An Image Segmentation Approach Using Watershed Technique

Bimalini Meher [1*], Chandra Sekhar Panda [2]

1,2 Department of Computer Science, Sambalpur University, Jyoti vihar, Burla, Odisha, India

Corresponding Author: bimalinim@gmail.com, Tel.: +917682935731

Abstract— Watershed algorithm is used in image processing primarily for segmentation purposes. The main aim of this technique is to segment the image, generally when two regions of interest are close to each other i.e, their edge touch. Watersheds use many of the concepts of edge-detection, thresholding & region growing and often produce stable segmentation results. Watershed segmentation algorithm is an attractive method when compared to other segmentation algorithm. The Watershed segmentation technique can be applied to binary image, gray scale image and textural images. In many field of image processing including medical image segmentation, the watershed transform has been widely used. This method yields a result of accurate segmentation by reducing the over segmentation effect. Watershed transform is applied on distance transform, gradient image ,and marker controlled image and check which among the three yield the best result.

Keywords— Thresholding, Image segmentation, Distance Transform, Gradient Magnitude, Marker controlled watershed segmentation.

I. INTRODUCTION

An important step in image analysis is image segmentation, it is also the basic of further understanding of images. Watershed algorithm is a conventional and adequate image segmentation technique.

Segmentation subdivides an image into its constituents region or object. All subsequent representation tasks , such as object recognition and classification, object recognition and interpolation tasks, rely heavily on the segmentation technique .The idea of watershed segmentation method has taken from the field of geography . Watershed define as a region of land that aids in draining water (usually rain water) into a river or a creek. An secondary approach is to imagine that the landscape being immersed in a lake , with local minima which indicates the holes .Basins also called as (Catchment basins) fill up with water starting from the point of local minima to a point where the level of water reached the highest peak in the landscape[1][2] .As a result, regions or basins of landscape separated by dams, called watershed lines or simply watershed.

The output of the segmentation produces many watershed ridge lines which included in the object of interest, shows the edge touched regions which are separated by watershed ridge lines as well as the rest individual regions.

The problem of over segmentation and noise occurs during different transformation and this paper deals with such problems .In this paper we will discuss on watershed image segmentation using distance transform, gradient and watershed marker controlled watershed segmentation.

The Watershed Transform:-

The Watershed Transformation is a morphological based tool for image segmentation. The Watershed Transformation is a gray scale mathematical morphology was initially introduced by Digabel and Lantueljoul as well as Beucher and Mayer, and improved later by Beucher and Lantuejoul[3][4].
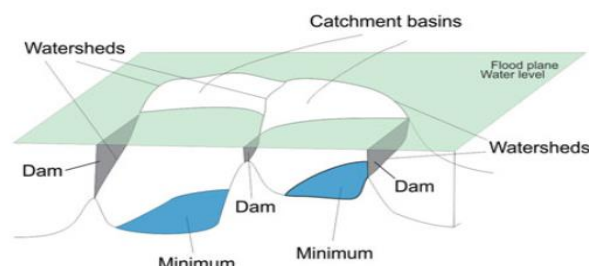

Figure 1. Watershed Transform in Topographic surface

The watershed segmentation algorithms represent the image in the form of a topographic relief, where the value of each image element characterizes its height at this point. In this paper the term pixel and vixel of image elements are used because this algorithm has the capabilities to process both 2D and 3D images[5]. Thus, the relief consists of low-lying valleys (minimums), high-altitude ridges (watershed lines) and slopes (catchment basins). The concept of plateau (an area with the same height of elements) is also used[6][7].

The main task in this segmentation method is to ascertain the location of all watershed lines and/or catchment basins, since in this case, each catchment basin is ascertained to be an individual segment of the image[8][9]. In some cases,

we only need to get the segments, but in some, we also need to know the boundaries of each segment.

II.   RELATED WORK

Arindrajit Seal Arunava Das, Prasad Sen [1] in their approach they have tried to improvise on the watershed segmentation procedure using distance transform method of watershed. Watershed transform is a powerful tool for the purpose of image segmentation. However, the purpose of watershed transform is not limited in image segmentation. They have used variable values for the threshold of regional maxima.

