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A Novel Technique to Detects and Segments Brain Tumor

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Abstract- The specialist area of medical imaging is gaining significance in the prevalent times due to the ever-increasing need of automated and speedy diagnosis in the shortest period of time. According to the literature available, researchers have suggested that clustering, Fuzzy K-C-Means (FCM), Magnetic Resonance Imaging (MRI), K-means methods are extremely effective for timely detection and segmentation of brain tumor with the help of MRI scanned images. Some of the major limitations of these methods include complexity, ambiguous nature of the fuzzy boundaries, and diversified nature of the infarct areas or regions. This paper proposes a new technique for overcoming these drawbacks or limitations by using Conditional Random Field (CRF) based framework. The suggested method combines the information in Tumor 1 (T1) and FLAIR in probabilistic domain, so that the foreground and back ground are identified. The performance of the proposed method is validated using peal signal to noise ratio, sensitivity, specificity, accuracy, Jacard coefficient and Dice coefficient. CRF based framework is an efficient and simple method that can be incorporated for modelling shapes and for observing the functions of energy.

Keywords — Brain Tumor, MRI Images, Fuzzy C-means clustering, Energy function, Conditional Random Field (CRF)**.**

I. INTRODUCTION

Bio-Medical Engineering (BME) deals with the application of engineering principles and techniques to medicine. The field of Medical image processing is very demanding. These methods are used to generate images of the internal parts of the body so diagnosis and treatment can be initiated. Tumor cells are abnormal in nature and formulates growths or lumps within the body. Each type or form of tumor is different in its form and structure and behaves differently from its counterparts and can be either noncancerous (benign) or cancerous (malignant) in nature.

The conditions or symptoms that take place during the diagnosis of tumor can lead to potential chances of cancer. MRI can be defined as a method that is used for drawing medical images and for visualizing the internal organs or parts of the body for diagnosis and medical treatment in a timely manner. MRI of head utilizes powerful magnetic fields, radio ways and computerization for generating a detailed image or to picture the working of the brain. This method is far better and efficient than other techniques or methods that are available for diagnosis of tumors in brain. The MRI provides extensive amount of data in relation to the anatomy of tissues within human body and assists in identifying tumor cells within body [1].

The paper has been organized in the order given below. Section II elucidates about related work. In Section III make clear the methodology for the CRF. Section IV presents results whereas conclusion or summary are given in section V.

II. RELATED WORK

CT and MRI provides 3D image of non-identical parts and organs of the body such as the brain etc. and helps in getting familiar with the anatomy of a particular body part or organ. Medical imaging, 3D segmentation of images play a pivotal role in the initial phases or stages of object recognition employment. It is extremely vital to carry out quantitative and qualitative analysis and Automatic diagnosis for planning a particular treatment.

This paper proposes automatic detection of brain and segmentation of tumors through MRI brain image data and how they assist the doctors in planning a specific therapy/operation. MRI can be defined as a state-of the-art medical imaging facility that helps in the detection of Brain tumors and related diagnosis or treatment. Treatment of patients suffering from tumors depend on the size of the affected region or part of the brain and the time lapsed. [2]. Therefore, correct diagnosis of the affected lesions is enormously significant. Numerous magnetic resonance image (MRI) modalities/methods have been utilized for accessing the brain tumors. T1-weighted and FLAIR are the most

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sensitive amongst the various modality variants used for the early stage detection of tumors.

The practicality of FLAIR arrangements are accessed in diseases related to the central nervous system. FLAIR and T1-weighted used for medical diagnosis by physicians. Volume estimation and Automatic infarct segmentation have always been an area of interest for medical specialists and play a vital role in therapy/surgery planning.

III.METHODOLOGY

Consider a set of random variables $Y = y_1, y_2, \ldots, y_n$, and a set of labels $X = x_1, x_2, \ldots, x_k$. The main purpose of any segmentation problem is to assign a particular label from the set X to each variable in the set Y. Random fields offers a probabilistic framework for dealing with labelling issues that also includes information about neighbourhood, without any problem. Two prevalent categories of random field models include markov random fields (MRF) and conditional random fields (CRF). MRF computes joint probability of p(x, y) = p(y/x) p(x), where P(y/x) and P(x) are likelihood and prior probabilities. Likelihood can be factorized under the markovian property of restrictive independence, such as p(y/x) = ip (yi/xi). This supposition does not assist in modelling the multifaceted dependencies between the labels and the data, and hence we incorporate the other class of random field models known s CRF. In CRF we model the posterior probability of labels given data p(x/y). The posterior distribution p(x/y) over the labelling in CRF given as:

$$p(x, y) = Z_1 \exp(-E(x, y))$$

Using Hammersley-Clifford theorem, where Z is normalization constant and E(x, y) is an energy function. Labelling of an assumed random field can be defined as the maximum posterior probability.

$$X_{\max} = \arg\min(E(x, y))$$

In our research problem, random variables (y) correspond to intensity value at each pixel within an image, and the label set(x) correspond to $\{0,1\}$. Label-0 corresponds to tumor class and label-1 corresponds to non- tumor class. Initial labeling is vital for demonstrating energy function in the CRF and this paper incorporates Fuzzy C-means algorithm (FCM) for preliminary labeling. Then this function that utilizes initial labeling is explained and graph-cut approach is used for optimizing the energy function. The flow chart of the system model is illustrated in Fig1.

