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Implementation of Image Segmentation using Watershed Transformation

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ABSTRACT

Image segmentation is the process of segmenting the image into various segments that could be used for the further applications such as : Image understanding model, Robotics, Image analysis, Medical diagnosis, etc. Image segmentation is the process of partitioning an image into multiple segments, so as to change the representation of an image into something that is more meaningful and easier to analyse. Segmentation technique, basically convert the complex image into the simple image.

Keywords: Edge Detection, Digital Image Processing, Image Segmentation

I. INTRODUCTION

Images are considered as one of the most important medium of conveying information, in the field of computer vision, by understanding images the information extracted from them can be used for other tasks for example: navigation of robots, extracting malign tissues from body scans, detection of cancerous cells, and identification of an airport from remote sensing data. Now there is a need of a method, with the help of which, we can understand images and extract information or objects, image segmentation fulfil above requirements. Thus, image segmentation is the first step in image analysis. Sometime image denoising is done before the segmentation to avoid from the false contour selection for segmentation to segment the image without loss of information for medical. Image segmentation refers to the process of partitioning a digital image into multiple segments i.e. set of pixels, pixels in a region are similar according to some homogeneity criteria such as colour, intensity or texture, so as to locate and identify objects and boundaries in an image [1]. Diagnosing purpose is a challenging job.

II. METHODS AND MATERIAL

Image segmentation means assigning a label to each pixel in the image such that pixels with same labels share common visual characteristics. It makes an image easier to analyse in the image processing tasks. There are many different techniques available to perform image segmentation. Our motive is to implement almost the same concept as we humans try to implement, while understanding the image which we visualize. In human vision, the complex image is immediately segmented into the simple objects on the basis of color, texture, patterns, shapes, etc. This same thing is constructed with the help of the image segmentation techniques in the computer vision system. We could segment the digital image on the basis of these features, so that the task of understanding of image could be done in a simple and humanly way. On the basis of these defined features, there are several image segmentation techniques which would provide the segmented results. Image segmentation refers to the process of partitioning a digital image into multiple segments i. e. set of pixels, pixels in a region are similar according to some homogeneity criteria such as color, intensity or texture, so as to locate and identify objects and boundaries in an

image [1]. The choice of a segmentation technique over another and the level of segmentation are decided by the particular type of image and characteristics of the problem being considered.

Image Segmentation Techniques basically; there are two categories of segmentation techniques: Edge-Based, Region - Based Segmentation, based on the discontinuities or similarities.

Detecting Discontinuity It means to partition an image based on abrupt changes in intensity [1], this includes image segmentation algorithms like edge detection.

Detecting Similarity It means to partition an image into regions that are similar according to a set of predefined criterion.

2.1 Watershed Transform

The Watershed Transform is a unique technique for segmenting digital images that uses a type of region growing method based on an image gradient. The concept of Watershed Transform is based on visualizing an image in three dimensions: two spatial coordinates versus gray levels. In such a "topographic" interpretation, we consider three types of points: A. Points belonging to a regional minimum. B. Points at which a drop of water, if placed at the location of any of those points, would fall with certainty to a single minimum. C. Points at which water would be equally likely to fall to more than one such minimum. For a particular regional minimum, the set of points satisfying condition (B) is called the catchment basin or watershed of that minimum. The points satisfying condition (C) form crest lines on the topographic surface and are termed divide lines or watershed lines. The principal objective of segmentation algorithms based on these concepts is to find the watershed lines. 2.2.1 Advantages of Watershed Transform the Watershed Transform effectively combine elements from both the discontinuity and similarity based methods. Since its original development with grey-scale images, the Watershed Transform has been extended to a computationally efficient form (using FIFO queues) and applied to colour images. The main advantages of the Watershed method over other previously developed segmentation methods are

A. The resulting boundaries form closed and connected regions. Traditional edge based techniques most often form disconnected boundaries that need post-processing to produce closed regions.
B. The boundaries of the resulting regions always correspond to contours which appear in the image as obvious contours of objects. This is in contrast to split and merge methods where the first splitting is often a simple regular sectioning of the image leading sometimes too unstable results.
C. The union of all the regions forms the entire image region.

2.2 Watershed Implementation Methods

There are mainly three methods to implement watershed. They are listed below:

- Distance Transform Approach
- Gradient method
- Marker Controlled Approach

The watershed transformation is performed on a gradient image g extracted from the original image however the problem with the conventional intensity gradient is it is not able to detect the interfaces between homogeneously textured image regions. This is because the gradient image highlights the variations within the textures rather than showing the change between textured regions, as shown in Figure 4 below. A Texture Gradient is therefore required to detect the texture boundaries

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III. RESULTS AND DISCUSSION

The various steps involved in marker controlled watershed segmentation are shown below.

