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REVIEW OF IMAGE SEGMENTATION USING LEVEL SET METHOD

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Abstract: Image processing plays a vital role in medical diagnosis system. Out of various processing tools, image segmentation is very crucial in identifying the exact reason of disease. Image segmentation clusters the pixels into silent image regions i.e. regions corresponding to individual surfaces, objects or any part of objects. Various algorithms have been proposed for image segmentation. We have reviewed the different systems that have been developed for medical diagnosis purpose. Reviewing of these systems is based on level set methods of segmenting images. The theme, merits, demerits of various systems is discussed in this paper. Based on that, a new system has been proposed for segmenting the MRI image using variational level set algorithm without reinitialisation of MRI image. The system can be utilized both for simulated as well as real images.
Keywords: Level set, MRI, Image processing, segmentation;

I. INTRODUCTION

Role of image processing is very important when it comes to medical diagnosis system. Image segmentation subdivides an image into its regions of components or objects and an important tool for image processing [1]. The objective of segmentation is to divide an image into parts having strong correlation with areas of interest in the image [2]. Broadly segmentation can be classified as complete and partial. Complete segmentation results in a set of disjoint regions which correspond solely with input image objects. While in partial segmentation resultant regions do not correspond directly with input image [3]. According to C. Li, Image segmentation is often treated as a pattern recognition problem since segmentation requires classification of pixels [4].

The level set method for image segmentation is generally preferred. The level set method for capturing dynamic interfaces and shapes was firstly introduced by Osher and Sethian in1987 [5]. The basic idea of the level set method is to represent contours as the zero level set of an implicit function defined in a higher dimension, usually referred to as the level set function, and to evolve the level set function according to a partial differential equation (PDE) [6]. For medical processing purpose, it is been linked to computer applications. In image processing and computer vision applications, the level set method was introduced independently in the context of active contour (or snake) models for image segmentation [7-9].

Various advantages of level set methods is that they can represent contours of complex topology and are able to handle various topological changes, such as splitting and merging, in a natural and efficient way. Another desirable feature of level set methods is that numerical computations can be easily performed on a fixed Cartesian grid without having to parameterize the points on a contour as in parametric active contour models. Thus making the level set method, important in segmentation of MRI images.

This paper has been organized in four section. First section has included the brief introduction of the level set method for segmenting medical images. In next section, previously developed systems are discussed. Based on the discussion of developed systems, it is found that there is still scope to develope one more system. Hence the detail of proposed system is given in section III. Last section has the conclusion of the paper.

II. VARIOUS DEVELOPED MEDICAL SYSTEM USING LEVEL SET METHOD

A system had been developed for segmenting the liver tumor from CT images. Level set methods have been widely used in image processing for segmenting the biomedical images such as liver images. Various methods of segmentation were explored, and a few were chosen for implementation and further development. Liver Images were collected and the region of interest was selected. Segmentation had been performed by using Fuzzy C means algorithm followed by fine delineation using level sets. The method could clearly segment the tumor regions and their boundaries were well defined [1].

Manish Khare et. al. proposed a segmentation method which was based on level set without re-initialization approach, applied to certain specific shape based model, for medical images. Level set method without re-initialization, for certain specific shape based model had advantages over level set method with reinitialization. Large time steps were possible with the proposed method which speeds up the process of curve evolution. They had applied the proposed approach on several medical images [2].

Sasi Kumar had developed a system based on preferential image segmentation. Objective of the system was to preferentially segment objects of interests from an image and ignore the remaining portions of the image for the real world applications. These methods tend to classify whole image instead of meaningful objects. It utilized a tree of shapes to represent the image content. This representation provided a hierarchical tree for the objects contained in the level sets of the image. The hierarchical structure was utilized to select the candidate objects from the image. The Level set method provides a faster way to construct a tree of shapes. But the problem was it utilized only tree shape of image [3].

The above developed systems do not explain about the Intensity inhomogeneity which is often occurs in real-world images. Chunming Li proposed a novel region-based method for image segmentation, which was able to deal with intensity inhomogeneities in the segmentation. They have derived a local intensity clustering property of the image intensities, and defined a local clustering criterion function for the image intensities of a neighborhood of each point. Then that local clustering criterion function was 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 represented a partition of the image domain and a bias field that accounts for the intensity of the inhomogeneity image. Therefore, by minimizing this energy, our method is able to simultaneously segment the image and estimate the bias field, and the estimated bias field can be used for intensity inhomogeneity correction. The proposed method was validated on synthetic images and real images of various modalities, and found to be good [4].

Variational Level Set Algorithm in Image Segmentation for Foetus Ultrasound Imaging System was developed by Mei Yeen Choong. The variational formulation consists of two energies, internal and external energy. The internal energy term enalizes the deviation of the level set function from a signed distance function and the external energy term drives the motion of the zero level set towards the desired image features, such as object boundaries. results showed that the level set contour evolved well on the low contrast and noise consisting medical image, especially the ultrasound image which were well known for the speckle noise and low signal-to-noise ratio [5].

One of the systems described a way of medical image segmentation based on level set method to extract the region of interest of various medical images such as magnetic resonance imaging (MRI), computer tomography (CT), and positron emission tomography (PET) image. Author had divided the process in the parts. In first part, thresholding of the input image is done to make the entire pixel under threshold value to 0 and others to take the value as original image. Next, a morphological technique was used to remove some small ignorable parts. Finally he applied variational level set method for final segmentation [6].

Zafer Guler et. at. used scaling approach for image segmentation using level sets, which was carried out by the GPU programming techniques. Approach to level sets was based on the solution of partial differential equations. The proposed method did not require the solution of partial differential equation. Scaling approach, which used basic geometric transformations, is used. Thus, the required computational cost reduced down. The use of the CUDA programming on the GPU had taken advantage over classic programming as spending time and performance. Thereby results were obtained faster. The use of the GPU had provided to enable real-time processing [7].

Md. Golam Moazzam et. al. presented a shape-based approach to curve evolution for the segmentation of medical images. Interpretation of medical images was a very difficult problem in computer vision. So a promising mathematical framework based on variational models and partial differential equations had been investigated to solve the image segmentation problem. The approach benefited from well-established mathematical theories that allowed people to analyze, understand and extend segmentation methods. In the developed system, a variational formulation is considered to the segmentation using active contours models [8].

III. PROPOSED SYSTEM

After reviewing various developed systems, we have proposed our medical diagnosis system for MRI image monitoring. The main problem that the other systems were facing is of segmenting an image. Thus review of various systems has guided to use the level set method. Manish Khare et. al. system was really well in segmenting the specific shapes. He had used segmentation method which was based on level set without re-initialization approach. So in the proposed system, we have used the same approach to segment the image. And to modify the system, we will use variational level set algorithm using a simple finite difference scheme. Thus the system can be easily implemented and use for proper diagnosis of MRI images.

IV. CONCLUSION

Advancement in technology has helped the society in many ways. Various systems were developed every year to diagnosis of patients. This paper had reviewed various systems developed for medical diagnosis purpose. Review of these systems has shown that segmentation played an important role in medical imaging. Level set method was used in various systems to segment the desire portion of image. In order to increase the speed of simple level set method, variational level set algorithm without reinitializational approach was used. But the problem was the method was useful in detecting the specific shapes only. So we have proposed a new segmentation scheme. We used a new variational level set algorithm without re-initialization. This algorithm can be easily implemented using a simple finite difference scheme. We also used thresholding and erosion for removing the noisy element present in the image. Meanwhile, not only can the initial curve be shown anywhere in the image, but the interior contours (such as tumours) can also be automatically and quickly detected.

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