MEDICAL IMAGE SEGMENTATION USING ANT COLONY OPTIMIZATION ALGORITHM

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ABSTRACT

Brain tumor is one of the very risky disease occurs commonly in human beings. MRI brain image technique is widely used to measure and envision the brain's anatomical structure. the image formed by MRI are in high tissue contrast and have less output. However, the lot of effort need to analyze the MRI image manually. The recognition of tumor in brain required many process on MRI image which include image processing, image enhancement , binarization , image segmentation, image extraction , classification , the final classification process determine that a person is diseased or not .even though many effort and promising result are obtain in medical image segmentation of abnormalities are still a difficult task because of different shapes ,noise , degradation , intensity changes and location of different type of tumor .in this paper we propose ant colony optimization(ACO) method which is allow segmentation of tumor in MRI images and compare result with various segmentation Algorithm

Keywords: Binarization; Segmentation; Thresholding, Edge Detection; Ant Colony Optimization.

1. INTRODUCTION

Images are collection of pixels, it's used to convey the information ,image segmentation is important job in medical image analysis , One out of two man and one out of every three women will be diagnosed with cancer .at the simplest level cancer or cancer cells are cells that have lost the ability to follow the normal control that the body exerts on cells .tumor cancer cells together we would call that a tumor .cancer treatment actually is very complex and part of the reason is because cancer is this constellation of two hundred different disease .they have common characteristics but they are all very different from each other.

Segmentation is the process of separating the pixels from the background. The method is very simple. The pixels are separated based on their intensity values. A large number of segmentation methods are available like the thresholding method, clustering method, compression based method, edge based method, region growing method and partial differential equation based method. [12][13]

Edge methods are based on disjointedness and sudden changes in the pixel values [12][13]. The Thresholding method is of three types namely,

global, local and adaptive. Many of the global Thresholding methods define a unique threshold value for reforming the entire image from grey values to binary values. If a pixel value in the image is higher than the global threshold, then it is reformed to white (background). If a pixel value in the image is less than or equal to global threshold value then it is reformed to block (foreground).The definition of this global threshold could be made either using histogram properties, global edge information or determined a priori by the user.

Global thresholding is useful under easy conditions. A normal problem that occurs with this method is when the grey level transition between the object and the background is slow and unreliable across objects in the image[16]. So, we go in for local thresholding. Local thresholding measures the neighbourhood of pixels also[5]. If the pixel value is appreciably lesser than the adjacent pixels, it is reformed to black; otherwise it is reformed to white. Window adaptive method is the same as local adaptive but the only difference is that it checks the pixels adaptively [5].

2. RELATED WORK

Many of the algorithms do not perform well on degraded images. Local threshold method estimate only high contrast pixels. Image binarization and segmentation methods are based on the active contour and partial differential equation, but it requires some preprocessing steps like the Otsu method. Edge based segmentation, like canny edge method considers non-edge pixel also, so edge based segmentation does not perform well on degraded images. Level set is used for binarization and active contour for segmentation. But they need some preprocessing method to provide better result. Robust image technique used for binarization but it detects only north and south side gradient

MRI scan is best type of image to identify most type tumor, MRI use magnetic field and radio waves and computer form complete picture of the brain. Magnetic Resonance Imaging (MRI) is noninvasive procedure and can be used safely for brain imaging as often as necessary. MRI images are used to create well aimed and through pictures of organs from different points to find any abnormalities in tissue. There are two types one is high field another one is low field. MRI high field for provide high quality images and low field produce low field MRI for smallest diagnosis condition. MRI images allow the physician to view even hair line cracks and tears in injuries to ligaments, muscles and other soft tissues. MRI is based on the principle of absorption and emission of energy in radio free range of electron magnetic spectrum. Magnetic resonance imaging (MRI) is excellent for showing abnormalities of the brain such as stroke, hemorrhage, tumor multiple sclerosis or lesions. MRI scan is very long and noise process slight movement can damage the picture and it will produce the wrong report , MRI image report to find the location of abnormal tissues so output of MRI scan imitate in surgery

2.1 SMOOTHED AND PREWITT OPERATOR

Prewitt operator takes magnitude gradient and clearly detects the important object boundary from the original image

H1= $\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$ this detecting edge having the gradient in → direction.

H2= $\begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix}$ this detecting the edge having the gradient in ↑ direction.

Using Gradient we updating the horizontal as well as vertical operator then just take magnitude square of them and take root then apply some kind of threshold, the threshold used to determine the high gradient pixel form low gradient pixel. The output image is gradient image .the high gradient pixel represented in white color and block color pixel represent this pixel are not in the high gradient. White pixels represent the edge of the image because it contains maximum gradient value.

