International Journal of Enhanced Research in Management & Computer Applications
ISSN: 2319-7471, Volume 7 Issue 5, May-2018, Impact Factor: 3.578

Implementation of Watershed Algorithm of over segmentation of Images

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ABSTRACT

The watershed technique is a region-growing algorithm that analyzes an image as a topographic surface. It detects the regional minima of the gradients in the gray level image and grows these minima according to the gradient values. It can be viewed as a flooding process. However, a large number of noises produce corresponding spurious minima in the image. As a result, each of these spurious minima will be segmented as a separate region in the watershed processing, which causes the over-segmentation problem of the watershed algorithm.

Keywords: Image, watershed algorithm, over segmentation

INTRODUCTION

Segmentation partitions an image into distinct regions containing each pixels with similar attributes. The success of image analysis depends on reliability of segmentation, but an accurate partitioning of an image is generally a very challenging problem. Segmentation techniques are either contextual or non-contextual. Segmentation is the process that split the image into various regions of different characteristics like colors, intensity and texture and extracts the interested object. Several general-purpose techniques and algorithms have been developed for image segmentation. Since there is no general solution to the image segmentation problem, these techniques often have to be combined with domain knowledge in order to effectively solve an image segmentation problem for a problem domain. Thus Image segmentation needs to be approached from a wide variety of perspectives. Major applications of image segmentation are in medical Imaging, face recognition, finger-print recognition.

Image segmentation is the process of partitioning a digital image into multiple segments. Segmentation is the process that split the image into various regions of various characteristics like colors, intensity and texture and extracts the interested object. Image segmentation is a significant and conceivably, the most difficult task in image processing. It is the process of separating the target/ object from the background or surroundings area by extracting outline of the target object. It is an important pre-processing step for most image analysis tasks. The general segmentation problem involves the partitioning of a given image into a number of homogeneous segments (spatially connected graphs of pixels). Alternatively, segmentation can be considered as a pixel labeling process in the sense that all pixels that belong to the same homogeneous region are assigned the same label. Although it is a difficult problem, several algorithms have been proposed for its solution. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s). When applied to a stack of images, typical in medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like marching cubes.

LITERATURE REVIEW

The clustering methods have been discussed for medical image segmentation in particularly for MR Images of brain and are successful in combining fuzzy c-means and k-means to get novel fuzzy-k means algorithm [3]. Hybrid technique for medical image segmentation mainly works on fuzzy-c means and otsu's method after applying on vector median filter, for segmentation and have tried to prove the robustness of their method few kinds of noise have been

added to image and have obtained satisfactory results [4]. A new technique for general purpose interactive segmentation of N-dimensional images using graph-cut method has been proposed by Yuri and Jolly [5].

There are several methods employed for detection of threshold value to name a few mean method, ptile- thresholding, bimodal histogram, optimal thresholding, multispectral thresholding, edge maximization method. The threshold-based segmentation techniques are inexpensive, computationally fast and can be used in real time applications with aid of specialized hardware [6]. The available techniques for threshold-based segmentation, threshold selection based on the histograms suggested by Nobuyuki Otsu in 1979 is most used with minor modifications [7]. There are four different edge types that may be present in the image (a) step-edge (b) ramp edge (c) ridge edge and (d) ramp edge and are shown in the fig correspondingly [8]. The simplest approach to segment image based on the similarity assumption is that every pixel is compared with its neighbor for similarity check (for gray level, texture, color, shape) [9]. The watershed algorithm uses concepts from edge detection and mathematical morphology to partition images into homogeneous regions and is applied to the gradient magnitude of the image [10].

Graph based methods for image segmentation has several good features in practical applications. It explicitly organizes the image elements into mathematically sound structures and makes the formulation of the problem more flexible and the computation more efficient [11]. The watershed transformation is one of the oldest segmentation techniques (12, 13). Watershed transformation always provides closed contours, which is very useful in image segmentation, and requires low computation times in comparison with other segmentation methods [14]. Watershed transformation always provides closed contours, which is very useful in image segmentation, and requires low computation times in comparison with other segmentation methods [14].

