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A Review on: "Image Segmentation Based on Level Set Method

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***Abstract*— Level set methods have been mostly used in image Processing and computer vision applications. In conventional level set function generally generates the irregularities during its evolution, which may increases numerical errors and looses the stability of the evolution. Hence degraded Level set function periodically replace by numerical remedy called reinitialization with a signed distance function. However, the reinitialization raises serious problems as when and how it should be performed, but also affects numerical accuracy. To avoid this, in proposed method level set evolution is designed as the gradient flow that minimizes energy function with a distance regularization term and an external energy that drives the motion of the zero level set toward desired locations. The distance regularization term is defined with a potential function such as Single Well, Double Well, Triple Well, Quad Well & Huber such that the derived level set evolution has forward-and-backward (FAB) diffusion effect, which is able to maintain a desired shape of the level set function, particularly a signed distance profile near the zero level set. This proposes a new type of level set evolution called distance regularized level set evolution (DRLSE). The distance regularization of level set function eliminates the need for reinitialization and reduced the induced numerical errors. DRLSE uses the more general and efficient initialization of the level set function which able to use relatively large time steps in the finite difference scheme to reduce the number of iterations, while ensuring sufficient numerical accuracy. To demonstrate the effectiveness of the DRLSE formulation, we apply it to an edge-based active contour model for image segmentation**

***Index Terms*— Level Set Method, Image Segmentation, Intensity Inhomogeneity, Contour.**

I. INTRODUCTION

Image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and its boundaries (lines, curves, etc.) inside the images. More precisely, image segmentation is the process of assigning a label to every pixel in an image, such that pixels with the same label share certain characteristics. 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. Generally we can say that Segmentation partitions an image into distinct regions containing each pixels with similar attributes. It is one of the most critical tasks in automatic image analysis because the segmentation results will affect all the subsequent processes of image analysis, such as object representation and description, feature measurement and even the following higher level tasks such as object classification and scene interpretation this paper is organized as follows: Section I summaries image segmentation in. Section II described region based and edge based approaches to image segmentation. Section described III the Level set method for image segmentation. Section IV gives summary regarding various Level set methods applied to image segmentation in presence of intensity In homogeneity. Section V describes the Result and Conclusion of the paper.

II. IMAGE SEGEMATATION METHODOLOGY BASED ON REGION AND EDGES IN THE IMAGE

The application scope of image segmentation is used in Image retrieval, Machine vision, Medical Imaging, Object detection, Face detection, Locate object in Satellite images, Recognition Tasks, Iris recognition or can use artificial intelligent based system like atomized traffic light system in smart city. Image segmentation may use thresholding, Clustering methods, Histogram-based methods, Region growing methods, edge detection, region detection or any combination of these techniques. The output of the segmentation step is usually a set of classified elements. For image analysis, image segmentation is needed, which means to partition an image into several regions that have homogeneous or inhomogeneous texture feature. This process is usually realized by the region-based, boundary-based or edge-based method. Most of image segmentation approaches are cover under region –based or edge-based. Region based model used to identify each region of interest by using certain region descriptor to guide the motion of the active contour. It is very difficult to define a region descriptor for image with intensity Inhomogeneity. Region based models are assume intensity homogeneity inside the image. Edge based models use edge information for image segmentation. This model does not assume intensity homogeneity and can use segment images with intensity Inhomogeneity. These model are dependent on initial conditions and generally suffer from serious boundary leakage problems in images with weak boundaries. Regions based model cover more pixels than edges, more information available in order to characterize region of interest to be segmented. Detecting a region use of image texture is often seen but is not easy when dealing with edges. Region growing techniques are generally better in noisy images where edges are difficult to detect. The edge based method

can be preferable as the models are usually less complex, whereas edges are important features in an image to separate regions. Due to presence of noise or constriction it is hard to find edge in the image. This paper represent Level set methods based on region growing in presence of intensity Inhomogeneity.

III. LEVEL SET METHOD FOR IMAGE SEGMENTATION

The level set method, originally used as numerical technique for tracking interfaces and shapes developed by Stanley Osher and James A. Sethian in 1988 [8]. Now a days this technique is increasingly applied to image segmentation. The advantage of the level set method is that, one can perform numerical computations involving curves and surfaces on a fixed Cartesian grid without defining the objects. Few advantages of Level set methods are: implicit, parameter free, provides geometric properties of the evolving structure, allows for change of topology, and is intrinsic. In 1988 David Mumford and Jayant Shah [9] developed Level set methods (region based model) based on a general piecewise smooth (PS) formulation used to establish an optimum criteria for segmenting an image into subregions. Level set approach is numerically most stable implicit representation. This method defines problem in one higher dimension. Which is acts as a great tool for modeling time varying objects. The level set method amounts to representing a closed curve using auxiliary function called as zero level set. The formulation of level set implies that the level set value of a point on the contour with motion must always be zero. The level set method is boundary driven and region driven model free segmentation

