IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol-6, Special Issue-4, May 2018 E-ISSN: 2347-2693

Fuzzy Edge Detection Using Fuzzy C-Means Thresholding for MRI Brain Image

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Available online at: www.ijcseonline.org

Abstract— In this paper, the work aimed a robust edge detection based on fuzzy technique for MRI brain image. Segmentation is the critical task in medical applications and also it is the most important task in medical image analysis. In brain image, segmentation is commonly used for analyse the brain changes and structure of the brain image and analyse the region of the brain image. Edge detection is the basic tool for segmentation. Edge detection is the finding the boundary of the particular image and edges occur on the boundary between the object and the background. Here, this paper segments the MRI image using fuzzy c-means thresholding. It covert the grey image to binary image and the result image applied fuzzy interface system and find edge of the particular object in the MRI Image. Experiments were done by using the MRI scan images.

Keywords— *Fuzzy logic, Fuzzy C-Means Thresholding, Fuzzy Edge detection, Fuzzy interface system, MRI head scans*

I. INTRODUCTION

Segmentation is the process of dividing the image into multiple segments. The main objective of the segmentation is extracting the feature of the particular image. Several algorithms and techniques are used for image segmentation. This paper describes the fuzzy C-Means thesholding to segment the image.

The analysis of complex MRI data set is difficult task in medical field. These difficulties overcome the MRI data analysis required inventions computerized method to improve the quality. MRI brain thresholding is the essential task because the outcome analysis the entire image amount of data set and get high level of the quality. The manual analysis is often time consuming but error.

Edge detection is the active research area in image analysis. Edge detection is the extract the edge line in the image. In this paper the work done by using the fuzzy edge detection using fuzzy interface system.

Fuzzy logic is an aspect of many-valued and also It has the absolute values of variables. Fuzzy logic is a form of knowledge representation which is suitable for notions that cannot be define precisely on their contexts [3]. The undeniably fuzzy value may precinct between fully true value and fully false value. Fuzzy logic is handling the concept of partial truth.

A clustering technique is an unsupervised classification of objects into meaningful groups or clusters based on their similarity [12].Fuzzy clustering is the divide the data points in number of given cluster. Fuzzy clustering the data points belong to multiple clusters. The Non-fuzzy clustering the data points in distinct clustering. One of the well-known fuzzy clustering techniques is fuzzy c-means (FCM) [13]. This technique was also proved to be a better technique than hard clustering [14]. Fuzzy C means is a data clustering technique in which a dataset is grouped into n clusters with every data point in the dataset belonging to every cluster to a certain degree [1] of the MRI signal.

Section I contains the introduction of Segmentation, Edge detection, Fuzzy FCM, Section II contain the related work of image segmentation, Section III contain the methodology of FCM and Fuzzy interface system, Section IV explain the flow chart of entire process, section V describes result and discussion, Section VI conclusion.

II IMAGE SEGMENTATION

A. Edge Detection

Edge detection is the powerful tool for image segmentation. It detects the high-frequency component in the image. This study focuses on fuzzy logic based edge detection. The edge invention algorithm identified points in a digital image in which image brightness changes sharply or more formally has discontinuities[2].A handful of approaches to fuzzy logic

based edge detection have been accepted based on fuzzy If then rules [9], [10]. In most suitable way of these methods, adjacent points of pixels are assumed in some classes and then fuzzy system inference is implemented using appropriate membership function, detonate for each class [11].

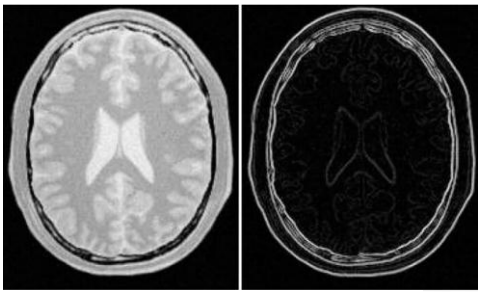


Figure 1: Edge Detection Image

B. Thresholding

Thresholding is the simple method for segment the image, from the given grey scale image the thresholding convert the image into the binary image. The pixel partitioning depends on the pixel intensity values. Thus the objective of converting the binary image is to mark pixels that belong to true foreground regions with a single intensity and background regions with different intensities. Once the segmentation is complete then the main object is extracted by using edge detection.