Step 1. The first step is to read the combined Texture and Intensity Gradient.
Step 2. Next step is to compute the Foreground Markers. These are connected blobs of pixels within each of the objects in the image. Variety of procedures could be applied to find the Foreground Markers. In the present work morphological techniques called "opening- by reconstruction" and "closing-by-reconstruction" are used to "clean" up the image. These operations will create flat maxima inside each object. Opening-by-reconstruction is erosion followed by a morphological reconstruction

whereas closing-by-reconstruction is dilation followed by morphological reconstruction. These operations will remove small blemishes without affecting the overall shapes of the objects. Good Foreground Markers can be obtained by computing the regional maxima of the resulting Gradient Image.

Step 3. Some of the mostly-covered and shadowed objects will not be marked in the previous step, which means that these objects will not be segmented properly in the end result. Also, the Foreground Markers in some objects go right up to the objects' edge. Hence it is necessary to clean the edges of the marker blobs and then shrink them a bit. This can be done by a closing followed by erosion. This procedure tends to leave some stray isolated pixels that must be removed.

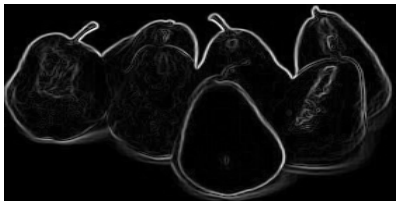
Step 4. Next the background locations need to be marked. In the cleaned-up image, the dark pixels belong to the background, so thresholding is a suitable operation to start with.

Step 5. The background pixels will be in black, but ideally the background markers shouldn't be too close to the edges of the objects that are being segmented. So the next step is to "thin" the background by computing the "skeleton by influence zones", or SKIZ, of the foreground. This can be done by computing the watershed transform of the distance transform of threshold image, and then looking for the watershed ridge lines of the result.

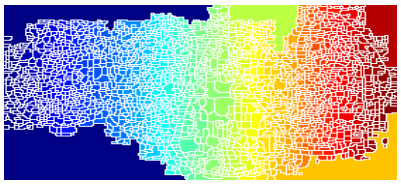
Step 6. The next step is to modify the Gradient Image so that it has regional minima only in certain desired locations i.e. at the Foreground and Background Marker pixels.

Step 7. The final step is to give this Modified Gradient Image as input to the Watershed Transform Algorithm.

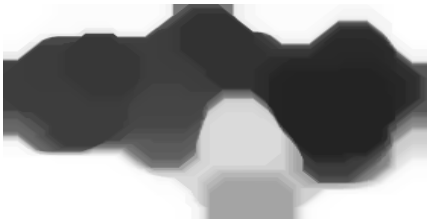
Gradient magnitude (gradmag)



Watershed transform of gradient magnitude (Lrgb)

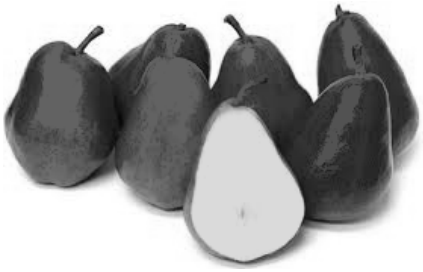


Opening-closing (loc)

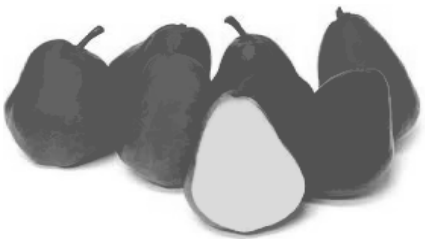


Regional maxima of opening-closing by reconstruction (fgm)

Opening-by-reconstruction (lobr)

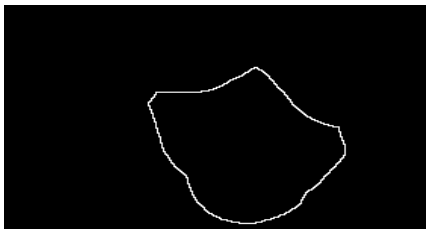


Opening-closing by reconstruction (lobrcbr)

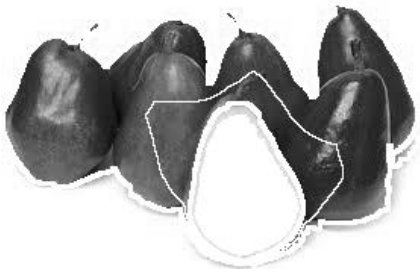


Thresholded opening-closing by reconstruction (bw)

Watershed ridge lines (bgm)



Markers and object boundaries superimposed on original image (I4)



Colored watershed label matrix (Lrgb)

IV. CONCLUSIONS

It has been show that good segmentation results can be achieved. Watershed algorithm is a powerful and fairly efficient tool for image segmentation, even for overlapping or adjacent rocks. These tools, when combined with the process of mark selection, permit an effective approach for practical image segmentation. The success of this combined procedure is however, dependent upon the process of mark selection. In order to avoid an over segmentation, we propose to adapt the topological gradient method.

V. REFERENCES

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