Indian Journal of Science and Technology, *Vol 9 (S1), DOI: 10.17485/ijst/2016/v9iS1/108428, December 2016*

ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Segmentation of Lung Tumor in CT Images using Graph Cuts

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Abstract

Background/Objectives: The goal of this method is to obtain optimal segmentation by minimizing the energy using max-flow. **Methods/Statistical Analysis:** Image segmentation is partitioning the image based on similarities. The noise and low contrast in Computed Tomography (CT) images makes the segmentation process difficult. Thus the physiological information from CT image is integrated using the graph cut method to get high contrast and good boundaries**. Findings:** The graph cut method provides the shape term and region term to locate the tumor site. **Improvements/Applications:** Graph cut approach solves binary problems.

Keywords: Computed Tomography, Energy Minimization, Graph Cut, Image Segmentation

1. Introduction

Image segmentation generally means dividing an image into multiple regions. Segmentation provides a meaningful information about an image. It is used for the identification of an object. Basically an image is segmented based on the features like color, texture and intensity. The property of the selected pixel and the information of the neighboring pixel are the two basic parameters of image segmentation. Image segmentation plays a major role in detection of cancerous cells, detection of land, water, forest region, military applications, computer visions and biometrics.

Particular segmentation cannot be applied to all types of image due to its dissimilar features. So many different techniques are followed in image segmentation. Hence it is difficult to develop a universal technique for image segmentation.

The lung cancer is major health problem. The combination of chemotherapy and radiotherapy is been used for the treatment of cancers. For malignancy grade of noninvasive lung tumors preoperative image is recommended before the treatment[1]. The lung tumor is detected by segmentation. The segmentation technique used is graph cut method[2,3]. The image is smoothened. Energy function consisting of region term and boundary term is obtained. For CT segmentation[4-7], the region term is integration of data cost function and shape penalty term. The tumor area is limited by utilizing prior information of the shape. The boundary term is based on related information on images, which detects the tumor with more accuracy.

2. Materials and Methods

The proposed algorithm uses graph cut method for tumor segmentation. Figure 1 illustrates the flow chart of the algorithm. The proposed algorithm is applied on CT images. The CT images are smoothened by the bilinear interpolation and noise is removed by median filter. After preprocessing, graph cut segmentation and max-flow

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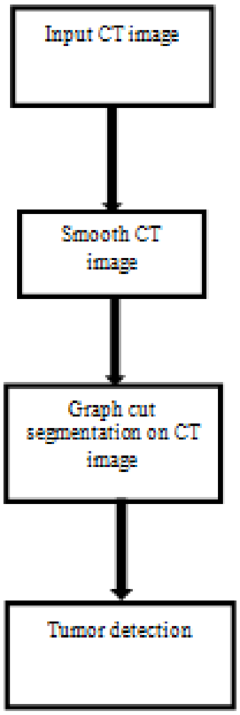


Figure 1. Flow chart of the proposed algorithm.

method is applied on the images. The region of interest and background are separated.

2.1 Preprocessing

In the pre-processing CT images uses bilinear interpolation to obtain the pixel. To differentiate background image from object seeds two seed points has been selected from tumor regions.

2.2 Tumor Segmentation on CT image using Graph Cut Method

The energy for graph cut segmentation[8], is

$$\sum_{(i,j)\in E} w_{ij} \left| x_i - x_j \right| \tag{1}$$

x= {0, 1}, x_{red}=1,x_{blue}=0. It can be improved that the constraint x= {0,1} is black, which means the min cut problem is the linear programming problem which minimize the energy L penalty. Using graph cut approach computer vision problems can be solved[9]. Computer vision problems that are formulated in terms of energy minimization can be minimized to instances of the problem of maximum flow in a graph. The minimum energy solution corresponds to the maximum a posteriori estimate of a solution. In specific max flow/min cut optimization model utilizes graph cuts.

Binary problems are solved using graph cut approach. In case of pixels labeled with two different labels and more than that, graph cut approach produces optimum solutions. In smoothing noisy images, maximum a posteriori estimate of a binary image is obtained by maximizing the flow and the problem will be solved effectively. Previously image solving problems are solved using simulated annealing or iterated conditional modes[10].