These paper us threshold the image using fuzzy c-means threshold. Fuzzy c-means is unsupervised clustering algorithm and derivatives are the powerful clustering method in many applications. The algorithm assigns membership to each data points to each cluster centre. It calculates the distance between the data points and the cluster centres. This is the minimum distance and put the data points in the particular cluster. It process iteratively.

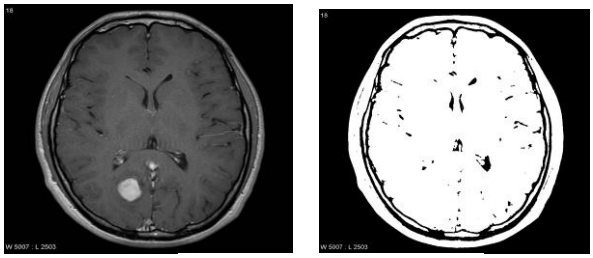


Figure 2: Threshold Image

III METHODOLOGY

A. C-Means Algorithm

The algorithm influenced by assigning the membership to each data point similar to each cluster center on the basis difference between the cluster center and the data point. The data point is not far from to the cluster center more is its membership towards the particular cluster center.

Let X= $\{x_1, x_2, \ldots, x_i\}$ be the set of data points and C=$\{c_1, c_2, \ldots, c_j\}$ be the set of centers.

Step 1: Randomly select 'c' cluster center
Step 2: Calculate the fuzzy membership using

$$u_{ij} = \frac{1}{\sum_{k=1}^{c} (d_{ij}/d_{ik})^{2/m-1}} \quad (1)$$

Where d_{ij} represent Euclidean distance between i data and center. m is the fuzziness index m$\in [1, \infty]$

Step 3: Compute the fuzzy centers using

$$c_j = (\sum_{j=1}^{n} (u_{ij})^m x_i) / \sum_{i=1}^{n} (u_{ij})^m, \ \forall j = i, 2, \ldots, c \quad (2)$$

Step 4: Repeat step (2) and (3) until the maximum 'J' value achieved
The main objective of c-means algorithm is to minimize

$$J = \sum_{i=1}^{n} \sum_{j=1}^{c} (u_{ij})^m \|x_i - c_j\|^2 \quad (3)$$

Here $\|x_i - c_j\|^2$ is the Euclidean distance between data and the clusters centre.

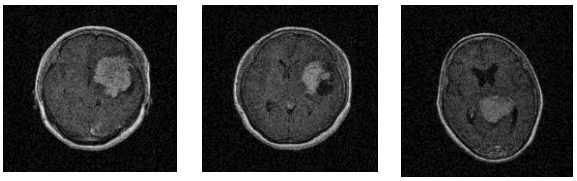
B. Fuzzy Interface System

We applied 3*3 masks to traverse the image and 8 inputs and 1 output. We use sigmoid membership function for input and triangular membership function for output. Two inputs for the binary image color black and white three outputs are black white and edge

Table 1:3*3 mask

f(x-1,y-1)	f(x-1,y)	f(x-1,y+1)
f(x,y-1)	f(x,y)	f(x,y+1)
f(x+1,y+1)	f(x+1,y)	f(x+1,y+1)

Table 2: Fuzzy Rules



(a) (b)

Figure 4: (a) Original Image (b) Contrast Sketching

f(x-1,y-1)	f(x-1,y)	f(x-1,y+1)	f(x,y-1)	f(x,y+1)	f(x+1,y+1)	f(x+1,y)	f(x+1,y+1)	f(x,y)
W	W	W	W	W	B	B	B	E
B	B	B	W	W				E
B	W	W	B	W				E
W	W	B	W	B	W	W	B	E
B	B	W	B	W				E
W	W	B	W	W				E
B	W	W	B	W				E
W	B	B	W	B	W	W	B	E
B	B	B	B	W				E
W	W	W	B	W				E
B	B	B	W	B	W	W	W	E
W	W	W	W	B	B	B	B	E
B	B	B	B	W				E
B	B	W	B	W				E
W	W	W	B	B	B	B	B	E
W	B	B	W	B				E
B	W	W	B	W				E
W	W	W	B	W				E
W	W	W	W	W	B	B	W	E
B	B	W	W	W				E
W	W	W	W	W				E
W	W	W	W	W				E
W	W	B	W	B	W	W	W	E
W	B	B	W	B	W	W	W	E
W	B	B	W	B	W	W	W	E
W	W	B	W	B	W	W	W	E
B	B	B	W	B	W	W	W	E
W	W	B	W	B	B	B	W	E