Table 1: Current Research in the field of Image Segmentation

S.No.	Author	Year	Work done
[15]	Kebin Wu and David Zhang	2015	Proposed a robust tongue segmentation method by fusing region-based and edge-based approaches. Before segmentation, ROI (region of interest), which will be used as input for the subsequent segmentation, was extracted by a novel way.
[16]	Celebi et al.	2015	Review preprocessing, segmentation, and post processing aspects of these methods and discuss performance evaluation issues.
[17]	Bartell et al.	2017	Implement a watershed-based image analysis and classification algorithm in a GUI, enabling a broad set of users to easily understand the algorithm and adjust the parameters to their specific needs.
[18]	Kavzogl & Tonbul	2017	Two widely-used segmentation algorithms, namely region-based multi-resolution segmentation and edge-based watershed transform were applied to a very high resolution imagery acquired by VorldView-2 sensor to evaluate and compare their performance in terms of segmentation quality metrics.
[19]	Kim et al.	2018	Using the golden section method and load path algorithm, the proposed method first determines the patient-specific optimal threshold value that enables reliably separating a femur from a pelvis while removing cortical and trabecular bone in the femur at the minimum. This provides regional information on the femur. The watershed algorithm is then used to obtain boundary information on the femur. The proximal femur can be extracted by merging the complementary information on a target image.
[20]	Hasan et al.	2018	Segment the images manually by partitioning into two distinct regions which is erroneous and at the same time, may be time-consuming. So, it is a must be better the MRI images segmentation.

The review of available literature gives a glowing picture of the different image segmentation techniques. However, most of these techniques require either manual initialization, or they rely on a prior model obtained from training sets, which consumes more running time. The shortfalls of the different methods have been dealt with refinement and care had been taken in dealing with advantages of the different methods, so that these advantages could be put to use in the right way.

IMPLEMENTATION OF WATERSHED ALGORITHM

Watershed algorithm involves the following steps:

- Read the input image.
- Perform the gradient calculations.
- Apply watershed transformation.

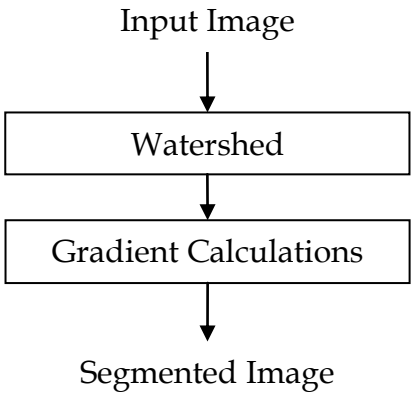
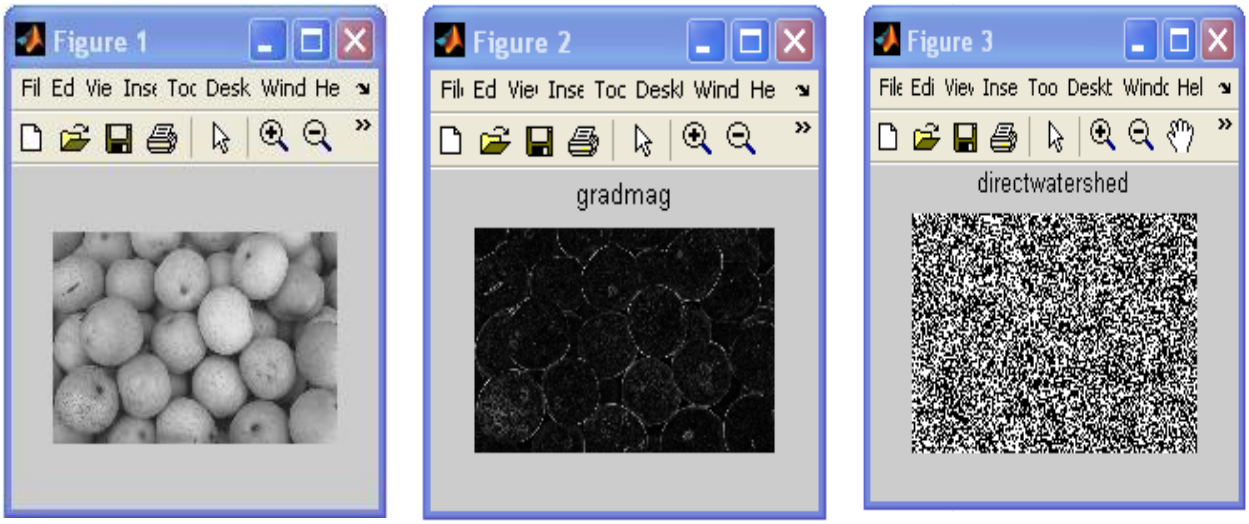


