IOSR Journal of VLSI and Signal Processing (IOSR-JVSP)
Volume 5, Issue 2, Ver. II (Mar. - Apr. 2015), PP 45-48
e-ISSN: 2319 – 4200, p-ISSN No. : 2319 – 4197
www.iosrjournals.org

Spatial K Fuzzy and level set approach for image segmentation in brain MRI for tumor detection.

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Abstract: *It's very important to improve the quality of medical image as it helps in detection of lesion location, for surgery planning and avoid misdiagnosis for surgery. This paper is based on image segmentation, tumor detection and area calculation. In image segmentation of normal magnetic resonance image (MRI) clustering approach is widely used. In this paper FCM (fuzzy c means clustering) is used for bias estimation to remove noise. SKFC (spatial k fuzzy clustering) is proposed for image segmentation. These two algorithms give approximate boundary. Level set after clustering gives the exact boundary for white matter (WM), grey matter (GM), cerebrospinal fluid (CSF) and tumor. After the segmentation of brain MRI, tumor is detected and its exact location is identified. The area of tumor by calculating the white pixels in binary image is proposed to be one of the tumor stage detection parameter.*

Keywords: *Bias estimation; FCM; SKFC; level set; tumor.*

I. Introduction

There are different tissues namely gray matters (GM), white matter (WM), cerebrospinal fluid (CSF) and other abnormal tissues widen over the whole brain and it's too difficult to demarcate them individually when a brain MRI is considered**.** In brain when normal cells grow old or get damaged they die, and new cells take their place. When this process goes wrong, new cells form while the body does not require them, and old or spoiled cells do not die as they should. Due to enhancement of extra cells habitually forms a mass of tissue called tumor. This work is based on tumor detection and area calculation. Clustering technique is introduced to detect the tumor in abnormal image. Fuzzy c Means (FCM) is use for bias estimation which involves partitioning the space into different cluster region with similar intensity image value. Bias estimation and correction of image is used to eliminate the side effect of intensity of inhomogeneity because sometimes due to imperfection of imaging device MRI gets blurred. Basavaraj anami and prakash unki [8] have propose a two stage automatic method for brain MRI segmentation which contains MFCM clustering algorithm and level set method for normal brain MRI. In this initial segmentation is done with by modified FCM which forms the first stage and the segmented result of first stage are used in second stage which comprises the level set based segmentation. The modified FCM is modified by adding a spatial information to fuzzy c means clustering and this two stage based segmentation gives clustered output. The above work is performed on normal MRI and has no pre-processing stage. The pre-processing of image is necessary because images from MRI scan may contain blur. In this work normal and abnormal both MR images is processed and bias estimation with FCM is performed for removal of blurred portion and sharpening the edges in image. Then segmentation is done with spatial k fuzzy clustering algorithm which determines the approximate boundary of tissues in normal and abnormal brain magnetic resonance image. Level set after the image segmentation gives the proper boundary with some numbers of iterations. Once segmentation is done the clustered output of SKFC and level set helps in tumor detection and area calculation

II. Literature Review

Literature survey is carried out which is related with segmentation of brain magnetic resonance image. [8] Basavaraj anami et al proposed brain MRI segmentation which contains MFCM clustering algorithm and level set method for normal brain MRI. In this initial segmentation is done with by modified FCM which forms the first stage and second stage is of level set.

[6] J. Kaihva zhang et al proposed a novel level set approach to simultaneous tissue segmentation and bias correction of MR images. [7] M. shashidhar et al presents a modified fuzzy algorithm for abnormal magnetic resonance image segmentation which contains tumor.

A. Meena and K. Raja [1] proposed a spatial fuzzy c means algorithm for the segmentation of PET image having brain neurodegenerative disorders. [3] Mrs p. vijaylakshmi et al proposed a brain magnetic resonance image segmentation which is done with k means clustering algorithm.

According to literature survey, it is observe that there is fewer work is done in the area of brain tumor detection and area calculation. The existing methods are semiautomatic and required involvement from radiologist during segmentation and tumor detection.

III. Proposed Work

The generalized block diagram of proposed work is given in fig1.

