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A Review on Efficient Detection of Diseases from MRI using Thresholding and Deformable Models

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Abstract— Medical imaging plays vital role in the field of medicine and is rapidly increasing and getting sophisticated day by day. This paper reviews the thresholding and deformable models as capable medical image analysis technique. Deformable models (DMs) are being used in digital image analysis to maintain essential characteristics of image shape and intensity while accommodating fluctuations. Thresholding technique is used to detect the contour of the tumour in brain.

Keywords— medical imaging,, thresholding , deformable models, segmentation.

I. INTRODUCTION

Medical image processing has provided field of medicine with many methods for extracting and visualizing anatomical regions of interest. In the analysis of the objects in any image, the identification of the object from its background images is important. The techniques that are used to find the particular objects are known as segmentation techniques—segmenting the foreground from background. Segmentation is an exhaustive partitioning of the input image into homogeneous regions.

The segmentation has two objectives: (i) to decompose an image into regions for further analysis, (ii) to perform a change of representation of an image for faster analysis. Different types of segmentation techniques are used for segmentation. Based on the application, a single or a combination of segmentation techniques can be applied to solve the problem effectively[1].

The available segmentation approaches can be grouped into eight categories such as thresholding, Region growing, Clustering, Markov-random field models, Artificial neural networks, Classifiers, Deformable models, and Atlas guided approaches[2]. These segmentation techniques have several basic concepts such as pixel based methods for analyzing the gray values of the individual pixels, Region based methods for analyzing the gray values in larger areas, and Edge based methods for detecting edges.

Thresholding techniques identify a region based on the pixels with similar intensity values. This technique provides boundaries in images that contain solid objects on a contrast background . Thresholding technique gives a binary output image from a gray scale image. This method of segmentation applies a single fixed criterion to all pixels in the image simultaneously. Whereas the model based segmentation could be used when an object is in geometric shape the technique serves as a superior one than the other methods. The objective of this paper is to review methods and procedures for segmenting, based on thresholding and DMs. It would cover global thresholding, local thresholding, adaptive thresholding, histogram based threshold technique, iterative based threshold selection, Threshold Selection based on Otsu's method, Threshold Selection based on Clustering, and parametric deformable models, Geometric deformable models, Extended Deformable Models (EDM)

II. THRESHOLD BASED IMAGE SEGMENTATION

Thresholding techniques identify a region based on the pixels with similar intensity values. This technique provides boundaries in images that contain solid objects on a contrast background . Threshold method is the widely used technique in image segmentation. It is used to discriminate foreground from background. This method converts a grey scale image into binary image. The binary image contains the data required for location and shape of the objects. Complexity of image is reduedc because the image is converted ito a binary image. By this way, thresholding technique gives a binary output image from a gray scale image. This method of segmentation applies a single fixed criterion to all pixels in the image simultaneously.

The thresholding methods are –

- Global Thresholding
- Local Thresholding
- Adaptive Thresholding

A) Global Thresholding

In the global threholding, the intensity value of the input image should have two peak values which correspond to the signals from background and objects. It gives the degree of intensity separation between two peaks in an image[4].

Global thresholding is simple and easy to implementation.
But this thresholding technique does not produce the desired output when pixels from different segments overlap in terms of intensities. This overlapping of intensities has two reasons:

- Noise in the image
- Variation in illumination across the image

In case of noises in the image, minimum-error method is used to estimate the underlying cluster parameters and the classification error is minimized by choosing threshold. And in case of variation in illumination across the image, Variable thresholding technique is used. In variable thresholding, the foreground image objects are separated from the background based on the difference in pixel intensities of each region.
If the background illumination is uneven, Global thresholding method is not suitable.

B) Local Thresholding

Local thresholding is superior to the global threshold method in the case of poorly illuminated images.
In local thresholding technique, the threshold value T depends on gray levels of f(x, y) and some local image properties of neighboring pixels such as mean or variance.

C) Adaptive Thresholding

Adaptive thresholding technique is used when images are captured under unknown lightning condition and it is required to segment a lighter foreground object from its background. This technique changes the threshold value based on the slowly varying function of position in the image or on local neighboring hood statistics. Threshold T depends on the spatial coordinated (x, y) themselves.

Threshold Selection

In image segmentation using thresholding technique, the main attribute is the choice of selecting threshold value. It is selected by different ways depending upon the type of thresholding:

- In case of manual thresholding method, the threshold value can be selected by the user with the help of image histogram. This method is generally accomplished by a tool that allows the user to select the threshold value T based on choice.
- In case of automatic threshold selection method, the value of T can be chosen based on histogram, clustering, variance, means etc

These methods are -

- Histogram based Threshold Selection
- Iterative based Threshold Selection
- Threshold Selection based on Otsu's method
- Threshold Selection based on Clustering

A) Histogram Based Threshold Selection

Some images may have an object based on contrasting background. Histogram based thresholding is applied to obtain all possible uniform regions in these kind of images. An image having an object on a contrasting background gives a bimodal histogram. The two peaks correspond to the relatively large number of points inside and outside the object. The valley gives the threshold gray level. If the image containing the object is noisy and degraded due to illumination artifacts the histogram itself will be noisy and will not be sharp. This results an interruption in the selection of the threshold value T. To overcome this problem, the histogram is smoothened using either a convolution filter or the curve-fitting procedure.

