© 2019 JETIR March 2019, Volume 6, Issue 3 www.jetir.org (ISSN-2349-5162)

Image Segmentation using Distance Regularized Level Set Evolution method

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ABSTRACT*-Group-level methods have been widely used in applications to segment and manipulate the image. Because the re-initialization process can cause serious problems, and can affect numerical accuracy, a new type of system is proposed without re-initialization, during which a new set of levels can be preserved during the development of the level group.Various experiments show that this method is more powerful in configuration and faster and more accurate also compared to the old model known well. The evolution of the level group can be described as a gradient flow that reduces the energy function with the term regulation of distance and external energy that can drive the zero-level movement specified towards the desired positions. This can lead to a new type of development that can be useful to maintain the desired shape of the level group function essentially near the zero-level group, which can be called the DRLSE development.This helps eliminate the use of re-initialization and can be used to reduce errors. The main feature of the set-level model is that one can easily make digital calculations involving curves and surfaces without the possibility of specifying the parameters of objects. Now, how to adjust the level is an important way to split the image. In order to analyze the medical image, it must first be divided into different parts using an image fragmentation process that can only be DRLSE, which can reduce undesirable side effects. Thus, this paper provides a simple application for active contour method using level groups.*

Keywords:**Image segmentation, DRLSE,Canny edge detection.**

I.INTRODUCTION

Level-set methods (LSM) are a conceptually frameworks for using level sets as appliance for the numerical inquiry of different shapes and surfaces.Also, the process of level-set method results which can be very easy to follow shapes that can change the configuration, for example, when a shape is splitted in two develops holes, or the reverse of these operations.Image segmentation is a process which is based on two properties- similarities and dissimilarities in the intensity inside image.Some key ideasin case of the levelset method were also proposed earlierbyDervieux and Thomasset [1], [2] in the late 1970s, but their work did not draw much attentionto the study, it was only after the work by Osher and Sethian in [3], the level set method became a well-known method.All these processes make the level-set method a greatergadget for creating the time-varying objects, like enlargement of an airbag, or an example of oil drop floating in the water.

Image segmentation is a process which is complex in artificial vision and especially in medical imaging applications because of the importance on the accuracy of results which can provide the information about the complex structure of human body organs. Explicit deformable models or active contours are used in image processing and also mostly used in medical imaging.In the applications ofprocessing of an image and computer vision, the level-setmethodwasintroducedindependentlybyCasellesetal. [4] and Malladi et al. [5] in the context of active contour.It will emphasize not only what had been done in the image science applications using these level set techniques, but also in the other area of sciences where the level set methods can be applied without fail. The main idea is to point out the related formulations and solution methods to the image science communities. These communities may includecomputer vision, image/video processing, and graphics. These are very diverse,with some specialties such as Hollywood type special effects and medical imaging. In recent years a major number of algorithms have been proposed and also different approaches have been adopted in image segmentation due to its importance. The two basic approaches which are often seen in the process of image segmentation - region-based and edge -based. Edge detection techniques consists of are at a decision so as to decide whether pixels are an edge or not where edges are the local modifications in the case of image intensity. The primary goal behind this theme is to enhance the performance or to speed up the image segmentation process on large volume image data sets, i.e. very high-resolution images (VHR) [6]. Image segmentation plays a very important role in many medical fields for example in surgeries, diagnosis, identifying anatomical structures.Generally, the process of image segmentation using the level set method can be defined as the process of partitioning an image into non-overlapping, constituent regions based on the characteristics like intensity, color, texture etc. which are homogenous in nature.

This paper proposes a novel distance regularized level set based method for the image segmentation.The remainder of this paper is organized as follows:Introduction for the process of image segmentation is explained in Section Iwhereas literature review is described in the Section II, and the proposed method which is given by the distance regularized level set formulation is said in Section III for the purpose of energy minimization. Experimental results are shown in Section IV, followed by a discussion of the relationship between our model and this paper is finally summarized in Section V.

