An Improved Watershed Image Segmentation Technique using MATLAB

Anju Bala

Abstract -Watershed Transformation in mathematical morphology is a powerful tool for image segmentation. Watershed transformation based segmentation is generally marker controlled segmentation. This paper purposes a novel method of image segmentation that includes image enhancement and noise removal techniques with the Prewitt's edge detection operator. The proposed method is evaluated and compared to existing method. The results show that the proposed method could effectively reduce the over segmentation effect and achieve more accurate segmentation results than the existing method.

Keywords: Image Segmentation, Image enhancement, Marker Controlled Watershed Segmentation, Prewitt's operator, Watershed Transformation

1 INTRODUCTION

IMAGE segmentation is an important and, perhaps, the most difficult task in image processing. Segmentation refers to the grouping of image elements that exhibit "similar" characteristics, i.e. subdividing an image into its constituent regions or objects. All subsequent interpretation tasks, such as object recognition and classification, rely heavily on the quality of the segmentation process.

The watershed transform is a broadly used technique for image segmentation. The watershed transform can be classified as a region-based segmentation approach. The intuitive idea underlying this method comes from geography: it is that of a landscape or topographic relief which is flooded by water, watersheds being the divide lines of the domains of attraction of rain falling over the region [1]. An alternative approach is to imagine the landscape being immersed in a lake, with holes pierced in local minima. Basins (also called 'catchment basins') will fill up with water starting at these local minima, and, at points where water coming from different basins would meet, dams are built. When the water level has reached the highest peak in the landscape, the process is stopped. As a result, the landscape is partitioned into regions or basins separated by dams, called watershed lines or simply watersheds.

Anju Bala is currently pursuing Master's degree in Computer science and Engineering in H.P.University, Shimla, India, PH-01772-832569. E-mail: anjurana_libra@yahoo.com

In practice, the watershed is applied to the image gradient and the watershed lines separate homogeneous regions, giving the desired segmentation result. The gradient image for the transform is often found using the morphological gradient. However, noise in the gradient image results in over-segmentation which can have a significant adverse affect on the quality of the segmentation results. The quality of the gradient estimate has a major influence on them segmentation performance. So the result of different gradients on watershed has been found with the help of peak signal to noise ratio.

Over-segmentation is a significant problem for most watershed algorithms, which were addressed in numerous literatures [2-6]. Conventionally, watershed transform is mostly designed for the purpose of image segmentation.

The division of the image through watershed algorithm relies mostly on an estimation of the gradients. The low-contrast [5] edges produce an under segmentation and generate small magnitude gradients, causing distinct regions to be erroneously merged. In this paper we will discuss the image segmentation done by watershed transformation in which the image enhancement techniques are used so as to avoid under segmentation and noise removal techniques to reduce over segmentation. These are pre-segmentation techniques applied to input image.

1.1 THE WATERSHED TRANSFORM

The watershed transform [7] is a morphological based tool for image segmentation. In grey scale the mathematical

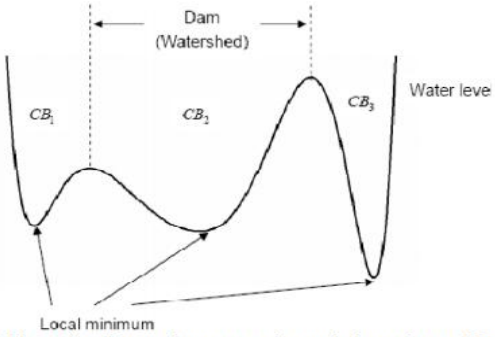


Fig. 1 Illustration of immersion process of watershed transforms. (CB: Catchment basins)

morphology watershed transform for segmentation is originally proposed by Digabel and Lantuejoul in1977 and later improved by Li et Al in 2003. The watershed transform can be classified as a region-based segmentation approach. Fig. 1 Illustration of immersion process of watershed transforms. (CB: Catchment basins).The idea [8] of watershed can be view as a landscape immersed in a lake; catchment basins will be filled up with water