2.2 Sobel Operator

Sobel operator same as prewitt operator. Only different in the elements .one Important different is in case of edge which are absolutely going → this particular direction we are enhancing those edges as compared to the edge oriented slightly different. This kind of operator obviously picking up the clearly horizontal and vertical gradient edges.

H1= $\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$ this detecting edge having the gradient in → direction.

$H2 = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$ this detecting the edge having the gradient in ↑ direction.

The gradient defined as

$$|H| = \sqrt{H_1^2 + H_2^2}$$

$$|H| = |H_1| + |H_2|$$

$$\theta = \arctan\left(\frac{H_2}{H_1}\right)$$

6.2.2. ROBERTS OPERATOR

Roberts operator horizontal and vertical difference of local sums this reduce the noise in image .It's used to compute two Dimensional spatial gradients. Every point in the output represent the correct gradient of the input image

H1= $\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$ H2= $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$

The operator consists of a pair of 2×2 convolution kernels. One kernel is obtained by rotating the other kernel by 90°. It can be applied separately to the input image. These can be joint together to get the correct gradient.

The gradient distinct as,

$$|H| = \sqrt{H_1^2 + H_2^2}$$

$$|H| = |H_1| + |H_2|$$

$$\theta = \arctan\left(\frac{H_2}{H_1}\right) - \frac{3\Pi}{4}$$

2.4 . CANNY OPERATOR

Previous edge detection method contains lot of drawback like,

1. Robust to noise.
2. Localization means cannot detect correct location of pixels.
3. Too many or too less means misses some edge or add extra edge.

the gradient of the Gaussian is optimal detector is called canny edge detection. first find Smooth image with Gaussian filter. Then second is computing derivative of filtered image. Third is finding the magnitude and orientation of gradient. Fourth step is applying non maximum suppression. And then apply hysteresis threshold.

Canny edge detection first step is Smoothing:

$$s = I * g(x, y) = g(x, y) * I$$

$$g(x, y) = \frac{1}{\sqrt{2\Pi e}} e^{-\left(\frac{(x^2+y^2)}{2\partial^2}\right)}$$

Derivatives:

$$\nabla_s = \nabla(g * x) = (\nabla_g) * I$$

$$\nabla_s = \begin{bmatrix} g_x \\ g_y \end{bmatrix} * I = \begin{bmatrix} g_x * I \\ g_y * I \end{bmatrix}$$

$$\nabla_g = \begin{bmatrix} \frac{\partial_g}{\partial_x} \\ \frac{\partial_g}{\partial_y} \end{bmatrix} = \begin{bmatrix} g_x \\ g_y \end{bmatrix}$$

Gradient magnitude and gradient orientation:

(s_x, s_y) Gradient vector

Magnitude: $\sqrt{s_x^2 + s_y^2}$

$$\theta = \tan^{-1}\frac{s_x}{s_y}$$

Direction:

4. Non maximum suppression: It's used to supply the pixels which are not local maxima.
5. Hysteresis threshold: it uses two threshold values high and low threshold. if the pixels is present above high threshold value the pixel is edge pixel. The pixel is present below low threshold values declare this pixel is non edge pixels. the pixel presents between the low and high threshold value if that pixel connected to

another pixel which is above high threshold values we considered these pixels is edge pixel [6]

3 ANT COLONY OPTIMIZATION

Ant colony optimization technique is search technique between source and destination to find shortest path along the available path. AOC is search technique developed by Marco dorigo in 1991in PhD thesis its search technique to find shortest path it mimics the behavior of natural ant and that has name ant colony optimization. First ant wanders randomly until it finds the food source and return to the nest laying pheromone trail. Pheromone is chemical substance released by ants when it goes in search food it is released by the tail of the ant other ant follow one of the path random also laying pheromone trails [1]. The ant on the shortest path lay pheromone trails faster, making its more applying to future ants. The ant become increasing likely to follow this shortest path. The pheromone trails of the longer path.

3.1. ANT COLONY OPTIMIZATION BASED EDGE DETECTION

This ACO method based on graph representation that has been applied successfully in various optimization problem these algorithm us artificial stigmergy that means mechanism for communication by modifying environment. Image segmentation is preprocessing step in application this aco transform the given input image into binary image that indicate the either present and absence of edge. Edge detector represent the special group of algorithm with in the objective of finding pixel belong to true edge. pixel define the discrete space in which the artificial ant move and edge pixel represent food operation performed by set of MRI images.

