ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

Enhancement of watershed Transform using Edge Detector Operator

Sujata Saini [1], Komal Arora [2]
[*1] M.TECH, [2] Asisstant Professor, Department Of Computer Science, Sat Priya Group of Institutions(SPGOI), Maharshi Dayananda University(M.D.U.), Rohtak, Haryana, India
sujata18saini@gmail.com

Abstract

Watershed Transform or watershed segmentation technique is categorized under the segmentation techniques. It specifies the region based/ Boundary based segmentation, in which the segments are constructed on the basis of the regions. But, watershed transform in itself is not sufficient for the better results. In order to get more precise value, some other methodology need to be implemented with it. In this paper we have used the Edge detection based segmentation technique along with the watershed transform. Along with that, PDE-Based segmentation technique could also be used to get the accurate curvature value of the defined image. With the help of these additional methods, the segmentation could approximate the accuracy into the segmented image, which further would help in the various critical applications like medical diagnosis, traffic monitoring, pattern recognition, etc. In the previous paper, the whole scenario has been manifested along with the ideology of the concept. In this paper, the results will be examined using the prescribed ideology.

Keywords: Image segmentation, Watershed transform, Edge detectors, Canny edge operator, Level Set method.

Introduction

In the previous paper, the image understanding model was described, which symbolizes the need of the 'image segmentation'. As shown in the figure, segmentation technique is used to segment the original image into the segmented objects which are meaningful to be followed next. Image segmentation is an essential process for most sub-sequent image analysis tasks. The general segmentation problem involves the partitioning a given image into a number of homogeneous segments, such that the union of any two neighboring segments yields a heterogeneous segment [1]. 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 [2]

However, because of the variety and complexity of images, robust and efficient segmentation algorithm on digital images is still a very challenging research topic and fully automatic segmentation procedures are far from satisfying in many realistic situations. Among the various image segmentation techniques, level set methods offer a powerful approach for the image segmentation since it can handle any of the cavities, concavities, splitting/merging, and convolution. It has been used in well wide fields including the medical image processing [3,4]. Another well-known image segmentation technique is morphological watershed transform, which is based on mathematical morphology to divide an image due to discontinuities [10]. In contrast to classical area based segmentation, the watershed transform is executed on the gradient image. A digital watershed is defined as a small region that cannot assigned unique to an influence zones of a local minima in the gradient image. Also these methods were successful in segmenting certain classes of images; due to the image noise and the discrete character of digital image, they require significant interactive user guidance of accurate prior knowledge on the image structure, and easy to be over segmentation and lack of smoothness.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

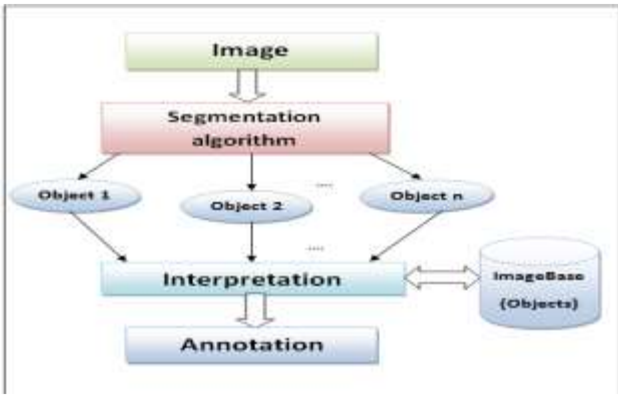


Fig1:Phases of image understanding model

A. Edge Detection: Canny Edge Detection Operator

EDGE detectors of some kind, particularly step edge detectors, have been an essential part of many computer vision systems. The edge detection process serves to simplify the analysis of images by drastically reducing the amount of data to be processed, while at the same time preserving useful structural information about object boundaries. There is certainly a great deal of diversity in the applications of edge detection, but it is felt that many applications share a common set of requirements. These requirements yield an abstract edge detection problem, the solution of which can be applied in any of the original problem domains. [6].

[7] Edge detection is basically is a process of finding sharp contrasts in the intensities of an image. It reduces the amount of data in an image while preserving important structural features of that image. Edges in the image are the places with strong intensity contrast. Edges represent object boundaries and therefore can be used in image segmentation to subdivide an image into its constituent regions or objects.