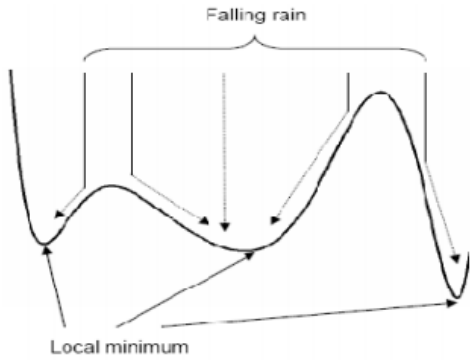


Fig. 2 Illustrations of flooding (process of watershed transform

starting at each local minimum. Dams must be built where the water coming from different catchment basins may be meeting in order to avoid the merging of catchment basins. The water shed lines are defined by the catchment basins divided by the dam at the highest level where the water can reach in the landscape [9]. As a result, watershed lines can separate individual catchment basins in the landscape. The idea is described in Figure 1 which describes the flooding or rain falling process of watershed algorithm. The process of rain falling is described in Figure 2.

2 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 "catchment basins" and "watershed ridge lines" in an image by treating it as a surface where light pixels are high and dark pixels are low. Segmentation using the watershed transform works better if you can identify, or "mark," foreground objects and background locations. Marker-controlled watershed segmentation [10] follows this basic procedure:

1. Compute a segmentation function. This is an image whose dark regions are the objects you are trying to segment.
2. Compute foreground markers. These are connected blobs of pixels within 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.

3 Proposed Technique

Unfortunately, in some cases, the markers selection and extraction are not so easy. Some pictures may be very noisy and image processing becomes more and more complex. In other cases, the objects to be detected may be so complex and so varied in shape, grey level and size that it is very hard to find reliable algorithms enabling their extraction. For that reason, we need to go a step further in the segmentation. We know that the initial watershed transformation of the gradient image provides very unsatisfactory results many apparently homogeneous regions are fragmented in small pieces. Fortunately, the watershed transform itself, applied on another level, will help us to merge the fragmented regions. Indeed, if we look at the boundaries produced by the segmentation, they do not have the same weight. Those which are inside the almost homogeneous regions are weaker. In order to compare these boundaries, we need to introduce neighborhood relations between them. The watershed transform presents some advantages:

- The watershed lines always correspond to the most significant edges between the markers. So this technique is not affected by lower-contrast edges, due to noise, that could produce local minima and, thus, erroneous results, in energy minimization methods.

- Even if there are no strong edges between the markers, the watershed transform always detects a contour in the area. This contour will be located on the pixels with higher contrast.

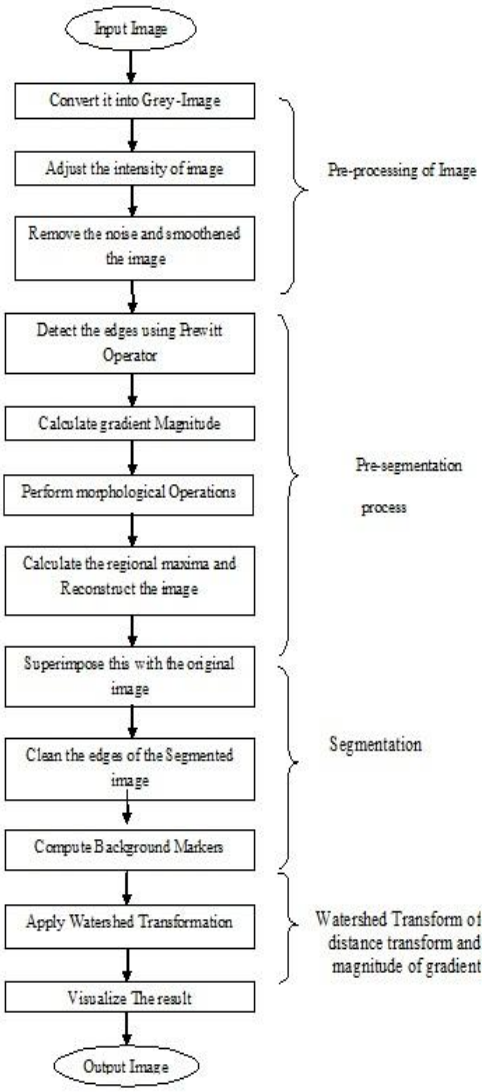


Fig. 3 Overview of proposed Technique

This approach is applied as follows: Mainly it is divided into four main steps the first step is to apply preprocessing techniques that includes reducing the noise and adjust the image intensity by preserving image information in it. The noisy images lead to over segmentation and not an accurate segmented image. So, here we first remove the noise from the image and pixel values are adjusted so that they will help to obtain the well segmented image.