IV. LITERATURE SURVEY

A. Level Set Method for Image Segmentation in the Presence of Intensity In homogeneities with Application to MRI [1]

Intensity Inhomogeneity creates considerable challenge in image segmentation. Most widely used Image segmentation algorithms are region-based and typically depend on the homogeneity of the image intensities in the regions of interest, which again fail to provide accurate segmentation results due to the intensity Inhomogeneity. This paper proposed an innovative region-based method for image segmentation, which is able to handle intensity Inhomogeneity problem in the segmentation. Considering intensity Inhomogeneity in the image a model is developed with a local intensity clustering property of the image intensities, and defines a local clustering criterion function for the image intensities in a neighborhood of each point. This local clustering criterion function is then integrated with respect to the neighborhood center to give a global criterion of image segmentation. In a level set formulation, this criterion defines an energy in terms of the level set functions that represent a partition of the image domain and a bias field that accounts for the intensity Inhomogeneity of the image. Therefore, by minimizing, this energy this model able to simultaneously segment the image and estimate the bias field, and the estimated bias field can be used for intensity Inhomogeneity correction (or bias correction). This model has been validated on synthetic images and real images of various modalities, with desirable performance in the presence of intensity inhomogeneities. Experiments show that the method is more robust to initialization, faster and more accurate than the well-known piecewise smooth model. As an application, the method has been used for segmentation and bias correction of magnetic resonance (MR) images with good results. The slowly varying property of the bias field derived from the proposed energy is naturally ensured by the data term in our variational framework, without the need to impose an explicit smoothing term on the bias field. The result of this method is as shown below.

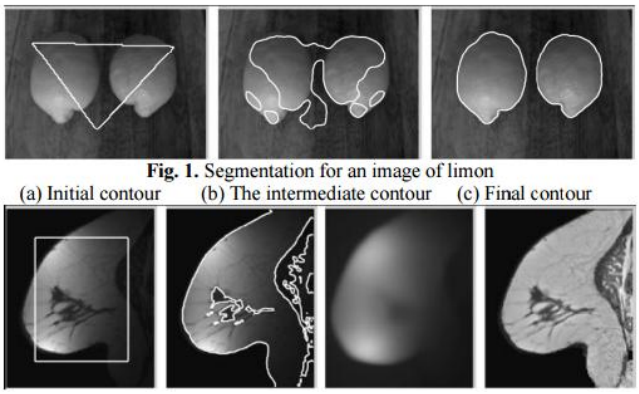

Fig. 1. Segmentation for an image of limon
(a) Initial contour (b) The intermediate contour (c) Final contour

Fig. 2. Applications to an MR image of breast (a)Initial contour (b) Final contour (c)Estimated bias (d) Bias corrected field image

B. A Level Set Approach to Image Segmentation with Intensity Inhomogeneity [2]

As most of image segmentation algorithm are based on intensity homogeneity of the interested object it is very difficult to segment the interested object from the image. This paper a new level set method for image segmentation in the presence of intensity Inhomogeneity. This paper model inhomogeneous objects as a Gaussian distributions of different means and variances where sliding window is used to transform the original image into another domain, where the intensity distribution of each object is still Gaussian but better separated. The means of the Gaussian distributions in the transformed domain can be adaptively estimated by multiplying a bias field with the original signal within the window. A maximum likelihood energy functional is then defined on the whole image region, which combines the bias field, the level set function, and the piecewise constant function approximating the true image signal. The proposed method can be directly applied to simultaneous segmentation and bias correction for 3 and 7T magnetic resonance images. Extensive evaluation on synthetic and real-images demonstrate the superiority of the proposed method over other representative algorithms. It is difficult to use local region statistics to well segment images with severe intensity Inhomogeneity because the regions must have sharp discontinuities in the statistics. So to handle this problem, this paper propose a very simple method by transforming the pixel intensities into another domain i.e. via averaging the

pixel intensity in a local region, in which the model theoretically validated that the intensities in the transformed domain have less overlapping in the statistics, thereby achieving better segmentation results comparing with the other model, for images with severe intensity Inhomogeneity. The proposed method can yield the closed-form solutions for the estimated parameters in the distribution, which significantly reduces computation effort. This model show that some representative level set methods like CV, LBF, and LIC are the special cases of the proposed method. The result of this method is as shown below.