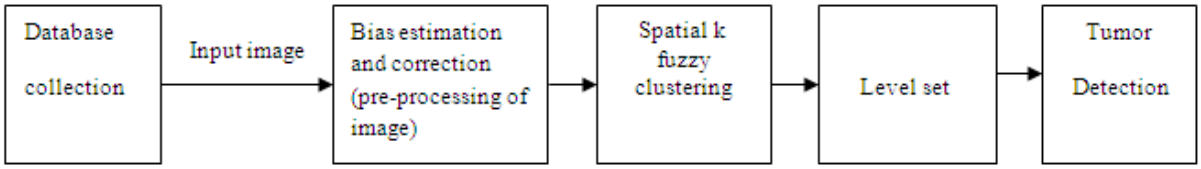


Fig 1: Block diagram of proposed work.

A. Bias estimation and correction (stage 1)

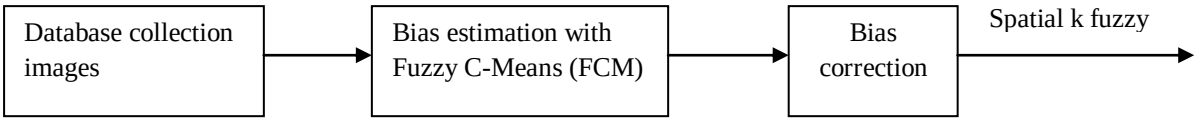


Fig 2: Block diagram of bias estimation and correction (stage 1).

In fig 2 the input image from database collection is pre-processed. In this stage bias estimation and bias correction of image is done. Fuzzy c means clustering is used for bias estimation in which first clustering is done and then the clustered image is passing through Gaussian filter. Bias correction of image is done with subtraction of estimated image from original image. By this process noise is removed and the blurred portion is recovered. Fuzzy C-Means (FCM) clustering algorithm was originally introduced by Dunn and then it was modified by Bezdek. It is the algorithm which allows one piece of the data to belongs to two or more clusters and is based on minimization of objective function;

$$J = \sum_{I-1}^{C} \sum_{j-1}^{n} U_{ij}^{r} \; || \, x_i - c_j \, ||$$

Where r is any real number, u_{ij} is degree of membership of x_i in cluster j. x_i is data measure in d-dimension. D-dimension cluster centre is c_j. U_{ij} is updated membership function:

$$U_{ij} = \frac{1}{\sum_{k-1}^{c} \left(\frac{|| \, xi - cj \, ||}{|| \, xi - ck \, ||} \right)^{\frac{2}{m-1}}}$$

Algorithm:-
Step1. Select a number of clusters in a given image.
Step2. Assign randomly to each point coefficients for being in a cluster in image
Step3**.** Reiterate until convergence criterion is met.
Step4. Calculate the center of each cluster in image.
Step5**.** For each point, calculate its coefficients of being in cluster.

B. Spatial k Fuzzy clustering (stage 2)

Fig 3: Block diagram of stage 2.

The bias corrected image input to spatial k fuzzy clustering. A spatial fuzzy k means clustering algorithm is used for clustering which clusters the image on the basis of spatial parameter. The spatial k fuzzy

clustering algorithm is fuzzy k means algorithm with spatial information. The spatial parameter combined with fuzzy k means clustering is defined as:

$$S_{pij} = \sum_{k \in w(x_j)} u_{ik}$$

Where $w(x_j)$ represents small square window function centered on pixel x_j in spatial domain. The spatial function S_{Pij} represents the probability that pixels x_j belongs to i^{th} cluster. K means clustering algorithm is proposed by Mac queen (1967) which is simplest unsupervised learning algorithm that solve well known clustering problem. In this K means algorithm grouping or clustering is based on minimization of Euclidean distance between the cluster centriod and the data to be cluster, also aim to minimizing an objective function. The objective function is below:

$$\sum_{j=1}^{k} \sum_{i=1}^{n} ||x_i^{(j)} - c_j||^2$$

K means algorithm contains following steps as follows:
Step1. Select the number K of clusters manually.
Step2. Create K clusters and determine the cluster's center.
Step3**.** Allot each pixel in the image to the cluster that minimizes the variance between the pixel and the cluster center.
Step4**.** Re-calculate cluster centers by averaging all of the pixels in the cluster.
Step5**.** Reiterate steps 3 and 4 until some convergence criterion is met.

In this stage clustering of different tissues is done which gives approximated boundaries to WM, GM, CSF and tumor if present.

