, CM represents the connected threshold method and NCM represents the neighborhood connected threshold method. From the table, we know CM has the maximum number. That is to say its edges' locating is better.

The method presented in this paper gives evidence on selecting the most suitable region growing method and provides a way to evaluate the segmentation result.

V. CONCLUTION

This paper represents a method to select and evaluate region growing methods. It is very useful in practical medical image segmentation. Especially, when there are no obvious features to distinguish which kinds of methods is best. The paper only considers one of the characters in the image segmentation, and others are also important. In the following research, we will focus on studying of others characters. Meanwhile, the effective of this method is confirmed by the experiment result.

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