IMPLEMENTATION OF FUZZY C MEANS AND SNAKE MODEL FOR BRAIN TUMOR DETECTION

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Abstract-Image processing plays an important role in medical field like analysis of medical scans and planning further treatment based on the processed images. Extensive research is being done in getting the desired results in image processing problems. This paper focuses on segmenting brain tumor in Magnetic Resonance images using fuzzy c means algorithm and then detect the tumor region using snake model.

Keywords. Fuzzy c-mean, cluster, segmentation.

INTRODUCTION

A tumor is an uncontrolled growth in cells. A tumor growth is cells dividing uncontrollably i.e. new cells are created even when existing cells have not died or been damaged.[11] Tumors are of two types: malignant or benign. A benign tumor is one which lacks the ability to invade or spread to neighboring cells or tissue whereas a malignant tumor has the ability to spread elsewhere. A metastatic tumor is one which has spread from another part of the body to the brain [1] . Radiologists examine the tumor growth using magnetic resonance images.

Magnetic Resonance Imaging (MRI) is an imaging technique that is used to image body parts. MR images can be used to study brain development and abnormalities that have developed. These images provide useful information such as the tumor location and its size, and provide an easy way to plan the surgical approach for its removal. There are various methodologies used to classify MR images which are fuzzy methods, neural networks, atlas methods, knowledge based techniques, shape methods, variation segmentation.[8] The primary step at analyzing MRIs and splitting them into regions containing meaningful information and data is image segmentation. [9]

The brain consists of white matter, gray matter and cerebrospinal fluid. Segmenting the image manually is an extremely time consuming task for an expert. Hence computer programs to do that task have been created [2] . Image segmentation is an image processing technique which partitions an image into distinct regions containing each pixel with similar attributes which will be meaningful and useful for image analysis [3] .

Segmentation techniques are of two types: supervised and unsupervised learning. [10]Supervised learning includes feeding the system with known input output sets and making suitable corrections when an output doesn’t match expected output. Unsupervised learning evolves to extract features or regularities in presented patterns without being told what output or classes associated with input pattern is desired. Unsupervised learning is completely automatic and doesn’t require user attention at every step. Different unsupervised image segmentation learning methods are K means, Fuzzy C means and Expectation Maximization methods. [5]

Clustering is a process of grouping pixels based on some criterion. There are two main approaches to clustering- crisp clustering and fuzzy clustering. In crisp clustering the boundaries are defined that is a pixel can belong only to one cluster. In fuzzy clustering there is more flexibility .So a pixel may belong to one or more clusters. Fuzzy clustering method provides a more useful way to classify patterns. Fuzzy c-means method is widely used because it can preserve more information compared to other similar techniques. Membership function is used while assigning pixels to each class.[13]

Active contour model is a framework for getting the outline of an object from a noisy image. Energy minimizing curves called snakes are used to get the regions of interest. Snakes are greatly used in applications like object tracking, shape recognition, segmentation, edge detection, stereo matching. [6]

Let us suppose X=(x_1, x_2, $x_{3,}$…..x_n) denotes an image with N pixels which is to be divided into C clusters, FCM follows an iterative process which minimizes the following objective function

$$J = \sum_{j=1}^{N} \sum_{i=1}^{C} u_{ij} m \left\| X_j - V_i \right\|$$

Where u_{ij} = membership of pixel x_j in i^{th} cluster m is the fuzzifier that controls the fuzziness of resulting clusters and lies between $1<m<\infty$

The membership function and the clusters enters are updated, the cluster centers can either be initialized randomly or by an approximation method.[7]

PROPOSED WORK

The objective function is given by

$$I_m = \sum_{i=1}^{n} \sum_{j=1}^{i} u_{ij}^{m} d_{ij} \quad (1)$$

Where mϵ[1,∞] is a weighting exponent, $u_{ij}\epsilon[1,0]$ is the degree of membership x_i in the cluster j, x_i is the i^{th} of d dimensional measure data, c_j is the d dimensional center of the cluster and d_{ij} is the Euclidean distance between i^{th} data point(x_i)and j_{th} centroid (c_j).[7]