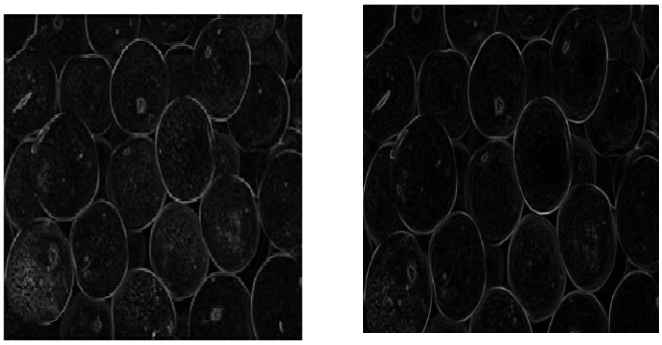
The next step is pre segmentation processes that includes various morphological [7] operations such as finding out regional maxima and mark the foreground objects that help in segmentation process. Then after marking the foreground objects reconstruct the image.

In the third step we did the main task of our process that is segmentation. After reconstructing the image we superimpose it with the original image, clean the edges of the segmented image and compute background markers.

The last step is to apply watershed transformation to the distance transform of the image and then see the result that is segmented image.

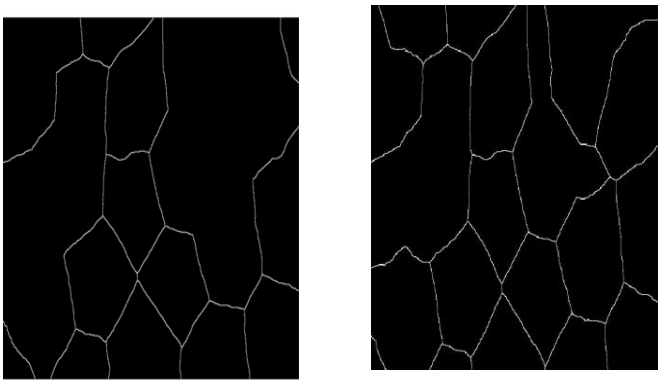
4 RESULTS

Fig. 4 Original Image



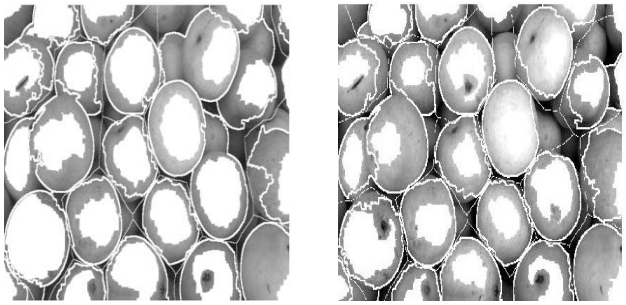
(a) (b)

Fig.5 Gradient magnitude of image (a) using Sobel operator (b) Using Prewitt's operator



(a) (b)

Fig. 6 Watershed Ridge lines (a) Using existing method (b) Using Proposed method



(a) (b)

Fig. 7 Segmented Image (a) Using Marker Controlled Watershed Segmentation (b) Proposed Watershed segmentation technique.

5. CONCLUSION

The goal of image segmentation process is to identify the segments of the image according to the characteristics of objects e.g. object shape, image color etc. In order to solve the over segmentation problem of traditional watershed technique an improved technique is proposed that uses pre processing methods to reduce the noise of image and adjust the image intensity. Also we use the Prewitt's operator to detect the edges instead of Sobel operator as in existing marker controlled watershed transformation.

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