Hybrid Clustering And Boundary Value Refinement for Tumor Segmentation using Brain MRI

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Abstract: The method of brain tumor segmentation is the separation of tumor area from Brain Magnetic Resonance (MR) images. There are number of methods already exist for segmentation of brain tumor efficiently. However it’s tedious task to identify the brain tumor from MR images. The segmentation process is extraction of different tumor tissues such as active, tumor, necrosis, and edema from the normal brain tissues such as gray matter (GM), white matter (WM), as well as cerebrospinal fluid (CSF). As per the survey study, most of time the brain tumors are detected easily from brain MR image using region based approach but required level of accuracy, abnormalities classification is not predictable. The segmentation of brain tumor consists of many stages. Manually segmenting the tumor from brain MR images is very time consuming hence there exist many challenges in manual segmentation. In this research paper, our main goal is to present the hybrid clustering which consists of Fuzzy C-Means Clustering (for accurate tumor detection) and level set method (for handling complex shapes) for the detection of exact shape of tumor in minimal computational time. Using this approach we observe that for a certain set of images 0.9412 sec of time is taken to detect tumor which is very less in comparison to recent existing algorithm i.e. Hybrid clustering (Fuzzy C-Means and K Means clustering).

Keywords: Brain Tumor, Clustering, Level set, Magnetic Resonance Imaging.

1. INTRODUCTION
Anatomical structure for human body overcomes different modalities, for instance, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and so on. Pictures as of modalities will be used as examination reason. MRI Brain images are used by the doctors for proper treatment. Cerebrum tumor segmentation from MRI brain pictures is truly a troublesome assignment. The size and state of cerebrum tumor have numerous varieties. Furthermore, brain
tumor can be situated at any locale and has distinctive power of pictures. The segmentation of cerebrum tumor is critical for surgical arranging. Generally, the tumor area in attractive reverberation imaging was followed by hand. This strategy is infeasible when managing extensive information set. This strategy requires extensive measure of master mediation and adequate data about the object of interest. This process is very difficult and also time consuming. Image segmentation will be the expansive & dynamic field at medicinal imaging. To extract the tumor region the level set segmentation method is used for discovering tumor part out of provided MRI images. Fuzzy C-Means clustering results in the accuracy of findings and Level set method is an effective method for segmentation of image as it has ability to tackle complex geometries and also provide high flexibility in topology of the object. This process is very difficult and also time consuming. Image segmentation will be the expansive & dynamic field at medicinal imaging. To extract the tumor region the level set segmentation method is used for discovering tumor part out of provided MRI images. Fuzzy C-Means clustering results in the accuracy of findings and Level set method is an effective method for segmentation of image as it has ability to tackle complex geometries and also provide high flexibility in topology of the object. This level set strategy progressively build up shape (at two measurements) or else the surface (at three measurements) verifiably through controlling the higher dimensional capacity, known as level set capacity.

2. LITERATURE SURVEY

This section, presents review of the selected literature in image segmentation of Brain MR Images. The key objective is to highlight key strengths and limitations of various segmentation approaches. Eman Abdel et.al. [2015] elaborates hybrid clustering technique which includes K-Means algorithm and fuzzy C-means algorithm. The study shows that k-means clustering algorithm clusters data by iteratively computing a mean intensity for each class and segmenting the image by classifying each pixel in the class with the closest mean. It iterates between computing the posterior probabilities and computing maximum likelihood estimates of the means, covariances, and mixing coefficients of the mixture model. The proposed technique results minimal computation time by using K-Means clustering. And results better accuracy by using Fuzzy C-means. The accuracy was evaluated by comparing the results with the ground truth of each processed image. The experimental results clarify the effectiveness of proposed approach to deal with a higher number of segmentation problems via improving the segmentation quality and accuracy in minimal execution time. Fuzzy C-means predicted tumor cells that are not predicted by K-means algorithm. Major limitation in this work is that original Fuzzy C-means algorithm yields good results for segmenting noise free images, it fails to segment noisy images. Therefore, improved results to reduce the number of iterations, which affects execution time and gives an accurate result in tumor detection [20].