II.LITERATURE REVIEW

The level set method tends to represent a closed curve using an auxiliary function which is called as zero level set. The formulation of this level set implies that the value of the level set of a point on the contour must always be zero with the motion.Chunming Li et.al. (2011) have discussed about how the intensity in homogeneity foreput the technical challenges during the segmentation process with an application to MRI.This has proposed an innovative idea in order to tackle the intensity in issue of homogeneityduring region-based segmentation.In recent years, active contour models (ACM) implemented via level set methods have been successfully used in image segmentation [7].A model by keeping in sight inhomogeneous intensitieswith a local intensity clustering property of the image intensities is developed, and defines a local clustering criterion function for the image intensities in a neighborhood of each of the points. This model has also been validated on the realimages and synthetic images of the various modalities like MRI and even many experiments show that this method is more robust to the process of initialization.

Chunming Li et. Al. [8]proposed that level set methods have been mostly used in the processing of image applications and also computer vision. In conventional level set function,it generally generates the irregularities during its evolution, which may increase the numerical errors and loses the evolutionstability. Hence, the degraded level set function periodically is replaced by the new numerical remedy called as reinitialization, with a signed distance function. However, the reinitialization raises very serious problems as when and how it should be performed, but also affects the numerical accuracy.By varying the time step, proposed method will be able to reduce thecomputation timeand iteration numbers, while maintaining sufficient numerical accuracy, due to the intrinsic distance regularization embedded in the level set evolution. The distance regularization of level set function is used to eliminatethe need for reinitialization and also to reduce the induced numerical errors.

Mengjuan C.et al [9] proposed a PS model which is based on the assumption that the intensity can be approximated by a piecewise smooth function, therefore, it will be able to handle some images with homogeneityintensity. However, the PSmodel has a very expensive computational cost which can limits its application. So, in order to overcome this,a new local region-based level set model has been proposed in level set formulation which is variational for the purpose of the image segmentation process.

Kaihua Zhang et al. [10] suggested a model for inhomogeneous objects in terms of Gaussian distributions of the different means and variances in which the original image is transformed into another domain by the use of sliding window where the distribution of intensity of each object is still Gaussian but will be better separated. The main means of the Gaussian distributions in the transformed domain can be easily and adaptively estimated by multiplyingoriginal signal with a bias field within the window. A maximum likelihood energy functional is then defined on the total image region, which then combines with the bias field, the level set function, and the piecewise constant function giving rise to the true image signal approximately. This proposed method can also be applied directly to the simultaneous segmentation of MRI images. this proposed method can produce closed-form solutions for the estimated parameters of the distribution, which greatly reduces computational effort.

Suvadip m. et al. [11] developed a segmentation method based on a distance-regulated set of levels, which allows to segment an image in the presence of variable and significant intensity constraints, using the traditional concept of active contour, without training edges. When compared to another conventional technique, this paper uses the illumination of regions of interest in a lower-dimensional subspace using a set of predefined basic functions, which allows us to represent a variety of biomedical / biological image objects even in the presence of noise.Therefore, a segmentation which is edge dependent approach has been proposed i.e. Legendre Level Set (LLS) which is robust to the variation in the intensity levels.

Rajitha B.et al [12] The existing image segmentation approaches suffer from the problem of result of over segmentation. There is a scope in order to increase the accuracy of the segmentation process.Therefore, in order to address the drawbacks of conventional image segmentation approaches, approaches with homogeneity-based can be used which deals with texture of the image.Hence, local homogeneity-based approaches for image segmentation process and image defect detection process are mainly focused.