3. Results and Discussion

Figure 2(a) shows the CT image 1 which is smoothened by bilinear interpolation. Bilinear interpolation finds the unknown value from the known value. Figure 2 (b) shows the background image without the region of interest. Figure 2(c) shows the region of interest i.e. lung tumor.

Similarly Figure 3 and Figure 4 presents CT images, their corresponding background image and region of diagnosis image.

On segmenting the CT images using graph cut method the tumor region is detected which is shown in Figure 2(c), Figure 3(c) and Figure 4(c).

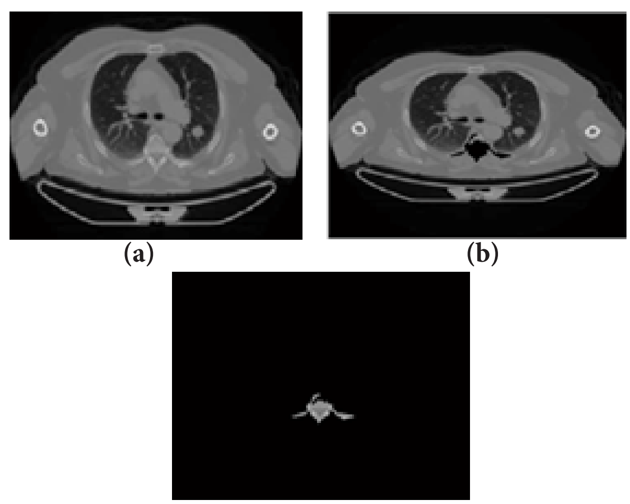
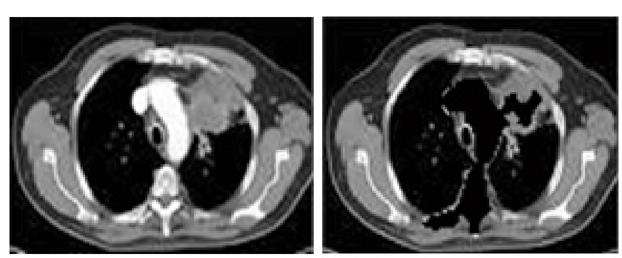
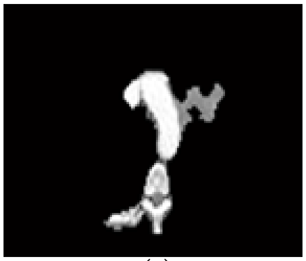

(a) (b) (c)

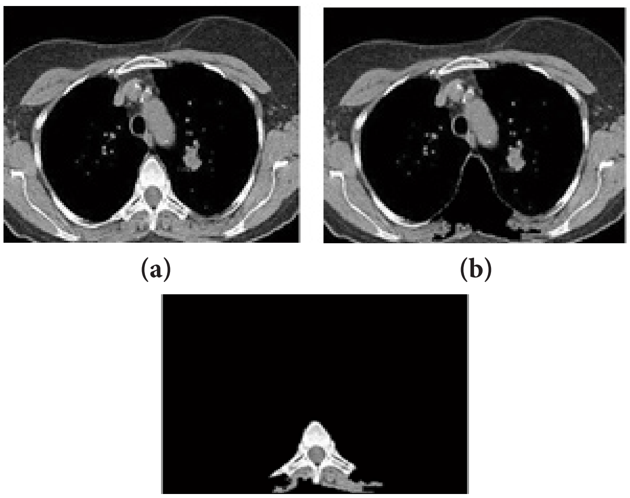
Figure 2. **(a)** Input CT image 1 **(b)** Background image **(c)** Region of diagnosis.


(a) (b)



(c)

Figure 3. (**a**) Input CT image 2 (**b**) Background image (**c**) Region of diagnosis.



(a) (b) (c)

Figure 4. (**a**) Input CT image 3 (**b**) Background image (**c**) Region of diagnosis.

4. Conclusion

The tumor segmentation is done on CT images. The energy function is obtained from CT and it is minimized using max-flow method. The graph cut method provides the shape term and region term to locate the tumor site.

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