S. Madhukumar et al. [2015] creates the qualitative comparison of Fuzzy C-means (FCM) and k-Means segmentation, with histogram guided initialization, on tumor edema complex MR images. Main emphasize is on the accuracy of segmentation scheme which depends on the ability to distinguish different tissue classes, separately. The suggested work evaluates the ability of FCM and k-Means to segment Gray Matter (GM), White Matter (WM), Cerebro-Spinal Fluid (CSF), Necrotic Focus of Glioblastoma Multiforme (GBM) and the perifocal vasogenic edema from pre-processed T1 contrast axial plane MR images of tumor
edema complex. The experiments on various MR images reveals that FCM identifies the vasogenic edema and the white matter as a single tissue class and similarly gray matter and necrotic focus, also. k-Means is able to characterize these regions comparatively better than FCM. FCM identifies only three tissue classes whereas; k-Means identifies all the six classes. FCM can separate the major different tissue types using just a small number of clusters, whereas k-Means is only able to separate them if a larger cluster number is used. Segmentation accuracy of FCM and K-means is image dependent.

Major limitation in this work is that FCM produces empty clusters. Even if the k-Means identifies all the tissue classes, certain parts of WM are clubbed with vasogenic edema because of their homogenous intensity features[19].

Jason J. Corso et al.[2008] stated that bottom up affinity-based segmentation and top down generative model techniques were not enough to get good results, and propose a novel methodology of automatic segmentation of heterogeneous images. Main difference in this paper is the use of Bayesian formulation to make complex calculations on soft models. It uses multichannel MR volumes to detect and segment brain tumor. Calculation in this model is more efficient than the conventional presented models, and results are presenting improved output in the form of quantitative analysis. An automatic segmentation technique is helping the medical clinic researchers with automatic labeling freeing them from manual labeling. Fuzzy clustering is also a very famous technique for detecting brain tumor. It has demonstrated that fuzzy clustering approach provides better results by using raw multi sequence data.[2]

3. SUMMARY OF BRAIN TUMOR SEGMENTATION METHODS

| Segmentation Methods                  | Merits                                                                 | Demerits                                                                 |
|--------------------------------------|------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Region based segmentation[14]        | It is best since it correctly segments regions that have similar properties and produces connected region. | It is quite expensive in terms of computation of both time and memory. Partial Volume effect. |
| Threshold based segmentation[5]      | Simpler, fast computations and lower complexity                         | Limited applicability to enhance tumor area. It does not take into account spatial domain, thus there is uncertainty that regions are connected. |
| Fuzzy C Mean Segmentation[3]         | Unsupervised. It converges the tumor boundaries.                       | Long computational time, sensitivity to noise.                            |
Artificial Neural Networks based segmentation [10] | Ability to model non-trivial distributions and non-linear dependence. | Gathering training samples is not straightforward and learning phase is slow.

4. PROPOSED WORK

Fuzzy Clustering involves the job of dividing data points into homogeneous classes or clusters making sure that items in the class that is same as similar as you can and products in different classes are as dissimilar as possible. The algorithm starts with data scanning, in this items are identified and their domain is extracted. for every single similarity that is domain of item is learn with another product, as similarity is determined for every single and every item in a domain. Similar items are then identified in a domain by applying similarity criterion. Candidates are generated after finding items being similar in a domain. After evaluation cluster center is identified and all sorts of the nearby points that having the distance similarity are grouped together and clusters are formed. Then this output is clustered based on similarity. After that boundary values are refined using level set approach after determining the segmented cut-out.

Proposed strategy uses 3 models for the Segmentation of tumor tissues from normal WM (White matter), GM (Gray matter) and CBF (Cerebrospinal Fluid):

1. Preprocessing of Brain MRI images using Gaussian filter (sigma=2 and 4).
2. Clustering using fuzzy C-Means and FCM Thresholding calculation for the maximization of inter cluster variance.
3. Level set method for defining the exact shape of tumor and increasing the intensity values of tumor for boundary refinement.

5. EXPERIMENTAL RESULTS

5.1 Data Sets

In order to check the performance of our image segmentation approach, we used realistic MR images of brain collected from the authorized MRI Imaging center.

5.2 Results

In this section, we show the results of our proposed image segmentation technique that are obtained using real MRI Brain images. This work was implemented using MATLAB (R2013a). We run our experiments on a core i3/2.4 GHZ computer with 3 GB RAM.