Algorithm is iterative process which include following step

1. Initialization
2. Pixel representation
3. Pheromone update rule

Initialization Process

Number of ant proportional to number of pixel $\sqrt{N.M}$ is randomly distributed on the pixel in the picture , here the pixel is not zero this is edge pixel otherwise it's not edge pixel

Pixel Transition Rule

$$p_{(i,j)}^{k} = \begin{cases} \dfrac{(\tau_{ij})^{\alpha} (\eta_{ij})^{\beta}}{\sum_{u} \sum_{v} (\tau_{uv})^{\alpha} (\eta_{uv})^{\beta}} & i,j \ \ u,v \ \ are \ \ allowed \ \ node \\ otherwise \ \ 0 \end{cases}$$

The displacement probability of the k^{th} ant to a neighbor pixel (i, j)

Where

$\tau_{i,j}$ is the intensity of pheromone trail

$\eta_{i,j}$ is the visibility pixel

$\alpha \ \ and \ \ \beta$ are control parameter $(\alpha, \beta > 0)$

Pheromone Update Rule

$$\tau_{ij} \ (new) = (1-p) \ \ \tau_{ij} \ (old) + \Delta \tau_{ij}$$

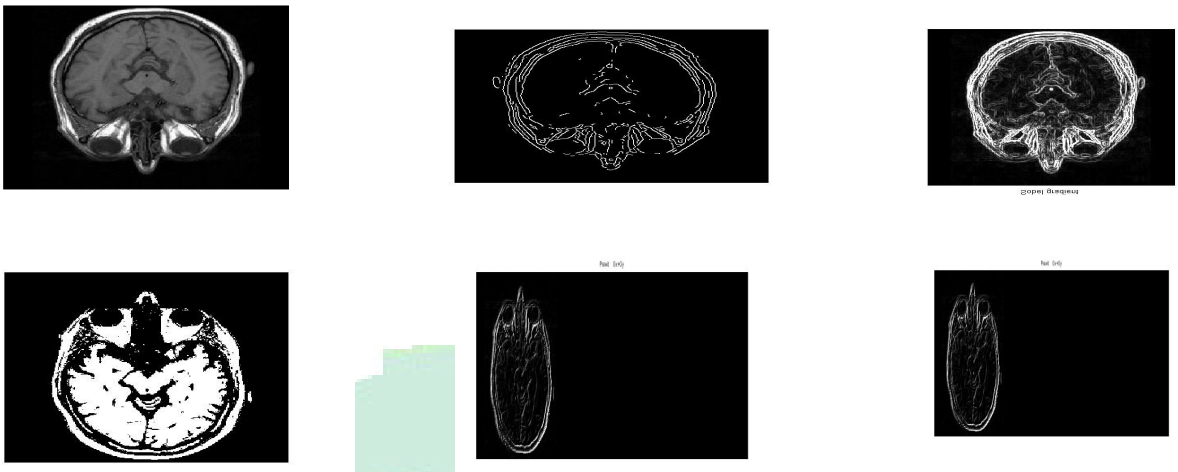
$$\Delta \tau_{ij} = \sum_{k=1}^{m} \Delta \tau_{ij}^{k}$$

$$\Delta_{\tau_{ij}}^{k} = \begin{cases} \eta_{ij} \ \ if \ \ \eta_{ij} > T \ and \ \ k^{th} \ \ ant \ \ displayed \ \ to \ \ pixel(i, j) \\ 0 \ \ otherwise \end{cases}$$

T- Threshold value which prevent ant from staying on the background pixel hence enforcing the search tool true edge

P-pheromones evaporation rate that prevent algorithm stagnation

Steps 2 and 3 are repeated in a loop. Algorithm stops execution when maximum number of iteration is reached



Comparison of Ant Colony Optimization Algorithm Output with the Existing One

4. EXPERIMENTS AND RESULT:

The algorithm was tested on MRI images. Selective local/global segmentation, sobel, Roberts operator and canny algorithms were used for MRI image testing. The result of AOC is better than the CANNY segmentation algorithm. The canny segmentation algorithm needs preprocessing to provide better output but AOC does not need any preprocessing. AOC works faster than CANNY. AOC provides more accuracy in segmentation. Fiest one is orginal image ,then the output of canny algorithm, sobel operator output , otsu method output image , output of prewitt algorithm, is compass operator output, output of ant colony optimization algorithm output.

4.1 **PSNR:**

Psnr means peak signal to noise ratio. Psnr used to compare the quality between original image and image [1]

$$MSE = \sum_{M,N} \frac{[I_1(M,N) - I_2(M,N)]^2}{M * N}$$

$$PSNR = 10\log_{10}\left(\frac{R^2}{MSE}\right)$$

Table I. Comparison of ground truth images and output images using Psnr.

