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Medical image segmentation using fuzzy watershed

Dillip Ranjan Nayak

Asst. Prof, Department of Computer Science & Engg., Govt. College of Engg, Kalahandi, Odisha, (INDIA)

E-mail : dillip678in@yahoo.co.in

ABSTRACT

Watershed transform is one of the important technique used in image segmentation. It is based on grey-scale morphology. Distance transform is a common tool used in watershed transform for image segmentation. A new approach of fuzzy Watershed Algorithm using Distance Transform is applied to medical Image for Segmentation. Our results show that the fuzzy watershed segmentation is more robust to noise and accurate in object boundaries.

KEYWORDS

Watershed transform;
Fuzzy;
Boundaries;
Distance transform.

INTRODUCTION

Image segmentation separates[1,2] the objects and components of the image. The approach is to partition an image based on abrupt changes in intensity value such as edges. Edge detection is a fundamental tool in image processing, machine vision and computer vision. Various image segmentation algorithms have been proposed to achieve efficient and accurate results. Among these algorithms, watershed segmentation is a particularly attractive method[3]. The major idea of watershed segmentation is based on the concept of topographic representation of image intensity. The watershed transform is a powerful morphological tool for image segmentation. The watershed transform has been widely used in many fields of image processing, including medical image segmentation.

The advantages of the watershed transformation are that it is simple, instinctive knowledge, and can be parallelized. The main drawback of this method is the over-segmentation due to the presence of many local minima. Beucher and Lantuejoul were the first to apply the concept of watershed to digital image segmentation problems. Beucher[4] proposed a method for image segmentation based on the mathematical morphology. Bieniek and Moga[5] present an efficient watershed algorithm based on connected components. Hamarneh and Li[6] have proposed a method of watershed segmentation using prior shape and appearance knowledge.

But most of the techniques previously proposed consider the over segmentation problems and focus on the denoising of the image. The medical image low contrast and under segmentation problem is not yet addressed by most of the researchers. The proposed technique focuses on the solution of under segmentation problem of low contrast images by applying fuzzy watershed on the input image.

Mathematical morphology is a nonlinear branch of the image processing field and concerns the application of set theory concepts to image analysis. Morphology refers to the study of shapes and structures from a general scientific perspective. These operators transform the original image into another image through the iteration with other image of a certain shape and size which is known as structuring element[7,8]. The basic

Regular Paper

morphological filters are morphological opening and morphological closing[9]. A morphological gradient is the difference between the dilation and the erosion of a given image[10]. Fuzzy logic is a powerful tool for handling the ambiguous and vague information of the image. According to Zadeh[11] fuzzy logic is a mathematical expression with concept of set theory. So fuzzy is easily applied in image morphology.

This paper is divided into various sections. Section II presents the proposed scheme, Section III describes Experimental results and Section IV summarizes and concludes the paper.

PROPOSED SCHEME

In initial stage an image is converted into gray scale or black and white image. Then the image is filtered with Gaussian filter for smoothing. The gradient image is accrued from the grayscale image with the help of proposed modified fuzzy top hat edge detection operator. Finally the watershed algorithm is applied to detect segment objects within the image. So the proposed algorithm describes the following steps as follows.

1. Read the Input image.
2. Convert the input image to a gray image.
3. Apply Gaussian operation to gray image for smoothing.
4. Fuzzify the smoothed image using the following membership function
   img=double(smooth image);
   mx=max(max(img));
   img1=img./mx.
5. Define structuring element d= [0,0.2,0;0,1,0.8;0,0.8,0] which contains fuzzy values.
6. Find fuzzy dilation and fuzzy erosion using img1 and