The Canny edge detection algorithm is known to many as the optimal edge detector. Canny's intentions were to enhance the many edge detectors already out at the time he started his work. He was very successful in achieving his goal and his ideas and methods can be found in his paper, "A Computational Approach to Edge Detection". [6]

B. Partial Differential Equation (PDE) Based Image Segmentation: Level Set Method

Using a PDE based method & solving the PDE equation by a numerical scheme one can segment the image. Image segmentation based on PDEs is mainly carried out by active contour model or snakes. This method was first introduced by Kassetal in 1987 [8]. Kass developed this method to find familiar objects in presence of noise and other ambiguities.

Many of the PDEs used in image processing are based on moving curves and surfaces with curvature based velocities. In this area, the level set method developed by Osher and Sethian[8] was very influential and useful . The basic idea is to represent the curves or surfaces as the zero level set of a higher dimensional hyper surface. This technique not only provides more accurate numerical implementations but also handle topological change very easily. It has several advantages; its stability and irrelevancy with topology, displays a great advantage to solve the problems of corner point producing, curve breaking and combining etc. Since the edge-stopping function depends on the image gradient, only objects with edges defined by gradients can be segmented.

Another disadvantage is that in practice, the edge-stopping function is never exactly zero at the edges, and so the curve may eventually pass through object boundaries.

C. Watershed Transform

The concept of watersheds is well known in topography. It was first proposed as a potential method for image segmentation by S. Beucher et al..in [9]. In [5], watershed transformation was simulated based on an immersion process, enabling an increase in speed and accuracy. Parallel watershed segmentation was later developed by A.N. Moga in[9], offering clear partitions within images.

Watershed transformation has increasingly been recognized as a powerful segmentation process due to its many advantages by S.Beucher et al.. in [9], including simplicity, speed and complete division of the image. Even with target regions having low contrast and weak boundaries, watershed transformation can always provide closed contours. In addition, watersheds typically occur at the most obvious contours of the object, even when oversegmentation is severe. This positioning of contours can offer a stable and accurate initialization for other post-processing and segmentation techniques. A detailed review of algorithms that make use of the watershed transformation for image segmentation can be found by J.B.T.M. Roerdink et al..in [9].

Oversegmentation and sensitivity to noise continue to plague watershed transformation with respect to medical image data. Typically, the gradient magnitude of the original image is computed before the watershed transformation is applied. Fluctuations in the gradient magnitude image, as well as negative impulse noise being regarded as a local minimum, can result in undesired additional watershed segments. Several methods have been proposed to

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

overcome these drawbacks. Among the most notable is the use of region markers [10-12], in which certain desired local minima are selected as markers, then geodesic reconstruction is applied to fill the other minima to non-minimum plateaus.

Proposed methodology

In the proposed methodology, three types of segmentation techniques: Edge Based Technique, Region-Based Technique, PDE-Based Technique as shown in below fig2. The combination of these proposed techniques could possibly lead to the better results. Also, we need to find the gradient of the image before applying watershed transform.

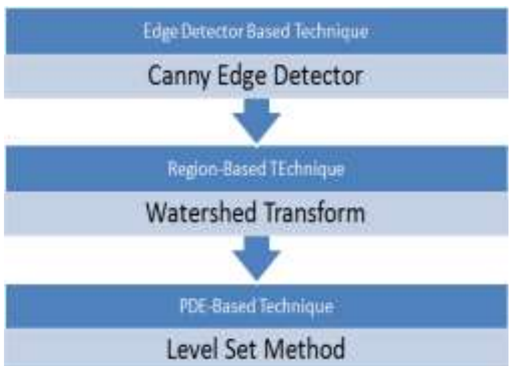


Fig 2: Proposed methodologies

1. Canny Edge detection :

The aim of JFC was to develop an algorithm that is optimal with regards to the following criteria:[6]

- **Detection:** The probability of detecting real edge points should be maximized while the probability of falsely detecting non-edge points should be minimized. This corresponds to maximizing the signal-to-noise ratio.
- **Localization:** The detected edges should be as close as possible to the real edges.
- **Number of responses:** One real edge should not result in more than one detected edge (one can argue that this is implicitly included in the first requirement).

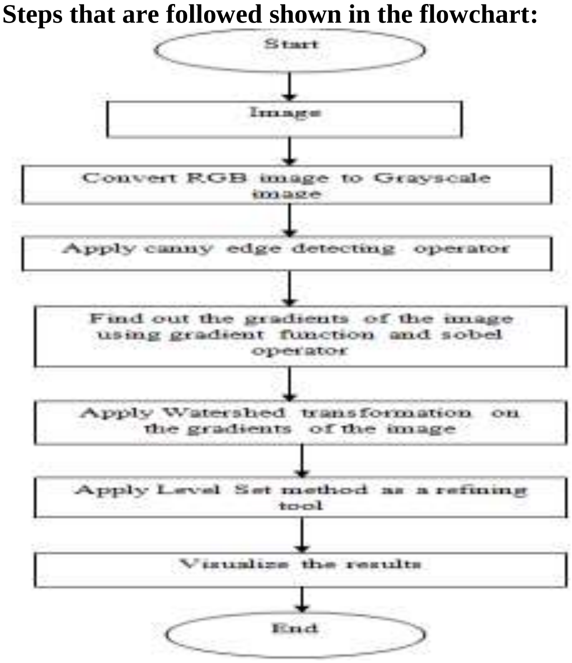
2. Combination of Watershed Transform and Level Set Method:

The watershed transform proposed by Vincent and Soille[5] is a well known segmentation technique, which is based on immersion simulation, and allows the generation of an initial image partition into regions and consequently, other region-based techniques can be used in order to produce closed, one pixel-wide contours or surfaces. The strength of watershed segmentation is that it produces a unique solution for a particular image, and it can be easily adapted to any kind of digital grid and extended to *n*-dimensional images and graphs. However, the noise in the image results in over segmentation. Another disadvantage of watershed segmentation, again related to the image noise and the image's discrete nature, is that the final boundaries of the segmented region are lack of smoothness.

Hua LI, et al..[1], in their proposed work described the hybrid of level set method and the watershed transform. In the initial step, the noise corrupting the image is reduced by noise reduction technique. This noise suppression allows a more accurate calculation of the image gradient and reduction of the number of the detected false edges. Except for the preprocessing stage, our segmentation strategy will consist in using watershed transform as a pre-segmentation tool, and then refine the segmentation result with the level set method. This approach combines the advantages of both methods: the watershed transform pre-segmentation is rough but quick, and the level set needs only a few iterations to produce the final, fast, highly accurate, and smooth segmentation.

By combining watershed transform and level sets, this method is able to produce highly accurate segmentations of topologically and geometrically complex structures in much less time than where level sets alone.

Steps that are followed shown in the flowchart:



ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

MATLAB: Proposed tool

In our work, the tool that is used is the MATLAB (MATrix LABoratory). [13]According to The MathWorks (producer of Matlab), Matlab is a technical computing language used mostly for high-performance numeric calculations and visualization. It integrates computing, programming, signal processing and graphics in easy to use environment, in which problems and solutions can be expressed with mathematical notation. Basic data element is an array, which allows for computing difficult mathematical formulas, which can be found mostly in linear algebra. But Matlab is not only about math prob-lems. It can be widely used to analyze data, modeling, simulation and statistics. Mat-lab high-level programming language finds implementation in other fields of science like biology, chemistry, economics, medicine and many more.

Image Processing Toolbox is a wide set of functions and algorithms that deal with graphics. It supports almost any type of image file. It gives the user unlimited options for pre- and post- processing of pictures. There are functions responsible for image enhancement, deblurring, filtering, noise reduction, spatial transformations, creating histograms, changing the threshold, hue and saturation, also for adjustment of color balance, contrast, detection of objects and analysis of shapes.

Experimental results

In the following results, the proposed methodology has been used, i.e the edge detection technique, gradient approach, watershed transform. In the future work, we are going to add the level set methods and then we will analyze the outcome.

We have used the MATLAB tool for the implementation of the methodology. In it, the image processing toolbox has been used, which contains the various methods that has been used for the implementation work. The image has been selected randomly.

The following steps are being followed:

- Firstly, the original RGB image has been converted into the grayscale image.
- Next, the canny operator has been used to detect the edges, it helps in getting the more accurate edges of the image.
- Then, the Gradient magnitude has been calculated, using *Gmag* and *Gdir* function and then both are summed up into a single form.

Finally the watershed transform function has been applied using *watershed* and *label2rgb* function.

With the help of above steps, the following results are concluded out:

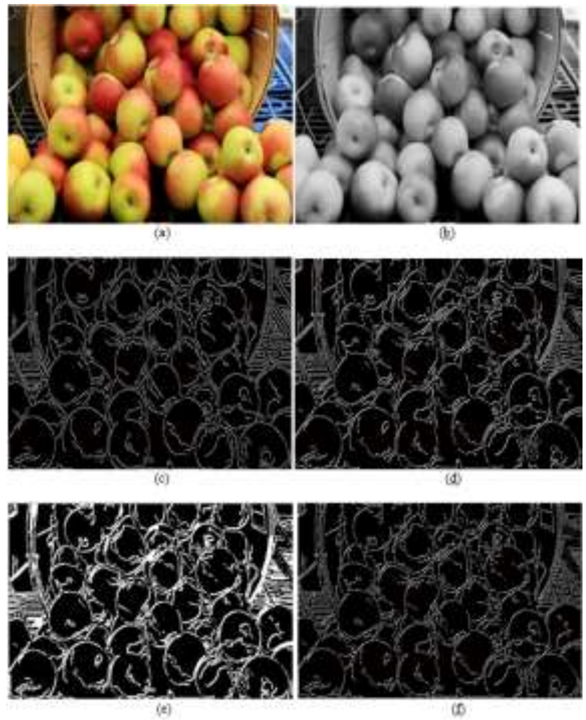


Fig:3 a) Original Image; b) Grayscale image; c) Canny edge detector image; d) Gradient magnitude using sobel operator ; e) Noise reduced image; f) Watershed transform

Conclusion & Future work

In this paper, we have used the watershed transform, gradient method along with the edge detection operator i.e. 1st derivative- canny operator. The results has been shown with the help of MATLAB tool. Classical Watershed transform has got oversegmentation problem, so in order to diminish that, marker-controlled methodology could also be used in it. Here, we have used the canny edge operator first, then the gradient method and finally the watershed transform. Also in our future work, we are going to use the level set methods as a post-segmentation tool on the watershed transform in order to refine the resultant factors.

We will use this methodology, in the image understanding model in our future prospects, that could be used in the common sense reasoning of intelligent systems, or other applications.

Following points are highlighted through this paper:

- Noise is reduced with the help of canny edge detection operator.
- Watershed transform methodology is fast, simple and efficient.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

- Level set methods could improve the results of the watershed transform.
- MATLAB is the efficient tool to carry out the image processing or segmentation functionality.

Future work is required in order to apply the level set methods into the proposed work.

References

1. *Hua LI, Abderrahim ELMOATAZ Jaral FADILI Su RUAN,"* ***An improved image segmentation approach based on level set and mathematical morphology****", a GREYC-ISMRA, CNRS 6072, 6 Bd Maréchal Juin, 14050 Caen, France b Dept. of Electronics & Information Engineering, Huazhong University of Science & Technology.*
2. *Anju Bala****, "An Improved Watershed Image Segmentation Technique using MATLAB",*** *International Journal of Scientific & Engineering Research Volume 3, Issue 6, June-2012 1 ISSN 2229-5518.*
3. *R. Malladi, J. A. Sethian, B. C. Vemuri, "****Shape Modeling with Front Propagation: A Level Set Approach"****, IEEE Trans. PAMI, 17, 158-175, 1995.*
4. *J. A. Sethian, "****Level Set Methods: Evolving Interfaces in Geometry, Fluid Mechanics, Computer Vision and Material Science",*** *Cambridge University, UK, 1996.*
5. *Vincent, P. Soille,* ***"Watersheds in Digital Spaces: An Efficient Algorithm based on Immersion Simulation"****, IEEE Trans. PAMI, 13(6), 583-598, 1991.*
6. *JOHN CANNY "****A Computational Approach to Edge Detection****", IEEE Transactios on pattern analysis and machine intelligence, VOL. PAMI-8, NO. 6, NOVEMBER 1986.*
7. *J Omwoyo, VG Magaña, M Mazana, A Maguya ,Ti5216100: MACHINE ,it.lut.fi Manolo Martín Márquez "****Canny edge detector****" Page 2 2006 ,2007.*
8. *X. Jiang, R. Zhang, S. Nie,"****Image Segmentation Based on PDEs Model: a Survey"****, IEEE conference, pp. 1-4, 2009.*
9. *Ghassan Hamarneh *, Xiaoxing Li, "****Watershed segmentation using prior shape and appearance knowledge"****, Image and Vision Computing 27 (2009) 59–68.*
10. *V. Grau, A.U.J. Mewes, M. Alcan ˜ iz****, Improved watershed transform for medical image segmentation using prior information****, IEEE transactions on medical imaging 23 (4) (2004) 447–458.*
11. *J.L. Vincent,* ***"Morphological grayscale reconstruction in image analysis: application and efficient algorithms"****, IEEE transactions on image processing 2 (1993) 176–201.*
12. *S. Beucher,* ***Watershed, hierarchical segmentation and waterfall algorithm, in: Mathematical Morphology and Its Applications to Image Processing",*** *Kluwer, Dordrecht, The Netherlands, 1994, pp.69–76.*
13. *Justyna Inglot, "****Advanced Image Processing with Matlab ",*** *Mikkeli University of Applied Sciences, thesis, 2010, pp. 12-13.*