IMAGES	ANOTHER EDGE ALGORITHM USING PSNR	AOC ALGORITHM ANALYZATION USING PSNR
A	31.8657810	25.2027331
B	34.0516973	24.9669822
C	33.5560060	24.6555320
D	29.5257166	25.0326877
E	31.9336470	33.933647
F	28.7352923	27.0729688

5. CONCLUSION

In the medical image processing accuracy is the important factor. The output of sobel and prewitt edge detector is not enough accurate with the thin and smooth edges. In canny edge detector, sometimes edge is spurious and they contain holes along curve which is not desirable. Also in the traditional methods, we convolve image with horizontal and vertical gradient operators which gives detection of edge in favour of rectilinear object only. In the field of medical segmentation, AOC method is one of popular research topic. This method increase the accuracy of segmentation. It is more suitable to capture curved object boundaries. In comparison with traditional method of edge detection AOC method gives better segmentation and accuracy

REFERENCES

1. M. Dorigo, A. Colorni, V. Maniezzo, "positivefeedback as a search strategy", Tech. report 91-016,department Electronic, Politecnico di Miano, Italy,1991.
2. H. Zheng, A. Wong, and S. Nahavandi, "Hybrid ant colony algorithm,for texture classification", in Proc.IEEE Congress on Evolutionary Computation,Canberra, Australia, pp. 2648–2652, Dec. 2003.
3. Alvarez, L., Lions, P.-L., Morel, J.-M., 1992. "Image Selective Smoothing and Edge Detection by Nonlinear Diffusion. II". *SIAM Journal on Numerical Analysis 29, 845–866.* doi:10.1137/0729052
4. Bolan Su, Shijian Lu, Chew Lim Tan, 2013. "Robust Document Image Binarization Technique for Degraded Document Images". *IEEE Transactions on Image Processing 22, 1408–1417.* doi:10.1109/TIP.2012.223108
5. Bresson, X., Esedog□lu, S., Vandergheynst, P., Thiran, J.-P., Osher, S., 2007. "Fast Global Minimization of the Active Contour/Snake Model". *Journal of Mathematical Imaging and Vision 28, 151–167.* doi:10.1007/s10851-007-0002-0
6. Canny, J.,1986. "A Computational Approach to Edge Detection". *IEEE Transactions on Pattern Analysis and Machine Intelligence PAMI*-8, 679–698. doi:10.1109/TPAMI.1986.4767851
7. Caselles, V., Catt, F., Coll, T., Dibos, F., 1993. "A geometric model for active contours in image processing".*Numerische Mathematik 66, 1–31.* doi:10.1007/BF01385685
8. Chan, T.F., Vese, L.A., 2001. "Active contours without edges". *IEEE Transactions on Image Processing* 10, 266–277. doi:10.1109/83.902291
9. Goldstein, T., Bresson, X., Osher, S., 2010. "Geometric Applications of the Split Bregman Method: Segmentation and Surface Reconstruction". *Journal of Scientific Computing 45, 272–293.* doi:10.1007/s10915-009-9331-z
10. Karthik, S., Hemanth.V.K, H.V.., Balaji, V., P. Soman, K., 2012. "Level Set Methodology for Tamil Document Image Binarization and Segmentation. "*International Journal of Computer Applications* 39, 7–12. doi:10.5120/4846-7117
11. Palumbo, P.W., Swaminathan, P., Srihari, S.N., 1986. <title>"Document Image Binarization: Evaluation Of Algorithms</title>", *in: Tescher, A.G. (Ed.), pp. 278–285.* doi:10.1117/12.976229
12. Pratikakis, I., Gatos, B., Ntirogiannis, K., 2010. H-DIBCO 2010 – "Handwritten Document Image Binarization Competition". *IEEE, pp. 727–732.* doi:10.1109/ICFHR.2010.118

13. Reghukumar, A., Haridas, D., Rajan, P., Kumar S, S., P. Soman, K., 2012." Document Image Segmentation and Restoration using Active Contour, Edge Enhancement Diffusion and Split-Bregman". *International Journal of Computer Applications 54, 14–20.* doi:10.5120/8625-2491
14. Sauvola, J., Pietikäinen, M., 2000. "Adaptive document image binarization. Pattern Recognition "33, 225–236. doi:10.1016/S0031-3203(99)00055-2
15. Stathis, P., Kavallieratou, E., Papamarkos, N., 2008." An evaluation survey of binarization algorithms on historical documents". *IEEE, pp. 1–4*. doi:10.1109/ICPR.2008.4761546
16. Zhang, K., Zhang, L., Song, H., Zhou, W., 2010. "Active contours with selective local or global segmentation: A new formulation and level set method".*ImageandVisionComputing28,668 –676*. doi:10.1016/j.imavis.2009.10.009