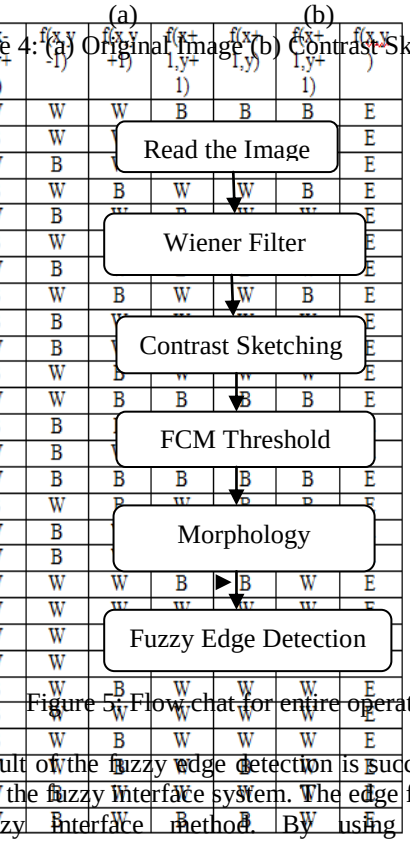
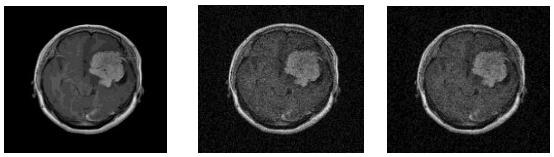


Figure 5: Flow chat for entire operation

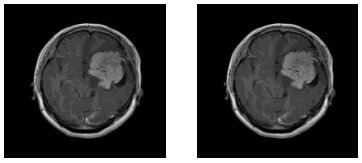
The eight inputs are the eight pixel values named as f(x-1,y1), f(x-1,y), f(x-1,y+1), f(x,y-1), f(x,y+1), f(x+1,y+1), f(x+1,y), and f(x+1,y+1) of the window mask which are used to scan the given image. f(x,y) act as output pixel of the window mask [5][6]. If p1 white and p2 is white p3 is white and p4 is white and p6 is white p7 is black and p8 is black and p9 is black then p5 is edge. Likewise, remaining 27 rules are inserted in Rule Editor. In this paper, 3*3 masks are used and 28 rules are followed [7] [8].

IV. RESULTS AND DISCUSSION



(a) (b) (c)

Figure 3: (a) Original Image (b) Noise Image (c) Wiener Filter



The Result of the fuzzy edge detection is successfully taken by using the fuzzy interface system. The edge found by using the fuzzy interface method. By using the sigmoid membership function for the eight inputs and scanning the mask with input rule. The size of the mask is 3*3 slid the whole image. Fuzzy rule based system provide accurate result for edge detection. It efficiency extract the edge in the given image.