Amandeep Kaur, Aayushi [2] shows images containing components of different shapes, they find that the Chessboard DT can achieve better watershed segmentation results than Euclidean DT and City block DT. Also, Marker controlled method is much effective in segmentation as it significantly reduces the number of minima's.

Advantages of watershed segmentation is given by S. Beucher[3] is When computing the watershed, there is a good match between the contours which undoubtedly appear in the image and the divide lines of the gradient watershed, even when it is severely over-segmented.

An Improved Watershed Image Segmentation Technique using MATLAB proposed by Anju Bala [4] concluded that if prewitt operator is used instead of sobel operator then it would reduce the present in the image and adjust the image intensity.

Watershed segmentation based on distance transform and edge detection technique by Pinaki Pratim Acharjya [7] usually used differential edge detection operators such as Sobel edge detector or LoG edge detector with the combination of morphological watershed segmentation using distance transform. The detected edges are more sharp, pin pointed and clear with abundant edge information.

A new approach for watershed based color image segmentation is proposed by Dibya Jyoti Bora, Anil Kumar [9]Gupta, the main focus is given on the pre-processing issues for the same algorithm. Here, as color image segmentation is concerned, so, HSV color space is chosen because of its notable performance on the same. The input RGB image is first converted to HSV one. The V channel of the HSV converted image is undergone a histogram equalization effect for enhancing the contrast of the image by spreading the intensity values over full range. This helps to brings out those edges of the image which are otherwise hidden. After that, through a few experiments, we have proved that together Otsu's thresholding with Sobel Filter forms a better pre-processing step for an image than any of them alone.

Qing Chen, Xiaoli Yang, Emil M. Petriu [10] found out that the common DTs include Euclidean, City block and Chessboard. Different DTs produce different watershed segmentation results for the binary images. For images containing components of different shapes, we find that the

Chessboard DT can achieve better watershed segmentation results than Euclidean DT and City block DT.

Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing[11], in their paper they define how marker selection can range from the simple procedures just described to considerably more complex methods involving size ,shape ,location ,relative distance ,texture content ,and so on .They concluded that using markers brings a prior knowledge to bear on the segmentation problem.

Explain the full potential of the multi-scale decomposition by Paul T. Jackway [14] that has yet to be explored; though, a strong monotonicity property of region provides a solid base for further development and application.

III.   METHODOLOGY

1.**The Watershed Segmentation Using distance Transform:-**

The Distance Transform is only applicable to the binary images and can be calculated by taking the distance from black pixel to the nearest white pixels. A binary image has only two gray level value and that are 0 and 1,where 1 represents white and 0 represents black[10]. A tool used often in conjunction with the watershed transform for segmentation is the distance transform. It is the distance from every pixel to the nearest non-zero value pixels[11].A toolbox function bwdist is used to compute the distance transform of an image. The syntax can be written as

$$D=bwdist(f)$$

Figure2.Distance Transform on a Matrix

There are three types of toolbox functions are present to calculate the distance transform of an image they are (I)Euclidean Distance Transform (ii)City Block Distance Transform (iii)Chess board distance Transform
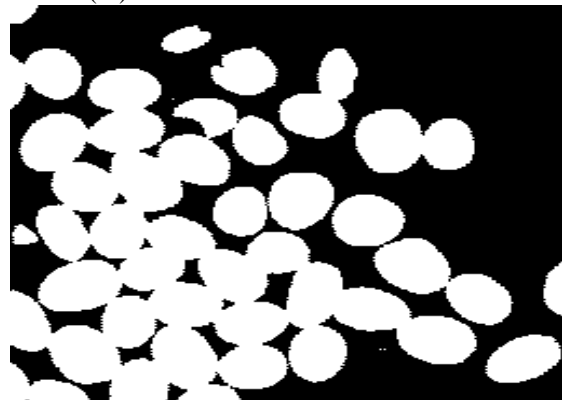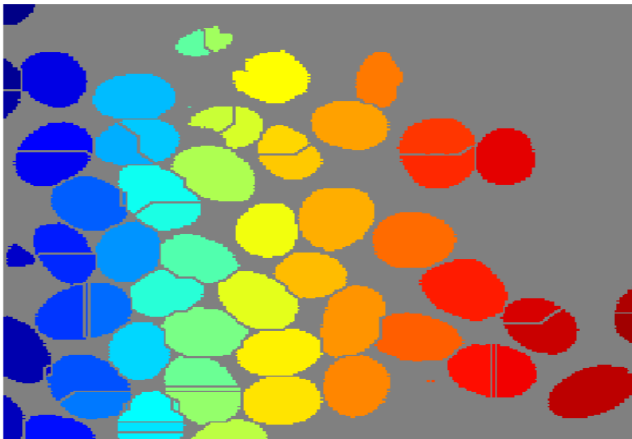