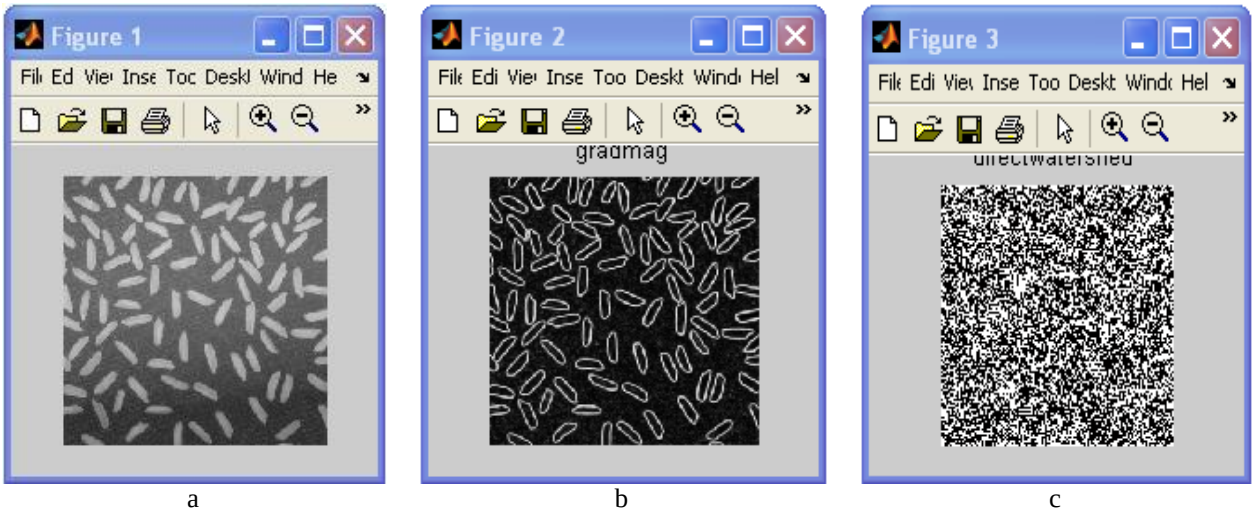
Figure 1: Flowchart of watershed algorithm implementation

Implementation results obtained after applying watershed algorithm to various images are as follows:



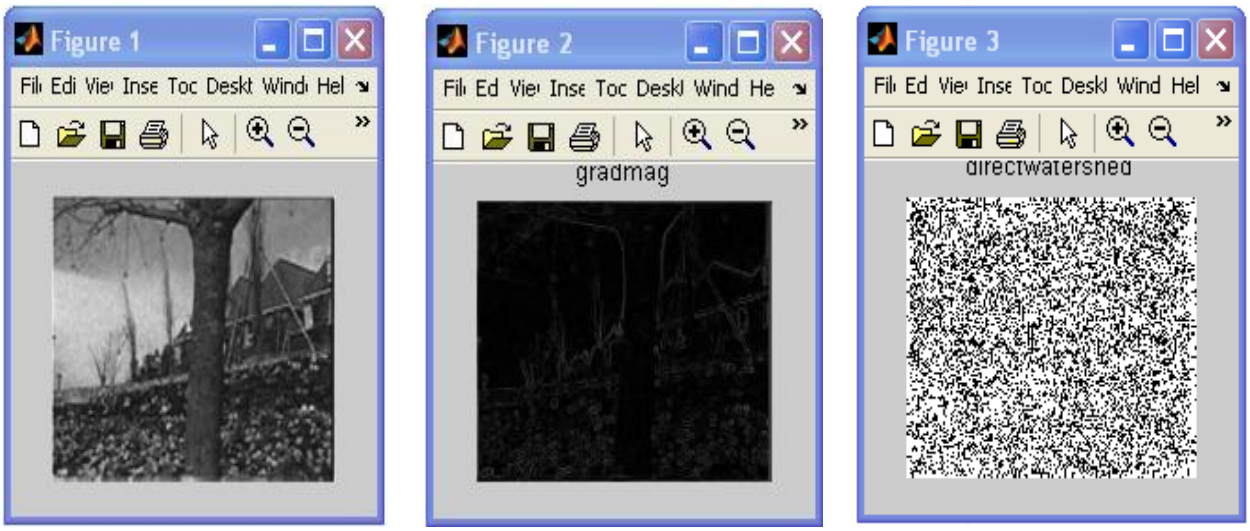
a b c

Figure 2: Pears Image (a) Input image, (b) Gradient Image, (c) Image after watershed transform
Total number of segments obtained after watershed transform in case of pears image are 29885 which is highly over segmented.