III. DISTANCE REGULARIZED LEVEL SET EVOLUTION (DRLSE)METHOD

In level set methods, a contour (or more generally a hypersurface) of interest is embeddedof an LSF as the zero-level set. Although the final result of a level set method is the zero-level set of the Level Set Function (LSF), it is necessary to maintain the LSF in a good condition, so that the numerical computation is accurate and level set evolution is stable. This requires that the LSF is smooth and not too steep or too flat (at least in a vicinity of its zero-level set) during the level set evolution. This condition is well satisfiedby the signed distance functions for their unique property $|\nabla\phi| = 1$which is referred to as the signed distance property. For the 2-D case, as an example, a signed distance function which is defined by z = f(x, y) can be considered as a surface. Then, the plane which is a tangent makes an equal angle of 45° with both the z – axis and xy-plane, which could be easily verified by the signed distance property $|\nabla\phi| = 1$.Therefore, the regularization term is called as distance regularization term, which was introduced by Li et al. [13] in a more general variational level set formulation.Segmentation approaches based on statistical model such as Active Appearance Models and Active Shape Models (ASM) (AAM)[14] are widely adopted.For this desirable property, signed distance functions are mostly used as level set functions in the level set methods. When coming to the conventional level set formulations, the LSF is periodically reinitialized as a signed distance function and typically initialized.

Algorithm Stepsin the proposed system:

Step 1: Read the input grey image of size M×N.

Step 2: Set the level set parameters: Distance regularization term coefficient as μ= 0.2, weighted length term coefficient as $\boldsymbol{\lambda}$=5 and weighted area term coefficient asα=-3 and parameter which specifies the width of the dirac delta function as ξ=1.5.

Step 3: Then apply Fast Fourier Transform to the convolution of Gaussian with the image by setting the scale parameter in Gaussian kernel asσ= 0.8 and also compute the term $IFFT(FFT(G\sigma * I(x, y)+\alpha H(\phi(x, y))))$, where His Heaviside function and $G\sigma$ is a Gaussian kernel.

Step 4: Initialize the Level Set Function (LSF) as the binary step function.

Step 5: Create the initial area, R as a rectangle.

Step 6: Next, display the first zero level contour and the initial level adjustment function.

Step 7: Begin the process of evolution of the level group and refine the zero-level contour by developing an additional level group with $\alpha = 0$.

Step 8: Display the final level adjustment function and the final zero level contour.

Step 9: Calculate and compare the DSM and execution time for each DRLSE without FFT and DRLSE with FFT.

Canny Edge Detection Algorithm

The canny edge detection operator was first developed by John F.Canny in 1986 which uses a multi-stage algorithm in order to detect a wide range of edges in the images. Most importantly, canny also produced a computational theory of the edge detection explaining about the technique works. Canny was aiming to discover the algorithm for optimal edge detection. The algorithm runs in 5 separate steps:

Smoothing: Blurring of the image so as to remove noise.

*Finding gradients:*The edges should be marked where the gradients has large magnitudes of the image.

Non-maximum suppression: Edges should be marked only for local maxima.

*Double thresholding:*Thresholding is used to determine the potential edges.

*Edge tracking by hysteresis:*By suppressing all edges, final edges are determined that are not connected to a very certain strong edge.

Methodology:

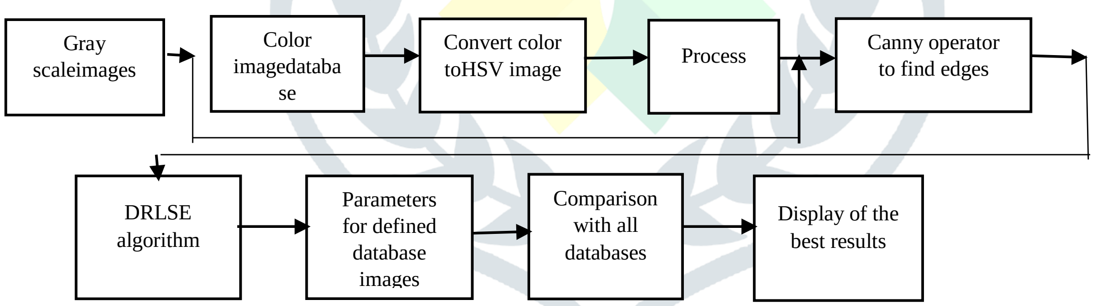
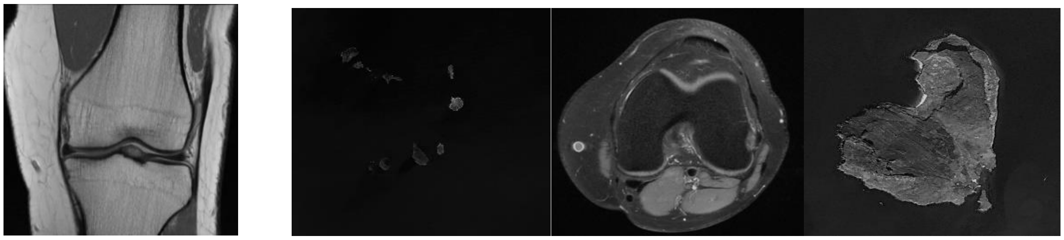