Given Dice Similarity Graph (Fig 1) represents our approach (Hybrid Clustering-FCM with Level Set method) takes minimal computation time in segmenting the tumor with respect to existing algorithms.
Table 1: Elapsed time Metrics of FCM, varying with no. of Iterations

| Data set | FCM | Iteration no. | Time(sec) | Iteration no. | Time(sec) |
|----------|-----|---------------|-----------|---------------|-----------|
| 1        | ![Image](image1) | 15           | 2.855619  | 10            | 1.681178  |
| 2        | ![Image](image2) | 15           | 8.129520  | 10            | 5.604556  |
| 3        | ![Image](image3) | 10           | 2.947505  | 5             | 1.869475  |
| 4        | ![Image](image4) | 7            | 7.577656  | 4             | 5.027032  |
6. Conclusion

Image segmentation is a vital research span because it plays a major role in picture research, and understanding. Segmenting a picture is the most challenging and tough task. Consequently, scanned documents have to frequently be segmented beforehand supplementary document processing methods, such as compression or rendering, can be applied. The aftermath displays that fuzzy Level Set Segmentation can segment a tumor endowed the parameters are set properly in MATLAB environment on the basis of results it is concluded that by selecting seed point manually using region based method hybrid segmentation approach (Fuzzy C-Means clustering with level set method) generates more accurate tumor and segment tumor in minimal computation time by refining the exact boundary of tumor present in brain by classifying tumor pixels using fuzzy C-Means clustering approach. Segmentation instruments in health imaging can be utilized for automatic segmentation of Brain tumors. Further work can be carried out to make this semiautomatic to automatic segmentation so that it can calculate the dimensions of the segmented tumor automatically.

References

[1] Z.P. Liang and P. C. Lauterbur, “Principles of Magnetic Resonance Imaging: A Signal Processing Perspective” the Institute of Electrical and Electronics Engineers Press, 2000.
[2] Jason J. Corso, Eitan Sharaon, Shishir Dube, Suzie El-Saden, Usha Sinha and Alan Yuille, “Efficient Multilevel Brain Tumor Segmentation with Integrated Bayesian Model Classification”, IEEE Transactions on Medical Imaging, vol 27, No.5, May 2008.
[3] Ahmed Kharaat, Mohamed Ben Messaoud, Nacéra Benamrane, Mohamed abid, “Detection of Brain Tumor in Medical Images”, IEEE International Conference on Signals, Circuits and Systems vol 24 No.4, June 2009.

[4] Dai Junfeng, Y A N Yunyang, “The Fast Medical Segmentation of Target Region Based on Improved FM Algorithm”, International Workshop on Information and Electronics Engineering, Procedia Engineering 29.SciVerse Science Direct pp-48-52, 2012.

[5] A. Rajendran , R. Dhanasekaran, “Fuzzy Clustering and Deformable Model for Tumor Segmentation on MRI Brain Image: A combined approach”, International Conference on Communication Technology and system design, Procedia Engineering 30, SciVerse Science-direct pp-327-333, 2012.

[6] S. Patel, K. S. Patnaik, “Analysis of Clustering Algorithms for MR Images Segmentation Using IQF”, International Conference on Communication, Computing & Security Science-direct procedia Technology, pp-387-396, 2012.

[7] R. Loganathan, and Y. S. Kumaraswamy. “Active Contour Based Medical Image Segmentation and Compression using Biorthogonal Wavelet and Embedded Zerotree.” Indian Journal of Science and Technology 6, no. 4 pp. 4390-4395, 2013.

[8] D. Selvaraj, R. Dhanasekaran, “MRI Brain Image Segmentation Techniques - A Review” in Indian Journal of Computer Science and Engineering, vol. 4, no.5 pp. 976-986, Oct-Nov 2013.

[9] Atiq Islam, Syed M. S. Reza, and Khan M. Iltekhariuddin, “Multifractal Texture Estimation for Detection and Segmentation of Brain Tumors”, IEEE Transactions on Biomedical Engineering, vol. 60, NO. 11, November 2013.