B) Iterative Based Threshold Selection

Some images have a contrasting background and their histograms do not give clear valley point. Iterative methods give better result when the histogram doesn‟t clearly define valley point. This method does not require any specific knowledge about the image. Iterative method has the ability to improve the anti-noise capability.
The iterative method using one dimensional K-means clustering converges at a local minimum. The main disadvantage is, a different initial estimate for threshold value may give a different result.

C) Threshold Selection based on Otsu's method

This method is based on computations performed on the histogram of an image.
If a segment has relatively homogeneous gray level values, then a threshold value is selected in any of the following three ways:

- It minimizes the variance of the gray levels within the segment or
- It minimizes the variance between objects and background or
- It attempts to optimize both within and between segments variance.

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The threshold selection based on Otsu's method maximizes the between-class variance

The main drawback of Otsu's method of threshold selection is that it assumes that the histogram is bimodal. This method fails if two classes are of different sizes and also with variable illumination.

D) Threshold Selection based on Clustering

In this method, gray levels are clustered into object and background. Clustering is done to differentiate natural grouping of data from a large data set which gives a concise representation of system behaviour. K-means clustering gives a useful method of threshold selection. In this method, the image is divided into k segments using (k-1) thresholds and minimizing the total variance within each segment. And the quality of the results depends on the initial set of clusters and the value of k.

III. DEFORMABLE MODELS

DMs are potentially powerful tools for the segmentation of images. They are convenient to use. They have the ability to combine low level knowledge derived from the image data with a priori high level knowledge.

Their behavior is constrained by energy function . This allows to model constraints as different terms of the energy function. The model can be easily extended from 2D to 3D [10] and from 3D to 4D.

Deformable models are classified in two classes[2] –

- PDMs (Parametric Deformable Model)
- GDMs (Geometric Deformable Model)

A) Parametric Deformable Models

PDMs are used widely in image processing techniques. They are used for detection of edges, lines and individual contours, motion tracking, and stereo matching. These are all examples of more general techniques of matching a DM to an image by means of energy minimization. From any starting point, the snake deforms itself into conformity with the nearest salient contour. Basic techniques have been applied to the problem of 3D object reconstruction. Finite difference method (FDM) is used to solve the minimization problem via the Euler_Lagrange method. Other optimization methods include Conjugate Gradient (CG) method, Dynamic Programming (DP), Finite Element Methods (FEM), Greedy optimization, and Watershed transformation.

PDMs are also called as 'Active Contour Models' or 'Snake models.' They are also known as boundary based models that represent curves and surfaces obviously in their parametric forms during deformation. This representation allows direct interaction with the model. It directs to a compact representation for fast real time implementation resulting PDMs to be used successfully in a wide range of applications such as segmentation and tracking .

Even if the PDM is widey used for many applications, it has two main drawbacks:

- The initial model and the desired object boundary differ greatly in size and shape.
- It is difficult to maintain any change in the topology such as merging, splitting.

Though PDMs are showing these drawbacks, these are covered up by Geometric Deformable Model resulting into providing a better image processing technique.

B) Geometric Deformable Model

GDMs overcome the primary limitations of PDM. GDMs are similar to snakes model except that it can explore volume data. So, it generates 3D models. It can probe the data with a low resolution model and then substitute a higher resolution model. The GDM is easily parallelized as it is controlled through local geometric operation on a discrete model. In some models, the curve or surface is propagates by means of a velocity is a function of curvature. The Geodesic Active contours (GAC) are based on the curve shortening theory. Some models are based on the relationship between active contours and the computation or minimal distance curves. This minimal distance curve is based on a Riemannian space whose metric as defined by the image content. This geodesic Model allows connecting the snakes based on energy minimization and GDM based on the theory of curve evolution. Another shape based curve PDM is derived for an implicit representation of the segmenting curve by applying principle component analysis to a collection of signed distance representations of the training data.

GDMs are based on –

- curve evolution theory
- level set method

Curve Evolution Theory

The curve evolution theory can be used to understand the deformation curves using geometric measures. The widely used curve deformations in curve evolution theory are curvature deformation and constant deformation. GDM provides the speed of deformation using curvature or constant deformation with the image data. The evolution is implemented by using level set method.

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Level Set Method

It is widely used in Image processing, Computer graphics and Computational geometry applications. It is a numerical technique for identifying the interfaces and shapes. This methodis advantageous as it can perform numerical computations relating surfaces and curves on a fixed Cartesian grid known as the Eulerian approach.