The fuzzy partitioning is carried out through an iterative optimization of the objective function given in (1) with the update of membership function u_{ij} and the cluster centers c_j by

$u_{ij} = \frac{1}{\sum_{k=1}^{c} \left[\frac{d_{ij}}{d_{ik}}\right]^{\frac{2}{m-1}}}$, $c_j = \frac{\sum_{i=1}^{n} u_{ij}^{m} x_i}{\sum_{i=1}^{n} u_{ij}^{m}}$ .This procedure will stop if the improvement of objective function over previous iterations is below a threshold value Ɛ ϵ [1, 0]. By iteratively updating the cluster centers and the membership grades for each data point, FCM iteratively moves the cluster centers to the right location within a data set[12]. The detailed algorithm as proposed by Bezdek is[7][13]

Step 1: Randomly initialize the membership matrix U= [u_{ij}], $U^{(0)}$ that has a constraint equation given by

$\sum_{i=1}^{c} u_{ij} = 1, \forall_j = 1, .. n$ (3)

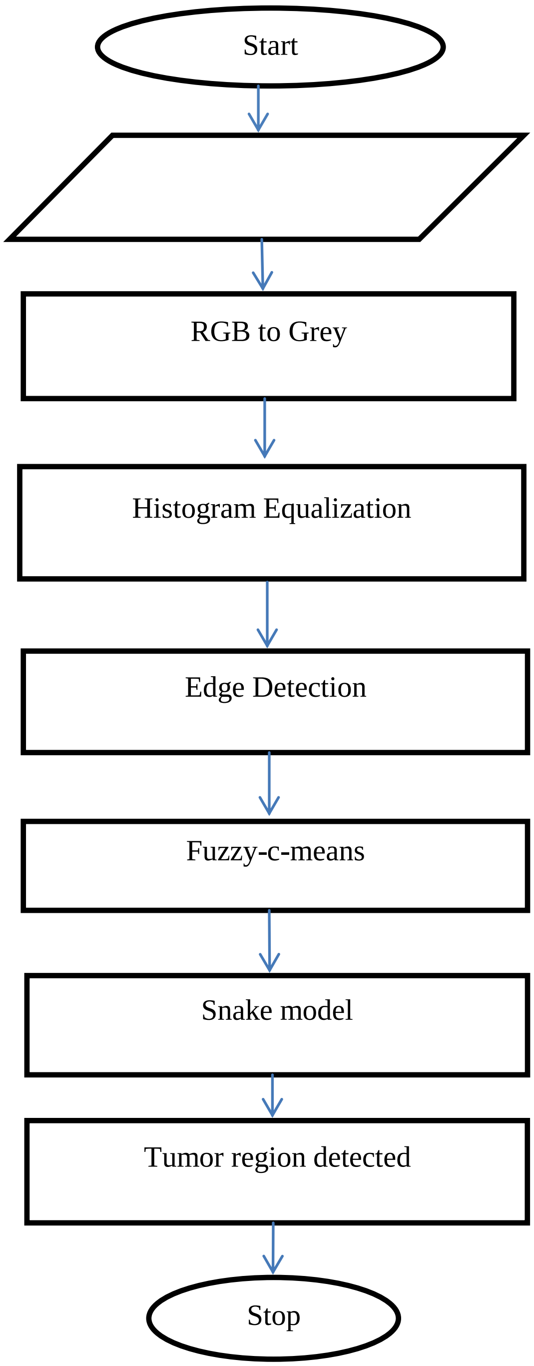
Step 2: At k step, calculate the centroids and objective functions by using the equations (2) and (1).

Step 3: Update the $U^{(k)}, U^{(k+1)}$ by using the equation (1).

Step 4: If stopping criterion exist then stop, otherwise return to step (2).

METHODOLOGY

The Brain MRI image will be first converted from RGB to grey image. Then it will undergo histogram equalization to remove the noise. The edges will be detected using Canny's edge detection method. Then image will be segmented using fuzzy c means algorithm. Then the image is passed to snake model for detecting tumor.