[10] H. Tulsani, S. Saxena and M. Bharadwaj, "Comparative study of techniques for brain tumor segmentation," International Conference on Multimedia, Signal Processing and Communication Technologies (IMPACT), 2013, Aligarh, pp. 117-120, 2013.

[11] Jin Liu, Min Li, Jianxin Wang, Fangxiang Wu, Tianming Liu, and Yi Pan, “A Survey of MRI-Based Brain Tumor Segmentation Methods”, IEEE Transactions TSINGHUA Science and Technology ISSN 1007-0214 vol 19, Number 6, pp 578-595 December 2014.

[12] Salabha Varghese, “Brain Tumor Segmentation by FCM and Enhancement by ANN, using GLCM Based Feature Extraction”, International Journal of Science and Research (IJSR), vol 3, Issue 11, November 2014.

[13] Meiyan Huang, Wei Yang, Yao Wu, Jun Jiang, Wufan Chen, “Brain Tumor Segmentation Based on Local Independent Projection-Based Classification”, IEEE Transactions on Biomedical Engineering, vol. 61, NO. 10, October 2014.

[14] Ruchi D. Deshmukh Prof. Chaya Jadhav, “Study of Different Brain Tumor MRI Image Segmentation Techniques”, International Journal of Computer Science Engineering and Technology (IJCSET) Vol 4, Issue 4 pp-133-136, April 2014.

[15] Youyong Kong; Yue Deng; Qionghai Dai, "Discriminative Clustering and Feature Selection for Brain MRI Segmentation," in Signal Processing Letters, IEEE, vol.22, no.5, pp.573-577, May 2015.

[16] Liu and L. Guo, "A New Brain MRI Image Segmentation Strategy Based on K-means Clustering and SVM," Intelligent Human-Machine Systems and Cybernetics (IHMSC), 2015 7th International Conference, Hangzhou, pp. 270-273, 2015.

[17] Christian Ledig, Rolf A. Heckemann, Alexander Hammers, Juan Carlos Lopez, Virginia F.J. Newcombe, Antonios Makropoulos, Jyrki Lötjönen, David K. Menon, Daniel
Rueckert, “Robust whole-brain segmentation: Application to traumatic brain injury”, Science Direct Medical Image Analysis 21 pp- 40–58,2015.

[18] Asra Aslam, Ekram Khan, M.M. Sufyan Beg, “Improved Edge detection algorithm for Brain Tumor Segmentation”, Second International Symposium on Computer vision and the internet, procedia computer –science, volume 58 pp-430-437,2015.

[19] S. Madhukumar, N. Santhiyakumari, “Evaluation of K-Means and fuzzy C-Means segmentation on MR images of brain”, Egyptian Journal of Radiology and Nuclear Medicine Science-direct 46, pp-475-479, 2015.

[20] Eman Abdel-Maksoud, Mohammed Elmogy, Rashid Al-Awadi, “Brain Tumor Segmentation based on a hybrid clustering Technique”, Egyptian Informatics Journal 16 Science direct, pp 71-81, 2015.

[21] Sudipta Roy, Sanjay Nag, Indra Kanta Maitra, Prof. Samir Kumar Bandyopadhyay, “A Review on Automated Brain Tumor Detection and Segmentation from MRI of Brain”, https://arxiv.org/ftp/arxiv/papers/1312/1312.6150.pdf

[22] Bjoern H. Menze, Koen Van Leemput, Danial Lashkari, Tammy Riklin-Raviv, Ezequiel Geremia, Esther Alberts, Philipp Gruber, Susanne Wegener, Marc-Andre Weber, Gabor Szekely, Nicholas Ayache, and Polina Golland, “A Generative Probabilistic Model and Discriminative Extensions for Brain Lesion Segmentation—With Application to Tumor and Stroke”, IEEE Transactions on medical imaging, Vol. 35, no. 4, April 2016.

[23] G Rajesh Chandra, Dr. Kolasani Ramchand H. Rao, “Tumor detection in brain using Genetic Algorithm”, International Conference on Communication, Computing and Virtualization, procedia computer science, Science –direct, pp 449-457, 2016.

[24] Smitha Padshetty, Virupakshappa, “A Hybrid level set method for Segmentation of tumor in MRI Brain Image”, International Journal for Innovative Research in Science and Technology, vol.3, issue 3, Aug 2016.