Figure3. Coffee Beans Image
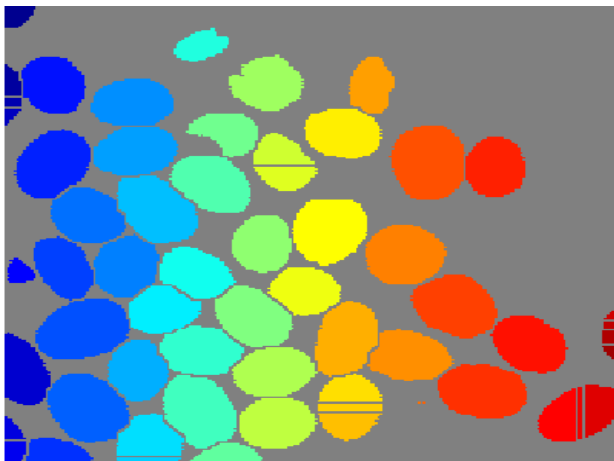
Figure4.Euclidean Distance Transform
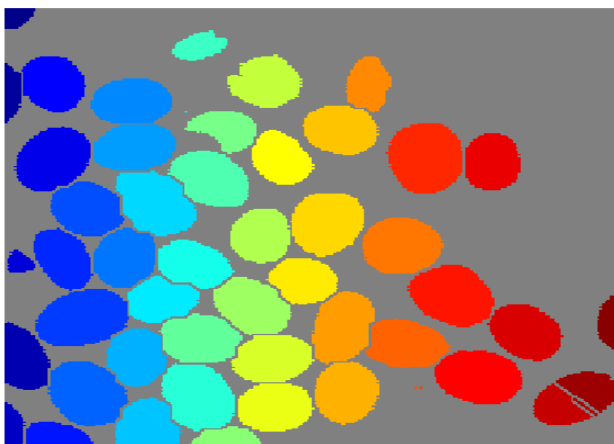

Figure5.CityBlock Distance Transform

Figure6.ChessBoard Distance Transform

Euclidean Distance Transform produces higher possibility of "salt and pepper" over segmentation. The City block distance transform produce over segmentation due to the propagation to the neighborhood in the shape of diamond. Better pruning effect can be achieved by Chess board distance transform using square shape propagation [12][13]. The downfall over segmentation, and jaggedness caused by city block distance transform and Euclidean Distance transform can adequately remove using Chess board distance transform.

2.Watershed Segmentation using Gradient Method:-

In this method , the image is pre-processed before applying the watershed transform. Gradient magnitude of a gray scale image is obtained during the pre-processed step. It has high pixel value along object edges and low pixel value everywhere else .The result of watershed transform would produce along object edges and those are the watershed ridge lines[14] .There is a shortcoming of Gradient method is over segmentation .Over segmentation means there is a large number of segmented regions. It is concluded from the experiment that it shows over segmentation problem, which usually appears with Gradient technique ,can be attenuated and the segmentation result can be performed using the Marker controlled approach [15].There is one more advantage of this approach is that it divide the segmentation technique into two different steps :The first step is to develop the main edges of the processed image ,in the second step calculate the watershed of gradient detect.

