Medical Image Segmentation using Marker Controlled Watershed Transformation

[1]Mandeep Kaur, [2]Gagandeep Jindal
[1,2]Dept. of CEC, Landran, Mohali, Punjab, India

Abstract
Segmentation refers to the process of partitioning a digital image into multiple segments (sets of pixels, also known as superpixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is used to cluster pixels into salient image regions, i.e., regions corresponding to individual surfaces, objects, or natural parts of objects. The watershed transform has interesting properties that make it useful for many different image segmentation applications: it is simple and intuitive, can be parallelized, and always produces a complete division of the image. However, when applied to medical image analysis, it has important drawbacks (oversegmentation, sensitivity to noise).In this paper medical image segmentation using marker controlled watershed segmentation is presented. Objective of this paper is segmenting the medical image using marker controlled watershed segmentation, and comparing the results of directly applying watershed transformation and marker controlled watershed transformation.

Keywords
Image segmentation, Watershed segmentation, marker controlled watershed segmentation.

I. Introduction

A. The Watershed Transform

Segmentation refers to the process of partitioning a digital image into multiple segments (sets of pixels, also known as superpixels) [3]. The watershed transform is a popular segmentation method coming from the field of mathematical morphology [1]. The intuitive description of this transform is quite simple: if we consider the image as a topographic relief, where the height of each point is directly related to its gray level, and consider rain gradually falling on the terrain, then the watersheds are the lines that separate the "lakes" actually called catchments basins) that form. Generally, the watershed transform is computed on the gradient of the original image, so that the catchments basin boundaries are located at high gradient points. Due to the number of advantages watershed transform has been widely used in many fields of image processing, including medical image segmentation, it is fast and can be parallelized (in [2], an almost linear speedup was reported for a number of processors up to 64), and it produces a complete division of the image in separated regions even if the contrast is poor, thus avoiding the need for any kind of contour joining. Several researchers have proposed techniques to embed the watershed transform in a multiscale framework, thus providing the advantages of these representations [4-5]. Most important drawbacks of watershed transformation are as follows.

1. Oversegmentation

When the watershed transform infers catchments basins from the gradient of the image, the result of the watershed transform contains a myriad of small regions, which makes this result hardly useful. The use of a marker image [6-7] to reduce the number of minima of the image and, thus, the number of regions, is the most commonly used solution. Also interesting is the utilization of a scale space approach to select the interesting regions, using different filters (morphological operations, or nonlinear diffusion [8-9].)

2. Sensitivity to noise

Local variations of the image can change dramatically the results. This effect is worsened by the use of high pass filters to estimate the gradient, which amplify the noise. Anisotropic filters have been used to minimize this problem [9-10].

3. Poor detection of significant areas with low contrast boundaries

If the signal to noise ratio is not high enough at the contour of interest, the watershed transform will be unable to detect it accurately. Furthermore, the watershed transform naturally detects the contours with higher value between markers, which are not always the contours of interest. A clear example is white matter-gray matter surface detection, where the proximity of other, higher contrast surfaces such as gray matter-CSF or CSF-bone will make the task difficult for the plain watershed transform.

B. Overview of the Work Presented

In this paper Medical image segmentation using marker controlled watershed transform is presented. We explain the comparison of watershed segmentation and marker controlled watershed segmentation for medical image segmentation application: Lung image segmentation. Method for the medical image segmentation is explained below in the section II A and II B.

II. Methods

A. Watershed Transformation

The concept of Watersheds is well known in topography. It was first proposed as a potential method for image segmentation. It is a morphological based method of image segmentation. The gradient magnitude of an image is considered as a topographic surface for the watershed transformation. Watershed lines can be found by different ways. The complete division of the image through watershed transformation relies mostly on a good estimation of image gradients. The result of the watershed transform is de- graded by the background noise and produces the over-segmentation. Also, under segmentation is produced by low-contrast edges generate small magnitude gradients, causing distinct regions to be erroneously merged. There are different ways to find watershed lines. Different approaches may be employed to use the watershed principle for segmentation. Local minima of the gradient of the image may be chosen as markers, in this case an over-segmentation is produced and a second step involves region merging. Marker based watershed transformation make use of specific marker positions which

have been either explicitly defined by the user or determined automatically with morphological operators or other ways [11-12]. Hamarneh and Li (2007) propose a method for image segmentation consist of watershed segmentation using prior shape and appearance knowledge. Watershed segmentation is a common technique for image segmentation [13]. Section II explains the methods used for the medical image segmentation. Section III explains the proposed work for the medical image segmentation. The results of the proposed technique are shown in the section IV. And the section V describes the conclusion of this paper.