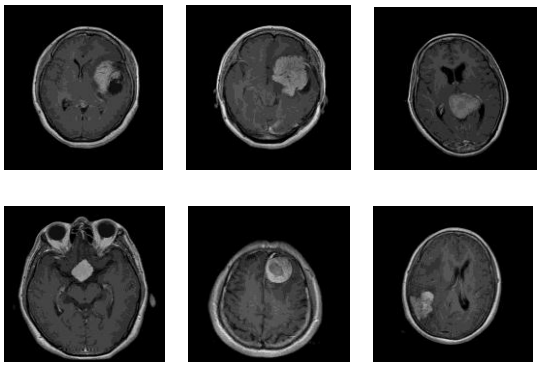


Figure 6:Original Image

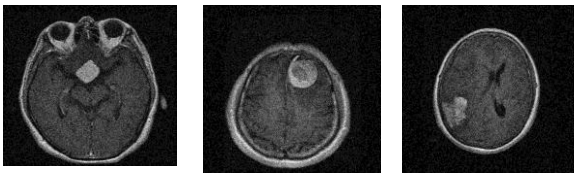


Figure 7:Wiener filter

Figure 8:Contrast Sketching

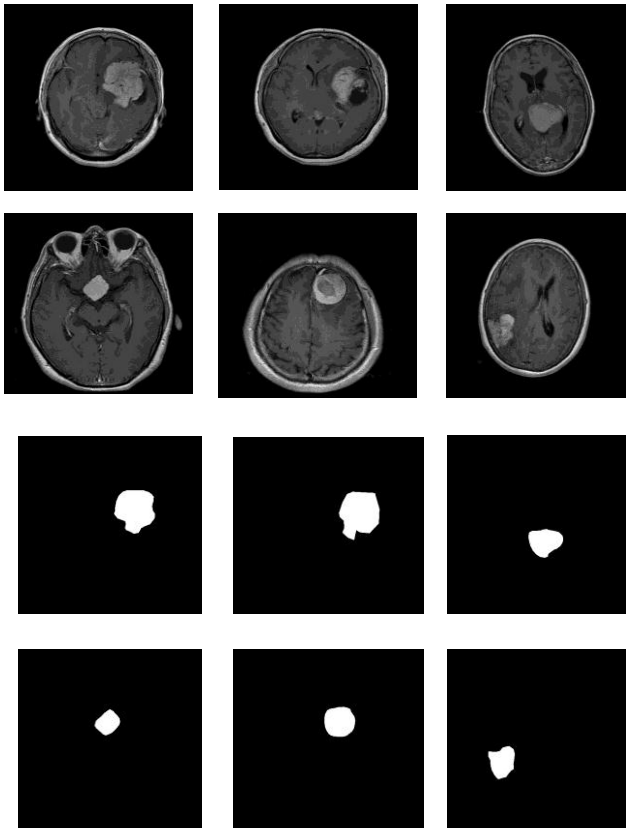
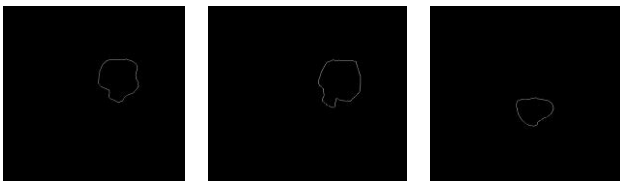


Figure 9: FCM Threshold Image



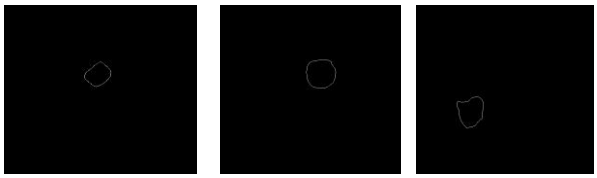


Figure 10: Fuzzy Edge Detection Image

V. CONCLUSION

FCM is the important clustering technique of image thresholding. Also, edge detection is the important technique in image segmentation. FCM method identifies a tumour in the given brain image. Then we need to find the edge of a particular tumor. The fuzzy logic method is used to find the more accurate result of edge detection. The size of the mask is 3*3 and we give more rules give the more accurate result.

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Authors Profile

N. Senthilkumaran was born in India, in 1977. He received B.Sc degree in Computer Science and MCA degree from Bharathidasan University, Trichy, India, in 1998 and 2002, respectively, and the M.Phil., and Ph.D. degrees in Computer Science from the Bharathiar University ,Coimbatore, India, in 2005 and 2011, respectively. He is currently working as an Assistant Professor in the Department of Computer Science and Applications, Gandhigram Rural Institute-Deemed University, India. His current research interests include digital image processing and medical image segmentation. Dr. N. Senthilkumaran is a Senior Member of the International Association of Computer Science and Information Technology (IACSIT), International Association of Engineers and Scientists (IAES), Universal Association of Computer and Electronics Engineers (UACEE) and Institute of Research Engineersand Doctors (IRED). He has published more than 45 scientific papers and book chapters in the field of digital image processing and medical image segmentation.

C.Kirubakaran was born in India, in 1986. He received B.Sc degree in physics, Gandhigram Rural Institute-Deemed University in 2007 and MCA degree from Institute of Road and Transport Technology, Anna university Coimbatore 2010, and the M.Phil degrees in Computer Science from the Bharathidasan University, Trichy, India, in 2012. At present he is pursuing his full time research at Gandhigram Rural Institute-Deemed University from 2013 to till date. His current research work is medical image segmentation. He has published research articles related to area of research and book chapter. He has awarded the Raji Gandhi National fellowship from 2016 to 2021.

N. Tamilmani pursed Bachelor of Science and Master of Science from Gandhigram rural University, INDIA in year 2017.She is currently pursuing M.Phil in Department of computer science and application, Gandhigram University, INDIA in 2018. Her main research work focuses on Medical Image Processing.