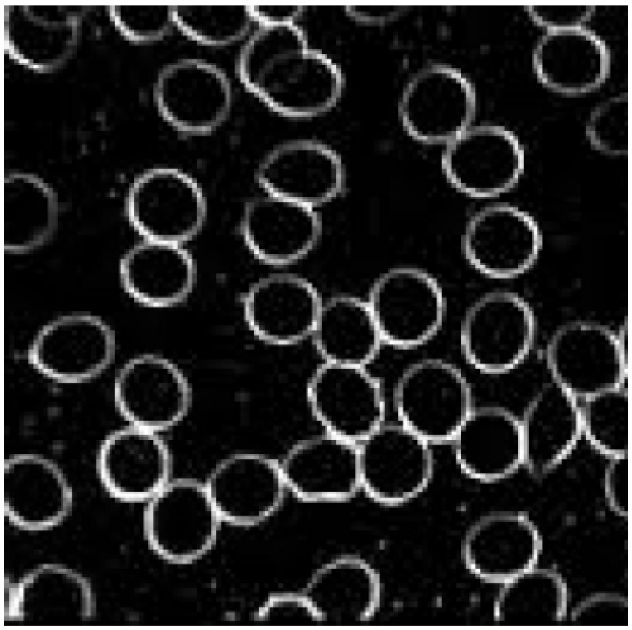

Figure 1 : Original blood image

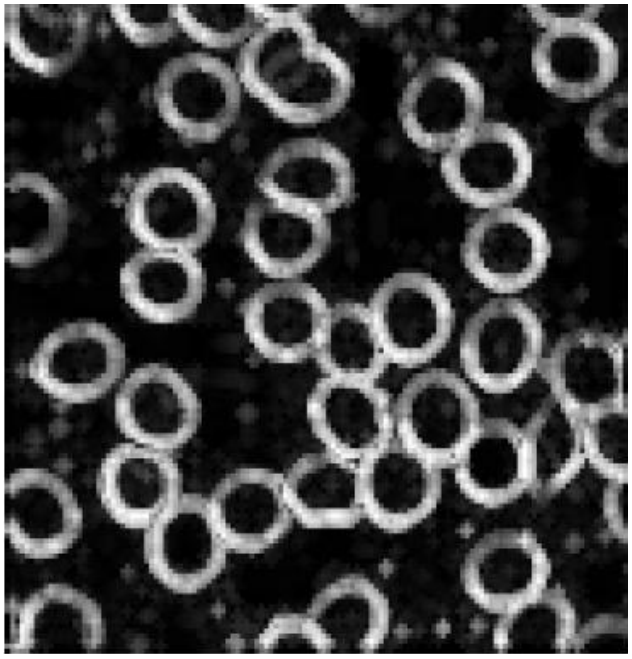

Figure 2 : Fuzzy gradient blood image

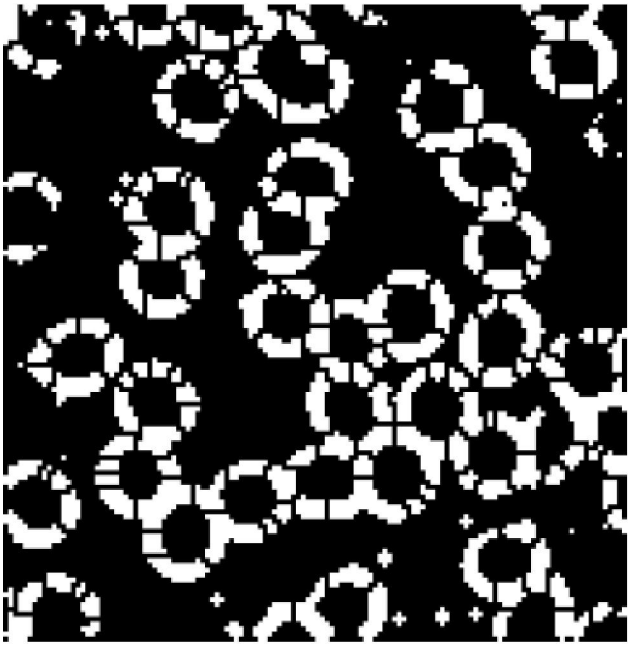

Figure 3 : Fuzzy water shed blood image

d

7. Develop gradient images using appropriate edge detection function
   Gradient image= abs (uint8 (fuzzy dilation)-uint8 (fuzzy erosion)).
8. Compute the watershed transform on the gradient image.

EXPERIMENTAL RESULTS AND DISCUSSION

In this paper the blood image (130*130) and brain image of (200*200) are taken for experment. The new developed algorithm is applied on these images to get better segmented images. The original blood image is shown in Figure 1. The fuzzy gradient image and watershed segmented image of blood image are shown in Figure 2 and Figure 3 respectively. The proposed approach is also applied on brain image which shown in Figure 4. Figure 5 shows the gradient image. Figure 6 is the segmented images after applying watershed algorithm. It have been observed by comparing the resultant images that the segmented images with watershed algorithm using fuzzy edge detection operators (Figure 3 and Figure 6) produces better segmentation and also the edges in the images are very sharp.