B. Marker-Controlled Watershed Segmentation

Separating touching objects in an image is one of the more difficult image processing operations. The watershed transform is often applied to this problem. The watershed transform finds "catchments basins" and "watershed ridge lines" in an image by treating it as a surface where light pixels are high and dark pixels are low. One of the most important drawbacks associated to the watershed transform is the oversegmentation that commonly results. The usual way of predetermining the number and approximate location of the regions provided by the watersheds technique consists in the modification of the homotopy of the function to which the algorithm is applied. This modification is carried out via a mathematical morphology operation, geodesic reconstruction [14], by which the function is modified so that the minima can be imposed by an external function (the marker function). All the catchment basins that have not been marked are filled by the morphological reconstruction and so transformed into nonminima plateaus, which will not produce distinct regions when the final watersheds are calculated. Segmentation using the watershed transforms works well if you can identify, or "mark," foreground objects and background locations. Marker-controlled watershed segmentation follows this basic procedure:

1. Compute a segmentation function. This is animage whose dark regions are the objects youare trying to segment.
2. Compute foreground markers. These are connected blobs of pixels with in each of the objects.
3. Compute background markers. These are pixels that are not part of any object.
4. Modify the segmentation function so that it only has minima at the foreground and background marker locations.
5. Compute the watershed transform of the modified segmentation function.

III. PROPOSED WORK

In this section work done for processing lung image segmentation is explained. Firstly we have applied the watershed segmentation on the medical images but the results are not properly segmented; now mark the background objects using marker now apply watershed segmentation and compare the results.

The steps of the proposed system are shown in fig. 1, Input image

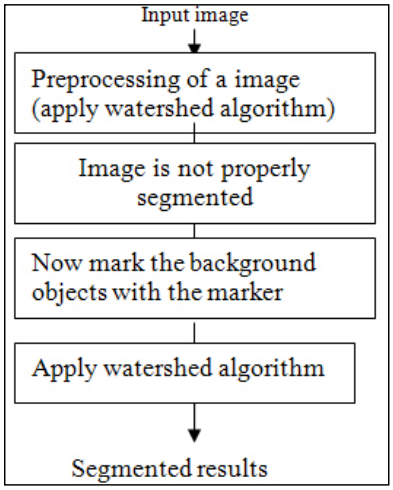

Fig. 1: proposed system

Preprocessing of image: In this section the DICOM Lung image is given as input and filter the image, and apply watershed algorithm, but it results into bad segmentation results. Marker controlled watershed segmentation: Now mark the background objects with the help of marker. A variety of procedures could be applied here to find the foreground markers which must be connected blobs of pixels inside each of the foreground objects. Here the method that is used is the use morphological techniques called "opening-by-reconstruction" and "closing-by-reconstruction" to "clean" up the image. These operations will create flat maxima inside each object that can be located using imregionalmax. Now compute background markers. Now you need to mark the background. In the cleaned-up image, the dark pixels belong to the background, so you could use a thresholding operation to mark the background objects. Now compute the watershed transform of the segmentation function. The function imimposemin can be used to modify an image so that it has regional minima only in certain desired locations. Here you can use imimposemin to modify the gradient magnitude image so that its only regional minima occur at foreground and background marker pixels. In next section IV Results are shown

IV. Results

The results obtained by the proposed work are shown below in fig. from 2(a) to 2(e)

Fig. 2:(a). Original image

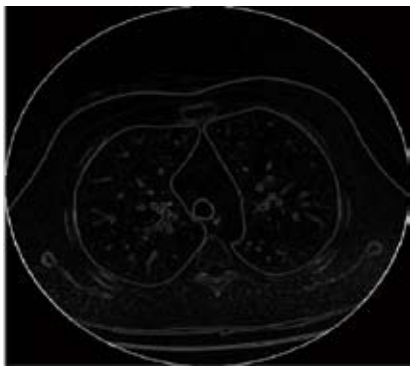

Fig. 2:(b). Use the gradient magnitude as the segmentation function

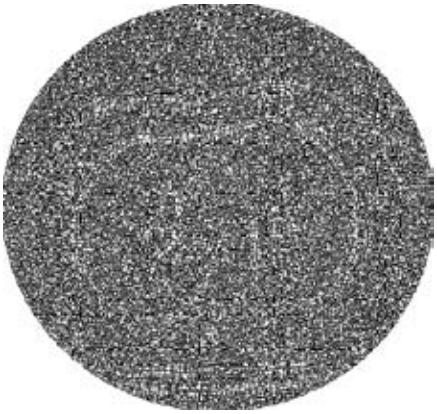

Fig. 2:(c). After applying Watershed algorithm.

Fig. 2:(d). After using Marker

Fig. 2:(e). After applying the watershed algorithm

V. Conclusion And Future Scope

This section describes the conclusion of this review paper. The segmentation refers to the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The watershed transform is a popular segmentation method coming from the field of mathematical morphology .The goal of this paper is defining the marker controlled watershed algorithm for the medical images. The results are shown above in section IV. Here the work has been done for only the lung images. The technique can be used for the other medical images. In future this technique can be used for other Dicom images.

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Mandeep Kaur received her B.Tech degree in Computer Science and technology from Institute of Engineering and technology Bhaddal affiliated to Punjab Technical University Jalandhar in 2009. Now she is pursuing M.Tech degree from Chandigarh Engineering College Landran, Mohali. Her research interest is digital image processing.

Presently, Gagandeep Jindal is currently working as Asst. Professor in the Dept. of Computer Science & Engg. at Chandigarh Engg. College, Landran, Mohali. He has received his M.E degree in Computer Science and Engineering from PEC University of Technology, Chandigarh in 2005. He is currently doing his Ph.D in the area of CBMIR. His research interests are in Image Processing and Image Retrieval.