RESULTS

The proposed Fuzzy c means algorithm was implemented with MATLAB R2013a in a Windows 7 – ultimate system(Microsoft).All the experiments were run on a HP Pavilion G6 using INTEL(R) CORE TM i5 -2450M CPU @2.5GHz processor having 6GB RAM and 64 bit operating system. The experiments and the performance evaluation were carried out on the medical images of different sizes.

Image database

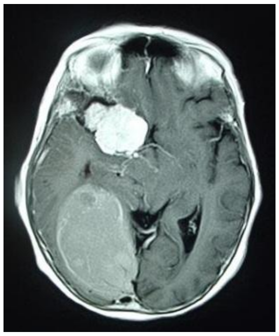


Figure 1

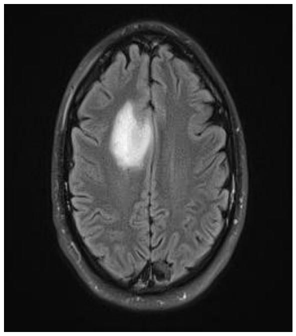


Figure 2

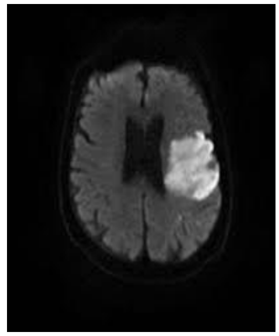


Figure 3

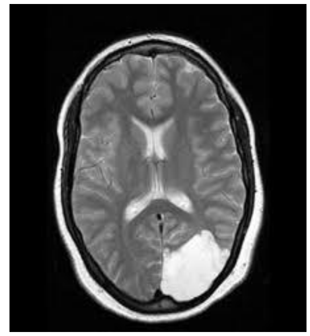


Figure 4

After segmentation

Figure 5

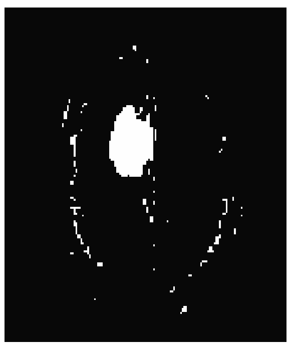


Figure 6

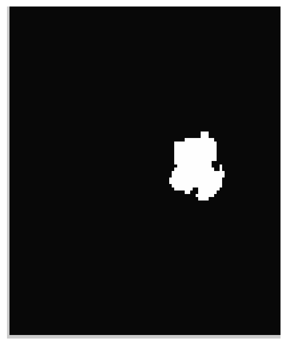


Figure 7

Figure 8

Table 1.Segmentation

Original Figure no.	Segmented Figure no.	Size of the image	Time taken for segmentation
Figure 1	Figure 5	336x406	2.46s
Figure 2	Figure 6	256x256	2.34s
Figure 3	Figure 7	204x204	1.96s
Figure 4	Figure 8	225x225	1.99s

The segmented images are run through Snake model. The active contours are controlled by a set of parameters. The user provides these control parameters based on the image. The control parameters are described below

alpha: Specifies the elasticity of the snake. This controls the tension in the

contour by combining with the first derivative term.

beta: Specifies the rigidity in the contour by combining with the second derivative term.

gamma: Specifies the step size

kappa: Acts as the scaling factor for the energy term.

W (Eline): Weighing factor for intensity based potential term.

W (Eedge): Weighing factor for edge based potential term.

W (Eterm): Weighing factor for termination potential term.