a b c

Figure 3: Rice Image (a) Input Image, (b) Gradient Image, (c) Image after watershed transform
Total number of segments obtained after watershed transform in case of rice image are 5812 which is highly over segmented.



a b c

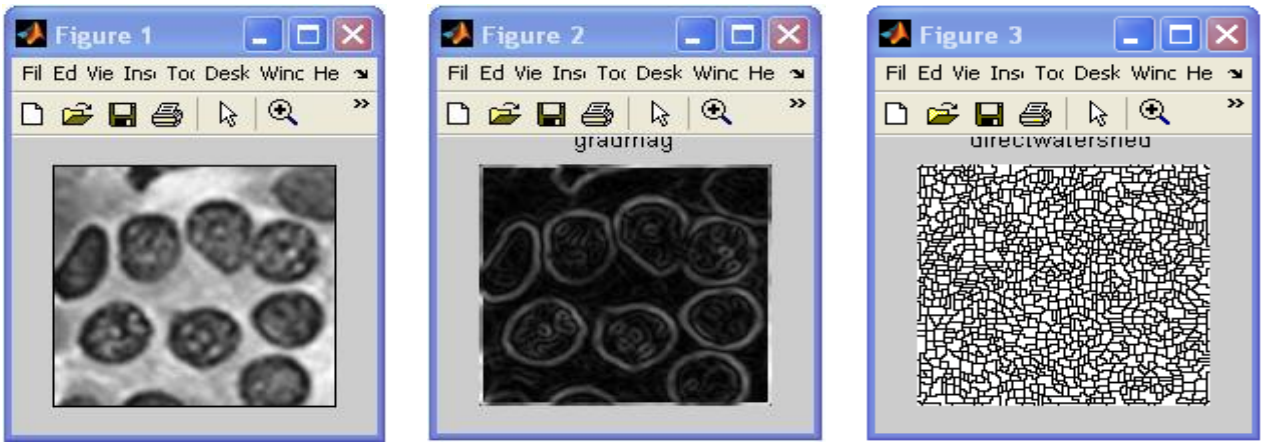
Figure 4: Tree Image (a) Input Image, (b) Gradient Image, (c) Image after watershed transform
Total number of segments obtained after watershed transform in case of tree image are 10099 which is highly over-segmented.

a b c

Figure 5 : Brain Image (a) Input Image, (b) Gradient Image, (c) Image after watershed transform
Total number of segments obtained after watershed transform in case of tree image are 3250 which is highly over segmented.

a b c

Figure 6 : Brain tumor Image (a) Input Image, (b) Gradient Image, (c) Image after watershed Transform.
Total number of segments obtained after watershed transform in case of brain tumor image are 7215 which is highly over segmented.



a b c

Figure 7 : Cancer cell Image (a) Input Image, (b) Gradient Image, (c) Image after watershed transform. Total number of segments obtained after watershed transform in case of cancer cell image are 1024 which is highly over-segmented.

CONCLUSION

This dissertation work presents the implementation and comparative analysis of watershed algorithm-based techniques for the avoidance of over segmentation. One of the main objectives of segmentation algorithm is to precisely segment the image without under or over segmentation. The watershed algorithm is one of the popular region-based segmentation technique and has an important drawback of over segmentation. Various preprocessing techniques to overcome this over segmentation problem are marker-controlled watershed algorithm, watershed algorithm using Webber perception principle, watershed algorithm using topological gradient, watershed algorithm using K-means clustering. This algorithm produces the better segmentation results as compared with other watershed algorithm-based techniques.

FUTURE SCOPE

It is concluded from the results that watershed algorithm using K-means clustering gives the better segmentation results as compared with other watershed algorithm-based techniques. Watershed algorithm using K-means clustering can be used to detect tumors. For future scope, it may possible that if we design some hybrid approach using K-means clustering and marker controlled watershed algorithm, this may give better segmentation results.

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