AN IMPROVED MEDICAL IMAGE SEGMENTATION USING CHARGED FLUID MODEL

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Abstract

Segmentation has a major role to play in the field of medical imaging for effectively detecting the deformities. Though there are huge medical imaging techniques available, Magnetic Resonance Image (MRI) is widely used because of the non-ionizing radiation which is being used. In this paper, we proposed a refined method using charged fluid model (CFM) which yields better results. It is essential to use an effective algorithm which can automatically segment the region of interest. Hence, we used Otsu's algorithm to segment the image automatically.

Keywords:- Charged Fluid Model, Segmentation, magnetic resonance images, region of interest.

INTRODUCTION

Medical imaging is the technique and process used to create images of the human body (or parts) for clinical purposes or medical science. Medical imaging uses state-of-the-art technology to provide 2 or 3-dimensional images of the living body. Imaging studies can diagnose disease or dysfunction from outside the body, providing information without exploratory surgery or other invasive and possibly dangerous diagnostic techniques. In recent years, the field of medical imaging has undergone drastic changes which in turn have facilitated the physicians in effectively diagnosing the diseases. But, still there is lot of scope to derive new techniques for effectively identifying the disease. In the field of medical imaging, segmentation plays a major role in taking the pre-surgery and post-surgery decision for faster recovery of the diseases.

Segmentation is a process of partitioning an image into non-intersecting regions which have two properties such as homogeneity within a region and heterogeneity between the regions [1].There are various algorithms available for image segmentation process [2–6]. But the most widely used segmentation algorithm specifically for medical images is based on gray-level value of the pixel as the medical images are of gray-level only. There are various medical imaging techniques such as CT, MRI, and PET etc. Among these, MRI is widely used medical imaging technique because of the non-ionizing radiation property that is used and having an excellent contrast between the soft tissues [7]. The MRI data of the patient is collected and is stored in the form of an image. In this MRI analysis, the difficult task is segmenting the region of interest. To achieve this, various algorithms have been proposed in the literature. But, these segmenting algorithms differ from application to application. There is no specific algorithm available which serves for all applications [8]. The various segmentation algorithm proposed earlier are threshold-based, region-based, statistics-based, deformable models, atlas guided technique and knowledge based approaches [9-11]. Among these, deformable models are the most popular models due to their ability to recover the shape of biological structures much more accurately in various segmentation applications [12-13]. The deformable models can be broadly classified into parametric and geometric models. A moving equation should be defined to drive the initial contours to the structure boundaries due to which these algorithms are viewed as a modeling of curve evolution [14]. There are various algorithms proposed in these deformable models among which Charged Fluid Model (CFM) [15] is much accurate. But there are few limitations existing in this algorithm like, this algorithm requires initialization inside the region of interest and the algorithm also needs some improvisations for interactive segmentation. Hence to improve these drawbacks, in this paper we propose an additional algorithm named Otsu's algorithm [16] which is used to automatically perform histogram shape-based image thresholding [17].

The paper is organized as follows: Section-II describes about the segmentation algorithm of CFM and section-III explains the experimental results of the proposed method. Section-IV demonstrates the evaluation of the proposed method and finally, section-V concludes the paper.

SEGMENTATION ALGORITHM

Physics-based probabilistic systems were being used to investigate and analyze the biological models. In charged fluid models, each fluid element has its own charge as if it has been calculated by interpolating the charges of the covered particles [15]. As there are few drawbacks in the CFM model stated in [15] like there should be an effective technique which can automatically segment the image, in this paper we introduce a new approach by including Otsu's algorithm to effectively segment the image for extracting the region of interest which in turn can help the medical practitioners to identify the deformity and its density for pre-surgery and post-surgery treatment. In this technique, the Otsu is used to automatically perform the histogram shape-based image thresholding. The advantage of using Otsu algorithm is that, the set of thresholds is selected automatically and stably based on integration of the histogram. The segmentation of the medical image involves 3 algorithms which are demonstrated below and the numbers specified in the brackets refer to the equations derived in paper [15].

Algorithm 1: Charged fluid (Ref.-15)

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1) parameter setting of in (11)*
2) image potential computation using (11)*

3) **repeat**(i)

a) uniform charge distribution over fluid elements
b) **repeat**(j)
Algorithm 2
c) **until**(j) electrostatic equilibrium is achieved by setting in (10)*
d) 1–pixel-wide front construction using the boundary element detection method
e) **Algorithm 3**
f) mean potential computation and charge normalization using (5)*

4) **until**(i) no deformation in the charged fluid shape
5) **Algorithm 4** for extracting the region of interest

Algorithm 2: Charge distribution procedure (Ref.-15)

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1) forward FFT computation of the charge array based upon (16)*
2) inverse FFT computation of the potential array based upon (17)*
3) electric field computation using (7)*
4) advance distance computation using (9)*
5) charge density computation using the SUDS based upon (15)*

Algorithm 3: Front deformation procedure (Ref.-15)

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1) mean electric field compensation using (18)*
2) effective field computation using (12)*
3) 2–pixel-wide interface localization based upon Fig. 6 in [15]

**indicates the equations used from reference paper [15].*

Algorithm 4: Extraction of region of interest

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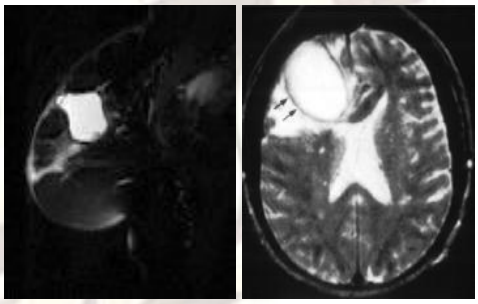
1) Compute histogram and probabilities of each intensity level
2) Set up initial $\omega_i(0)$ and μ_i (0).
3) Step through all possible thresholds maximum intensity
1. Update ω_i and μ_i
2. Compute $\sigma_b^2(t)$
4) Desired threshold corresponds to the maximum $\sigma_b^2(t)$

RESULTS & DISCUSSION

The experimentation of the proposed algorithm has been implemented on various images of brain and breast. All the algorithms have been implemented on a personal computer with CPU of Core i3 Processor 2.4GHz using MATLAB. In order to carry out the proposed work, we have considered the data sets of the brain images from brainweb images [18]. The advantages of using the brainweb database are that the comparision can be made available using the ground truth for the tissue classes (CSF, WM and GM) from which the digital phantom were created [19].

The original images are shown in Figure 1(a) breast image and 1(b) brain image having deformities. The output results are shown in figure 2(a) Breast image and 2(b) Brain image after segmenting and extracting the region of interest.



a) Breast Image b) Brain Image
Figure 1: Original images having deformities

a) Breast Image b) Brain Image
Figure 2: Output images having showing deformities

The proposed method is implemented using MATLAB software. The experimentation is carried out using Core i3 processor and the time taken to execute, this method is about 0.326 seconds when compared to the existing method which consumes approximately about 0.51 seconds.

CONCLUSION

The segmentation has a vital role in the field of medical imaging for effective diagnosis of the patient having deformities help the medical practitioner in performing the pre-surgery and post-surgery process. Hence in this paper, we proposed an effective segmentation method based on CFM model to segment the medical image. Hence, our proposed method yields better results when compared to the existing method and is much faster when compared to the existing model.

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