C. level set method (stage 3)

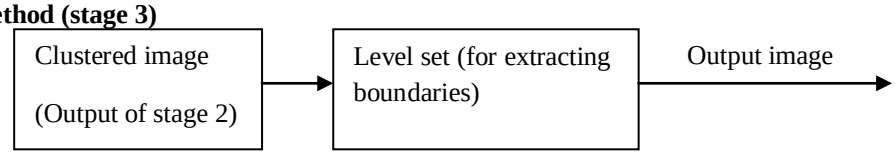


Fig 4: Block diagram of stage 3.

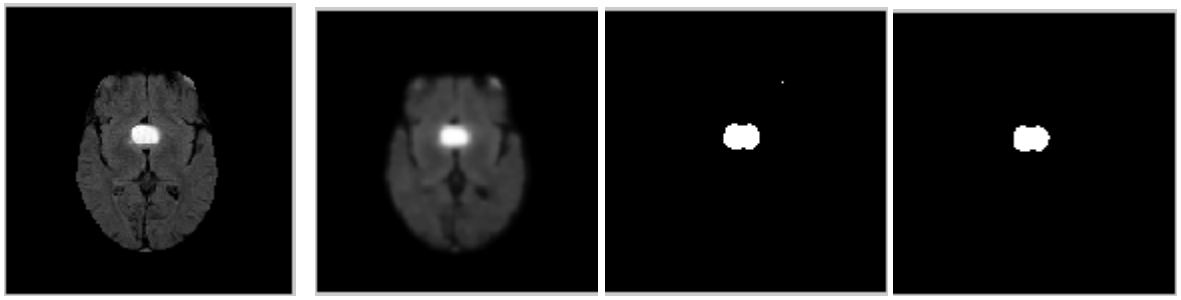
Output of spatial k fuzzy clustering (SKFC) is the input of level set (stage 3). Osher and sethian gives the level set method to holds the topology changes of curves. In this paper, initial segmentation is done with spatial k fuzzy clustering (SKFC) which gives approximated boundary. To get the exact boundary fuzzy level set method is used. This approach gives appropriate boundary. A straightforward illustration of level set method is when the surface intersects with zero planes, to give the curve. When this surface changes the curve will changes according to the surfaces changes. To approximate the evolution of active contours by tracking the zero level set implicitly with following equation:

$$\phi\ (t, x, y) = 0\ (x, y)\ is\ at\ \Gamma\ (t) \quad (1)$$
$$\phi\ (t, x, y) < 0\ (x, y)\ is\ inside\ \Gamma\ (t) \quad (2)$$
$$\phi\ (t, x, y) > 0\ (x, y)\ is\ outside\ \Gamma\ (t) \quad (3)$$

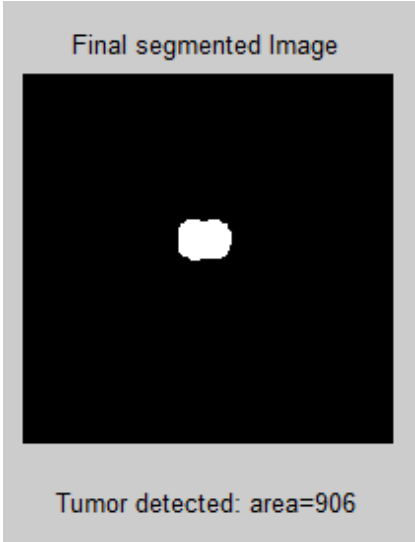
E. Area calculation

In this work binarization method is used to compute the area of brain tumor. The brain tumor occurs when there is the formation of abnormal cell within the brain. There are mainly two types of brain tumor 1) benign (mass) 2) Malignant.

IV. Result



(a) (b) (c) (d)



(e)

Fig:5 (a) input image from database collection, (b) bias estimation and correction, (c) clustered output of SKFC, (d) output of level set (e) final output of with area.

V. Conclusion

A combined spatial k fuzzy clustering and fuzzy level set based approach is proposed for automation of brain magnetic resonance image segmentation, tumor detection and area calculation. If the magnetic resonance image is contains noise then it is removed with bias estimation and correction process. K means algorithm with spatial information approximates the boundaries as interest well. The brain magnetic resonance image is segmented into WM (white matter), GM (grey matter), CSF (cerebrospinal fluid) and other abnormal tissue which is present abnormal brain. This method perform better result than existing conventional k means fuzzy clustering, and also enhancing the result of image segmentation, tumor detection, area calculation which will help in further clinical diagnosis and observations such as tumor stage detection, gash identification etc. This work was performed on MATLAB with tool image processing.

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