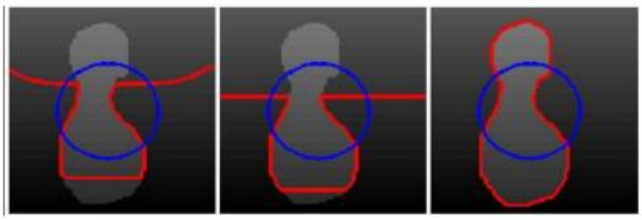

Fig. 3. Segmentation results with intensity inhomogeneity. (a) CV model (b) GCV model (c) Proposed method

C. Region Based Segmentation in Presence of Intensity Inhomogeneity Using Legendre Polynomials [3]

A new region based segmentation method is introduced in this paper which capable of segmenting objects in presence of significant intensity variation. Due to presence of intra-region Inhomogeneity segmentation is difficult. This paper proposed a framework using traditional concept active contour without edges. Comparing with existing local techniques, this paper use illumination of the regions of interest in a lower dimensional subspace using a set of pre-specified basis functions, which enables representation of variety objects, even in presence of noise. The paper compare results a dataset focusing on biological/biomedical images with tubular or filamentous structures. This paper proposes an edge independent segmentation approach i.e. Legendre Level Set (L2S) which is robust to variation in intensity levels. Initially proposed model focused on bi-level segmentation and later extension is given to multi-level framework. The result of this method is as shown below

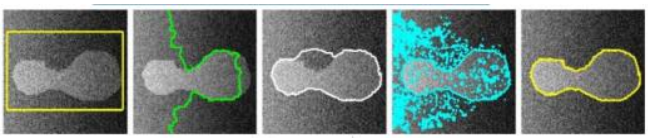

Fig. 4. Segmentation output (a)Initial (b)Chan-Vese (c)Lankton (d)C. Li et.al. (e) Final Contour Model Model Model Contour

D. A Local Region-based Level Set Algorithm for Image Segmentation [4]

The PS model is based on the assumption that the intensity in each region can be approximated by a piecewise smooth function, therefore, it can handle some images with intensity Inhomogeneity. However, the PS model has a very expensive computational cost which limits its application in practice. So to overcome this paper proposed a new local region-based level set model in a variational level set formulation for image segmentation. Difficulties in practical applications arise due to the presence of noise, complex background, low intensity contrast with weak edges and intensity Inhomogeneity. This model, a data term with a local region-based function is introduced to stop the contours at edges. Then, the data term is incorporated into a variational level set framework with a length term to smooth the contour and a distance regularization term to maintain the evolution of contour stable. The initial contour with this model can be served as a constant function which is convenient and efficient. Results obtained on synthetic and medical images show good performance in handling with images with intensity Inhomogeneity and noise. The result of this method is as shown below.

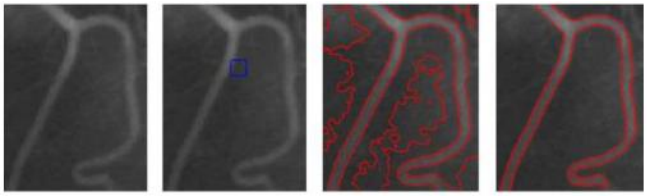

Fig. 5. Segmentation of vessel image. (a)Vessel image (b)Initial contour (b)Intermediate contour (c)Final contour

E. Particle Analysis Using Improved Adaptive Level Set Method Based Image Segmentation [5]

Now a day's new approach arise towards Particle analysis in material science and technology using Image Processing. Detection of size and shape of particles is important for material information and for better control over the quality of the product.

Image Segmentation technique provides effective analysis of size and shape features of material particles by segregating contiguous particles which further helps in counting total number of particles in an image. Problems associated with traditional Level set methods was false boundary detection and sensitivity to evolution curve's initial position are overcome in this paper by use of improved adaptive level set segmentation. The scope of image analysis technique consists of pre-processing the acquired image, segmentation of particles, particle parameters measurement and counting of particles. The requirement of a successful particle image analysis technique is to have an enhanced and noise free image for further dividing the particles into regions using different segmentation methods in order to calculate the different particle parameters and their distribution for thoroughly understanding the properties of the material being used in the analysis. In this paper, the adaptive level set based image segmentation methodology is applied on different material science laboratory microscopic images in order to effectively achieve parameters such as particle number, area, size, roundness and size distribution. The input images are taken as four different images of steel metal alloy from material science research laboratory. The results shows that the boundaries in the segmented images are sharp and effectively better than the input images in order to count the total number of particles. Particle size parameters such as area, length, width, centroid, etc. are calculated for all particles in the images and tabular result is given in paper. The result of this method is as shown below.