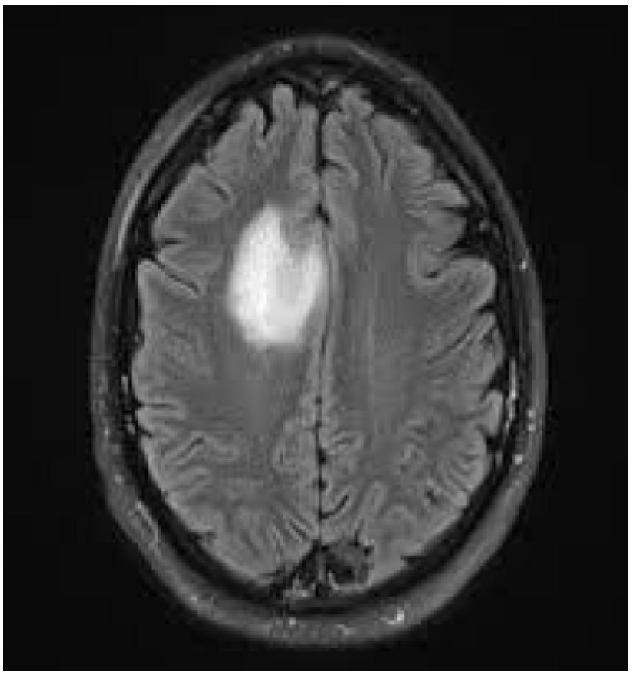

Figure 4 : Original brain image

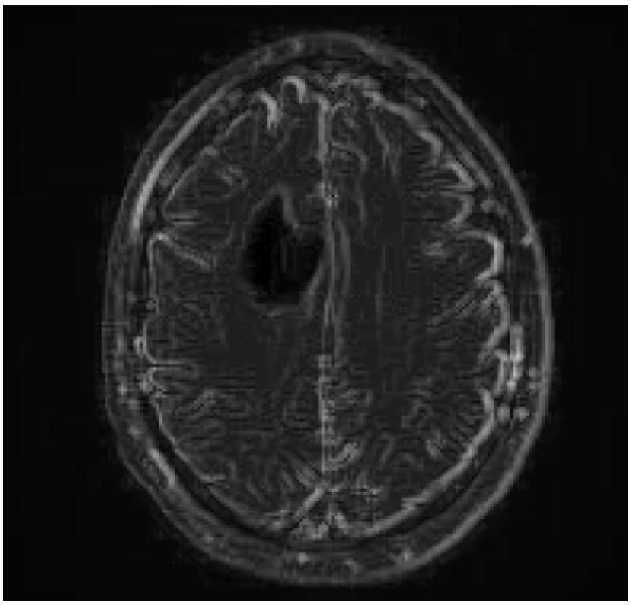

Figure 5 : Fuzzy gradient brain image

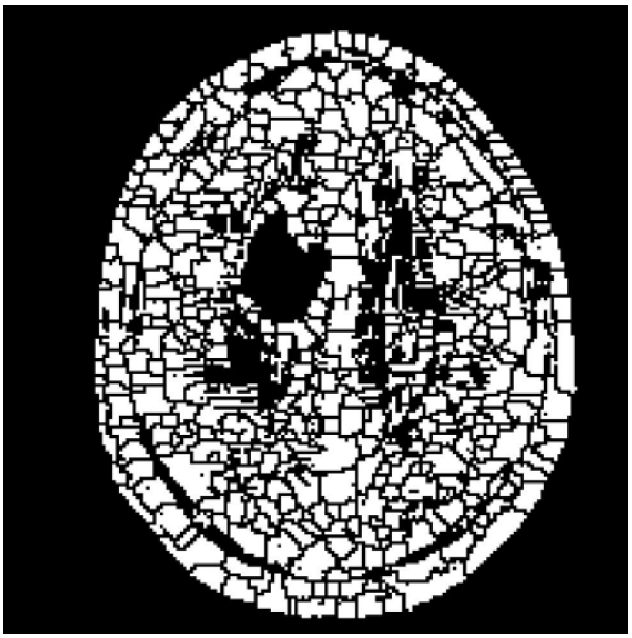

Figure 6 : Fuzzy water shed brain image

CONCLUSIONS

Fuzzy Watershed segmentation is an effective method for gray level image segmentation. To apply fuzzy watershed segmentation to gray images, we need to preprocess the gray images with fuzzy morphology which suitable for watershed segmentation. The algorithm is able to segment desired parts of gray-scale images. The proposed algorithm results give better identification of desired objects.

Regular Paper

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