3.Marker Controlled Method:-

Main advantage of watershed transformation are that is spontaneous knowledge ,simple , and can be parallelized .The main shortcoming of above method is, it generates over-segmentation due to the presence of many local minima[16].The marker controlled method has been introduced to eliminate the effect of over segmentation .This method used closed contours for segmenting objects and it is robust and flexible in nature .A marker is a connected component belonging to an image .Markers are basically are of two types ,internal marker used for objects and external marker used for boundary [17].Markers are used to modify the gradient image .Internal markers are used to limit the number of regions by specifying the object of interest .External markers are those pixels that are confident to belong to the background .Minima imposition is a procedure uses both internal and external markers to modify the gradient image[18].
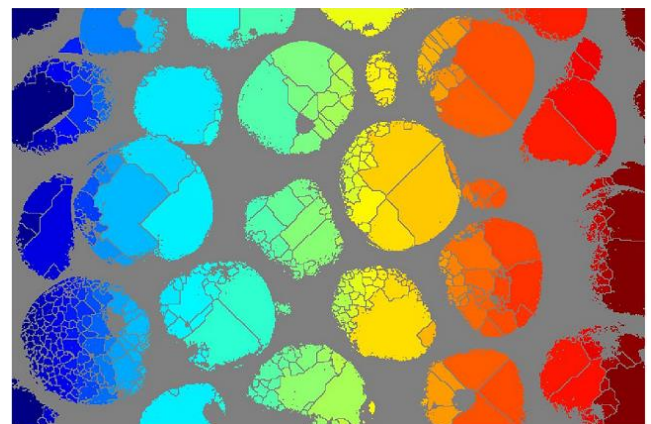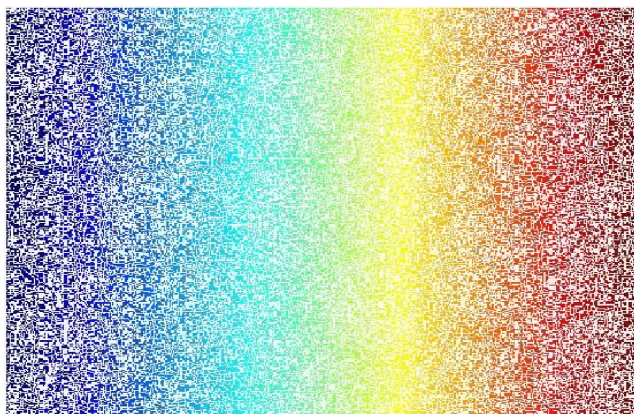

Figure7.Distance Transform Method
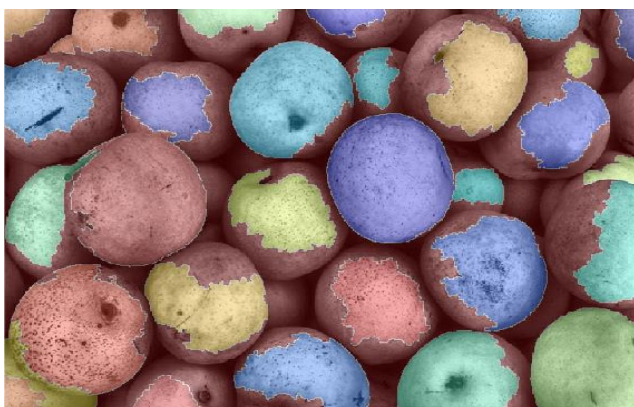
Figure8.Gradient Magnitude

Figure9.Marker Controlled Method

IV.   CONCLUSION

The watershed segmentation technique is used to resolve the problem of over segmentation as well as to segment two object of touched edges .Here we saw that different method of watershed segmentation including Distance Transform ,Gradient method and marker controlled image segmentation .We find that the ChessBoard distance transformation can achieve better watershed transformation than Euclidean and City Block distance transform for image containing similar shapes . The most efficient technique is the marker-controlled watershed technique as it significantly reduces the number of minima.

V.   FUTURE SCOPE

The purpose of watershed transform is not limited to any specific field. Image processing is very demanding field which needs extensive attention, hard work and research. Following are the suggestion for future work.

(i)Watershed Technique would be enhanced by adding new technique to it to get better result.

(ii)This Technique would be applied to specific field using various processing technique.

(iii)The work can be extended to text image, satellite image and video frame etc.

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