Fig1. Block diagram of Canny edge detection algorithm.

IV. RESULTS AND DISCUSSION

In this paper, MRI scan images are taken as the input images for the analysis. The experiment was done with the help of MATLAB version R2016a.The below figures show the images for the image segmentation process with the help of distance regularized level set functions. First, the input image is been selected and the process of execution is performed. Then, the level set function will evolve, moving the zero-level set towards the boundary of the desired object.

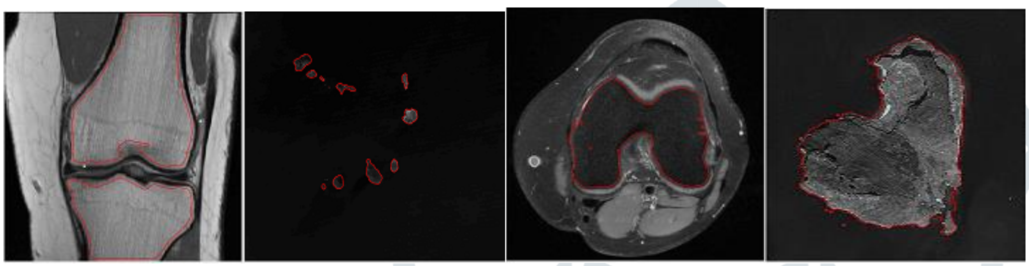
Figure2:



(a)(b)(c) (d)

Fig.2 shows the input images of MRI scan images given to the distance regularized level set evolution. (a)Input MRI scan image of knee, (b)Input MRI scan image of capeverde, (c)Input MRI scan image of femur, (d)Input MRI scan image of Scotland.

Figure 3:



(a) (b) (c) (d)

Fig.3 shows the output images of MRI scan imagesgiven to the distance regularization level set evolution process. (a)Output of knee contour at iterationnumber 651, (b)Output of capeverdecontour at iteration number 802, (c)Output of femur contour at iteration number 1002,(d)Output of Scotland contour at iteration number 602.

V. CONCLUSION

In this paper, we proposed a segmentation algorithm using level set method without the problem of reinitialization with some of the specific shape models. The experimental results show us that the proposed method work well with specific shape model used for particular medical images as well as for satellite images.Here presented a variational level set framework for the segmentation process andcorrection of bias of images with intensity inhomogeneities.This method is much more robust to the initialization than that of the piecewise smooth model. The experimental results of this proposed system have demonstrated superior performancein terms of accuracy, efficiency, and robustness.As an application, this method has been applied in the context of MR image segmentation and bias correction with promising results.Given its efficiency and also the accuracy, we expect that the proposed distance regularized level set evolution method will find its utility in many applications in the area of image segmentation, as well as also in other areas where the level set method has been and could be applied.

ACKNOWLEDGEMENT

We are grateful for the financial support for this work provided by the JYOTHISHMATHI INSTITUTE OF TECHNOLOGY AND SCIENCE and all faculty members of the ECE department to carry out this work successfully.

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