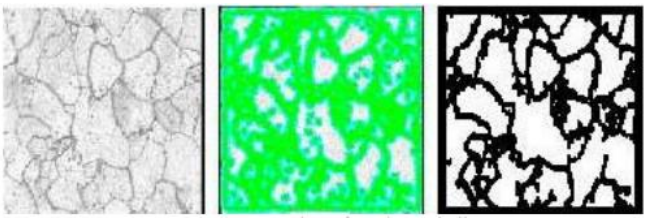

Fig. 5. Segmentation of steel metal alloy. (a)Input images (b) Segmentation outputs (c) final segmented after 80 iterations output images

F. Image Segmentation and Defect Detection Techniques Using Homogeneity [6]

The existing image segmentation approaches suffer from the problem of over segmentation. There is a scope to increase accuracy of segmentation. To address the drawbacks of conventional image segmentation approaches homogeneity based approaches can be used which deal with image texture. Image segmentation is based on two properties- similarities and dissimilarities in intensity inside image. Latest image segmentation techniques using homogeneity is presented in this paper. Homogeneity is one of the most widely used approaches for image segmentation because of its robust characteristics for texture segmentation. This paper focuses on local homogeneity based approaches for image segmentation and image defect detection. For this the approaches like image local homogeneity analysis with region merging, local homogeneity analysis with discrete cosine transform, local homogeneity analysis with wavelet transform, homogeneity with FFD method, homogeneity with color features, local homogeneity with Gabor filtering and homogeneity with watershed algorithm are used. The result of this method is as shown below.

Fig. 6. Segmentation of color image (a) Original image (b) Final segmentation.

G. A Parallel Approach for Region-Growing Segmentation [7]

In recent years a number of algorithms have been proposed and different approaches have been adopted in image segmentation due to its important. Two basic approaches are often seen in image segmentation - edge-based and region-based. Edge detection techniques consist of coming at a decision as to whether pixels are an edge or not where edges are local modifications in the image intensity. Edges typically occur along the bounds between two areas. The main features can be drawn out from the boundaries of an image. Region-based partitioning is a technique for setting the regions directly, on which divide an image into areas. This partitioning is performed frequently by using gray values of image pixels and it is based on similarity. This paper proposed image segmentation using a region growing algorithm. The primary goal behind this theme is to enhance performance or speed up the image segmentation on large volume image data sets, i.e. Very high resolution images (VHR). Since sequential processing of Very High Resolution (VHR) images takes a bunch of time, fronting for a parallel computer architecture which make usage of multiple cores. This paper targets for the origin of a Region-growing algorithm suited for GPU processing, developers with NVIDIA's CUDA (Compute Unified Device Architecture) platform. An experimental analysis upon different orbital sensor images has made out in order to assess the quality of results. The result of this method is as shown below.

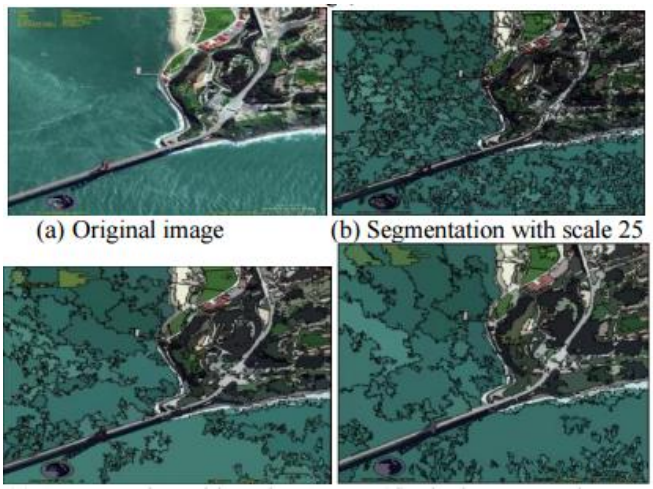

Fig. 7. Segmentation of satellite image of Golden Gate Bridge, San Francisco.