Geometric measures are used to evolve curves and surfaces. It results in an evolution which is independent of the parameterization. As the development has necome independent of the parameterization the curves and surfaces evolved are represented as a level set of a higher order dimensional function. It results in the topology change to be handled automatically. The evolution theory aims at studying the deformation process of curves or surfaces using only geometric measures such as the unit normal or curvature. The main aim of the GDM is to combine the speed of the deformation process with the image data.

The level set method is used to account for automatic topology adaptation. Also the basis for the numerical scheme is provided which is used by the GDMs.

The GDM is widely used in shape modeling of both synthetic and medical images. The GDM is advantageous than PDM in many aspects, including computational stability. It has the straightforward applications like model applied for higher dimensions, non intersecting curves or surfaces, sub pixel accuracy, and topological flexibility. One drawback of GDMs however, is their computational cost.

IV. CONCLUSION

We have discussed image processing techniques based on thresholding and Deformable Model to detect diseases from MRI efficiently. Thresholding segmentation of MRIimages can detect the region of interest in a proper way. The drawback of this method is that only two classes are generated that are grey level and white level. So, the processing of multi-channel images becomes impossible. Thresholding methods are reluctant to noise and intensity homogeneities. Any one or combination of methods can be used to give the needed output depending upon the requirements.

The DMs are important in medical image segmentation because they offer a simple and easy process to segment and represent the complex shapes from medical images. DM give a compact and analytical representation of an object from medical image. This gives a way to doctors to provide correct diagnosis and further the correct treatment. And to overcome drawbacks, like accuracy and robustness in DMs needs further development and refinement of the DM. The short comings arising in medical image analysis indicate several promising research directions.

REFERENCES

[1] G. Evelin Sujji1, Y.V.S. Lakshmi2, G. Wiselin Jiji3, " *MRI Brain Image Segmentation based on Thresholding",* International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970) Volume-3 Number-1 Issue-8 March-2013.

[2] A. Srinivasan and S. Sundaram, "*Applications of Deformable Models for In_Dopth Analysis and Feature Extraction from Medical Images— Review*", Pattern Recognition and Image Analysis Vol. 23 No. 2, 2013.

[3] S. Jayaraman, S. Esakkirajan, T. Veerakumar, Digital Image Processing, Tata McGraw Hill Education Private Limited, 2009

[4] Amanpreet Kaur, "*A Review Paper on Image Segmentation and its Various Techniques in Image Processing*", International Journal of Science and Research (IJSR), Volume 3 Issue 12, December 2014

[5] Salem Saleh Al-amri, N.V. Kalyankar and Khamitkar S.D , " *Image Segmentation by using Thershod Techniques*", Journal of Computing,vol2, pp 83-86,2010.

[6] Guang Yang, Kexiong Chen, Maiyu Zhou, Zhonglin Xu, Yongtian Chen, "*Study on Statistics Iterative Thresholding Segmentation Based on Aviation Image*", 8th ACIS International Conference on software Engineering, Artificial Intelligence, Networking, and Parallel/ Distributed Computing, snpd. Vol.2, pp187-188, 2007.

[7] W. X. Kang, Q. Q. Yang, R. R. Liang, "*The Comparative Research on Image Segmentation Algorithms*", IEEE Conference on ETCS, pp. 703-707, 2009.

[8] T. Shraddha, K.Krishna , B.K Singh and R.P Singh, "*Image Segmentation: A Review*" International Journal of Computer Science and Management Research vol.1 issue. 4 November 2012 .

[9] N.Senthilkumaran and R.Rajesh, "Edge Detection Techniques for Image Segmentation - A Survey", Proceedings of the International Conference on Managing Next Generation Software Applications (MNGSA-08), pp.749-760 , 2008.

[10] Y. McInerneya, G. Hamarneh, M. Shentone, and D. Terzopoulos, "*Deformable organisms for automatic medical image analysis,*" Med. Image Anal. 6(3), 251–266 (2002).

[11] R. Gonzalez and R. Woods, *Digital Image Processing* (Prentice Hall, 2002).

[12] Hong Zhang, Lin Yang, D. J. Foran, J. L. Nosher, and P. J. Yim, "3D Segmentation of the liver using free_form deformation based on boosting and deformation gradients," in *Proc. IEEE Int. Symp. on Bio_Medical Imaging:from Nano to Macro (ISBI'09)* (Boston, 2009), 494-497, DOI:10.1109/ISBI.2009.5193092.

[13] B. Jahne, "*Digital Image Processin"g* (Springer_Verlag,2005), Vol. 16, pp. 449_462.

[14] Myungeun Lee, Soonyoung Park, Wanhyun Cho, Soohyung Kim, and Changbu Jeong, "*Segmentation of medical images using a geometric deformable model and its visualization*," Canad. J. Electr. Comput. Eng. 33 (1), 15–19 (2008), DOI:10.1109/CJECE.2008.4621790.

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