Figure 9

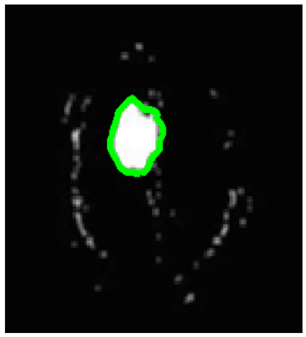


Figure 10

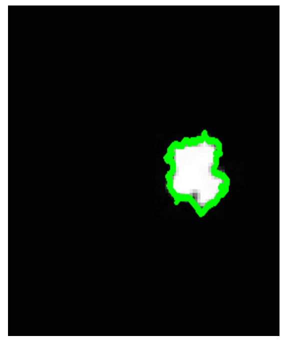


Figure 11

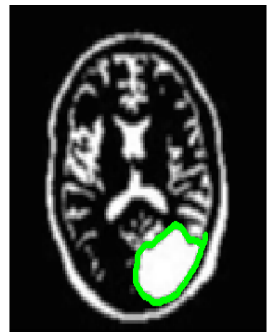


Figure 12

Table 2. Snake model

Figure No.	Sigma	Alpha	Beta	Gamma	Kappa	W(ELine)	W(EEdge)	W(Eterm)	No. of iterations
Figure 9	1	0.4	0.2	1	0.15	0.3	0.4	0.7	200
Figure 10	1	0.3	0.2	2	0.19	0.1	0.2	0.5	197
Figure 11	1	0.4	0.2	1	0.15	0.1	0.4	0.7	50
Figure 12	2	0.3	0.1	1	0.17	0.1	0.2	0.7	100

From the above experimental results we find that Figure1 of size 336x406 pixel takes the maximum time that is 2.46 seconds while figure 3of size 204x204 pixel takes the least time that is 1.96 s which implies that greater the image size more the execution time. Also, in the snake model the number of iterations required for the evolution of the contour is maximum for figure 1 i.e 200 iterations and minimum for figure 3 i.e 50 iterations.

CONCLUSION

The Brain MRI is segmented using fuzzy c- means algorithm after undergoing the preprocessing steps and tumor region is located using the snake model. The exploration done on the real Magnetic resonance images exhibits that the proposed algorithm has enhanced performance. The method of segmentation of colored images is based on fuzzy classification. The main advantage of fuzzy c means is that it requires no prior information on the images to segment. MRI images are highly weighted so other methods require more number of iterations while in this method the same result is obtained with less iteration and hence execution speed is high.

REFERENCES

[1] Wikipedia, Brain tumor. http://en.wikipedia.org/wiki/Brain_tumor.
[2] K. Somasundaram and T.Kalaiselvi . A Comparative Study of Segmentation Techniques used for MR Brain Images [Department of Computer Science and Applications, Gandhigram Rural University, Gandhigram, Tamilnadu, India]
[3] Brain Segmentation using Fuzzy C means clustering to detect tumor region. ISSN: 2277 – 9043 International Journal of Advanced Research in Computer Science and Electronics Engineering Volume 1, Issue 2, April 2012.
[4] Modified Fuzzy C-means algorithm in medical images. [International Journal of Scientific & Engineering Research Volume 3, Issue 9, September-2012 1 ISSN 2229-5518]
[5] Jain A.K., Murty M.N., Flynn P.J., "Data Clustering – A Review", ACM Computing Survey, vol. 31, no. 3, pp. 265-322, 1999.
[6] Everything you wanted to know about snakes but were afraid to ask
Jim Ivins & John Porrill
AIVRU Technical Memo #86, July 1993, (Revised June 1995; March 2000), Artificial Intelligence Vision Research Unit, University Of Sheffield, England S10 2TP
[7] http://home.deib.polimi.it/matteucc/Clustering/tutorial_html/cmeans.html
[8] Dzung L.Pham et.al. A survey of current methods in medical image segmentation. Annual Review of Biomedical Engineering,January 1998.
[9] Hassan Khotanlou, Jamal Atif, Olivier Colliot ,Isabelle Bloch,"3D brain tumor segmentation using fuzzy classification and
deformable models",WILF, pp. 312-318,2005
[10] W. Gonzalez, "Digital Image Processing", 2nd ed. Prentice Hall, Year of Publication 2008, Page no 378.
[11] Anamika Ahirwar, R.S. Jadon. Segmentation and characterization of Brain MR image regions using SOM and neuro fuzzy techniques. Proceedings of the First International Conference on Emerging Trends in Soft Computing and ICT (SCIT2011), 16-17 March 2011 at Guru Ghasidas Vishwavidyalaya, Bilaspur (C.G.) India, ISBN: 978-81-920913-3-4, pp 128-131.
[12] Ruspini, E. (1969). Numerical methods for fuzzyclustering. Information Science 2, 319-350.
[13] Bezdek JC, Hall LO, Clarke LP. Review of MR image segmentation techniques using pattern recognition. Med Phys 1993; 20:1033–1048.