H. Distance Regularized Level Set Evolution and Its Application to Image Segmentation [10]

Level set methods have been mostly used in image Processing and computer vision applications. In conventional level set function generally generates the irregularities during its evolution, which may increases numerical errors and looses the stability of the evolution. Hence degraded Level set function periodically replace by numerical remedy called reinitialization with a signed distance function. However, the reinitialization raises serious problems as when and how it should be performed, but also affects numerical accuracy. To avoid this, in proposed method level set evolution is designed as the gradient flow that minimizes energy function with a distance regularization term and an external energy that drives the motion of the zero level set toward desired locations. The distance regularization term is defined with a potential function such as Single Well, Double Well, Triple Well, Quad Well & Huber such that the derived level set evolution has forward-and-backward (FAB) diffusion effect, which is able to maintain a desired shape of the level set function, particularly a signed distance profile near the zero level set. This proposes a new type of level set evolution called distance regularized level set evolution (DRLSE). The distance regularization of level set function eliminates the need for reinitialization and reduced the induced numerical errors. DRLSE uses the more general and efficient initialization of the level set function which able to use relatively large time steps in the finite difference scheme to reduce the number of

iterations, while ensuring sufficient numerical accuracy. To demonstrate the effectiveness of the DRLSE formulation, we apply it to an edge-based active contour model for image segmentation.

The proposed DRLSE with various Potential Functions has capability to maintain the regularity of Level set function, particularly the desirable signed distance property in a vicinity of the zero level set, which ensures accurate computation and stable level set evolution. DRLSE is implemented by a simpler and more computational efficient numerical scheme than conventional level set methods. DRLSE is more flexible and provides efficient initialization for generating a signed distance function as the initial LSF. By varying the time step, proposed method able to reduce the iteration numbers and computation time, while maintaining sufficient numerical accuracy, due to the intrinsic distance regularization embedded in the level set evolution. The distance regularization of level set function eliminates the need for reinitialization and reduced the induced numerical errors. To demonstrate the effectiveness of the the results of proposed method shown below.

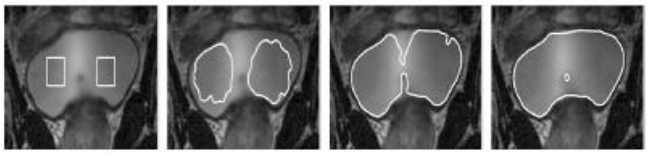

Fig. 8 Curve evolution in the narrowband implementation of the DRLSE model for an MR image of bladder. The initial contour, and the contours at iterations 50, 140, and 220 are shown from left to right.

V. RESULT AND CONCLUSION

A considerable challenge in image segmentation in real world images is intensity Inhomogeneity. The existing image segmentation algorithms rely on region based and it typically features similarity of image intensities in the region of interest. Because of the presence of intensity non uniformity the segmentation results are not accurate. So a Variational level set model for segmentation and bias correction of images with intensity Inhomogeneity is presented. Results shows in review paper 1 Segmentation and bias field estimation are therefore jointly performed by minimizing the proposed energy functional. The proposed method is much more robust to initialization than the piecewise smooth model. Results shows in review paper 2 combines the information from the neighboring pixels belonging to the same class, which equips it with a strong capability to separate the desired object from its background. The segmentation results are insensitive to different initializations of the level set function, making it useful for automatic applications. Comparisons with several representative methods on synthetic and real images have demonstrated the effectiveness of the proposed algorithm. Results shows in review paper 3 a novel framework for segmentation in presence of significant intra-region illumination variation is presented. Qualitative and quantitative results and comparison with the state of the art techniques suggest robustness of proposed approach. However, like most level set methods, L2S is somewhat biased towards contour initialization. Using Legendre polynomials for region intensity approximation provides an elegant solution. Results shows in review paper 4 propose a new local regionbased level set model for image segmentation. In this method, a new SPF function using local information is define to attract the contour to stop at object boundaries. The proposed model can handle images with intensity inhomogeneity and noise. Experimental results on synthetic and medical images show that the proposed method has good performance and is competitive with LBF and Zhang's models. Results shows in review paper 5, particle analysis performed based on the proposed improved adaptive level set segmentation algorithm which includes adaptive directional speed and stopping force based on weighted probability to overcome the disadvantages of boundary leakage and sensitivity to noise and curve's initial position present in the traditional level set methods. The experimental result shows that the input particle images are effectively segmented using the proposed improved level set algorithm and the size and shape parameters are successfully calculated. Results shows in review paper 6, homogeneity and wavelet transform based approaches provide the most promising results for image defect detection. In case of defect detection noise can also be treated as defect. Results shows in review paper 7, that the proposed algorithm is implemented the parallel version of Region- Growing algorithm in CUDA C++ and executed on a 96-core GeForce GT 540M. To avoid endless executions, the number of maximum iterations that the algorithm allows is set. A parallelized region-based method for image segmentation was introduced in this novel approach. The approach gives good segmentation results with low scale image. From all the above papers we can formulate that level set method can be performed very efficient way to image segmentation. Level set method which aims on implementation of a level set approach for active contour image segmentation

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