Image acquisition: The MRI images and data of brain are gathered from the medical centres. This image is than converted into 2D matrices with the help of Matlab [3].

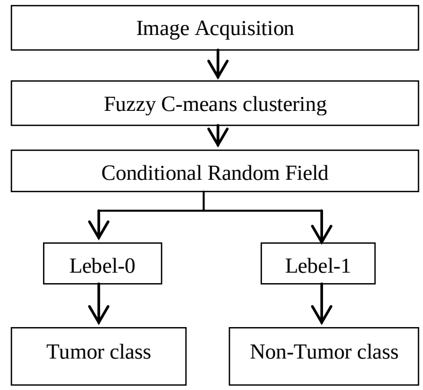

Fig1: Block Diagram of Proposed Method

Fuzzy C-means Clustering: Fuzzy C-means clustering can be defined as a soft method that assists in partial association of pixels into numerous clusters or groupings. This association is than computed through functions of this membership or association. The total sum of the degree of this membership at any given data point is equivalent to 1. This technique has better employability within segmentation uses in comparison to hard clustering algorithm. The algorithm looks for clusters by decreasing the objective function [4].

Conditional Random Field: CRF is a Framework that is incorporated for probabilistic models in relation to the labelling and segmentation of the sequenced data. It is an iterative parameter estimation algorithm for CRF [5].

IV. RESULTS AND DISCUSSION

The proposed system model using CRF technique for the uncovering and segmentation of brain tumor is executed in MATLAB. Performance of this technique is assessed on the basis of various brain tumor images that are collected from standard database and are than compared with the existing methods [6]. The simulation results are carried for 10 images out of which 8 images are with tumors and 2 images are normal condition, encompassing 200 slices. At the initial step of the algorithm, the slices are categorized as normal and abnormal, covering tumor, classes. Then tumor images are segmented in abnormal slices.

The MRI image is given as input image to the proposed system model and is shown in Fig 2(a). This input image goes under the FCM clustering. The clustered FCM image undergoes to Otsu threshold value. If the clustered FCM image value is below the threshold value i.e. FCM0, then the system displays that the image is non tumor image otherwise it gives that the image, FCM1, is a tumor image. The FCM0 and FCM1 segmented based on the Otsu threshold are shown in Fig 2(b). The CRF technique is implemented on the FCM1, which a tumor image, to identify the tumor boundaries using segmentation process. The detected brain

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tumor using CRF segmentation process is shown in Fig 2(c). The same process is implemented for various MRI images to identify the tumor. The simulation results of the proposed system model using CRF technique for various MRI images are shown in Fig 3(a)-3(c) and Fig 4(a)-4(c).

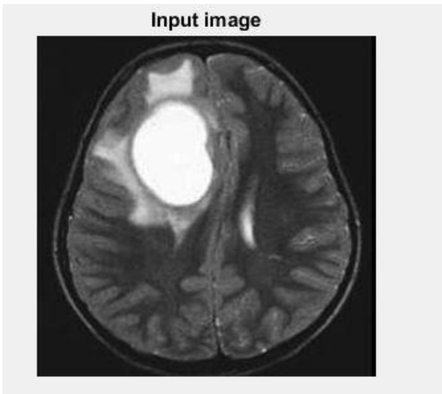

Fig 2(a): input MRI image

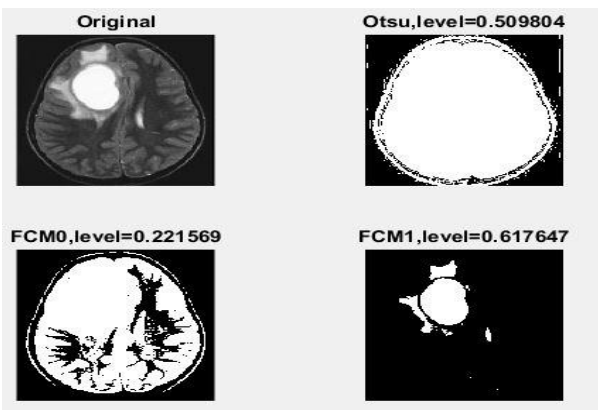

Fig 2(b): Clustered FCM image

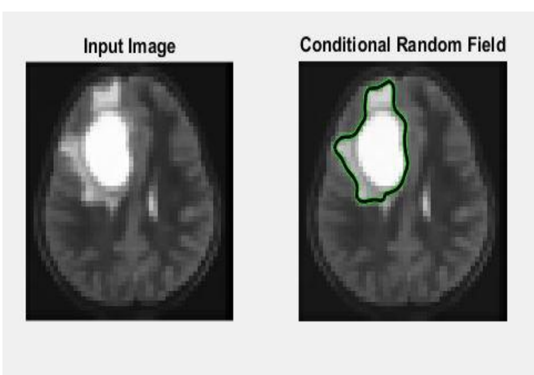

Fig 2(c): Identified tumor boundaries using CRF method

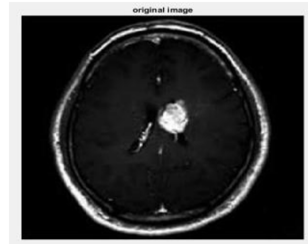

Fig 3(a): MRI input image

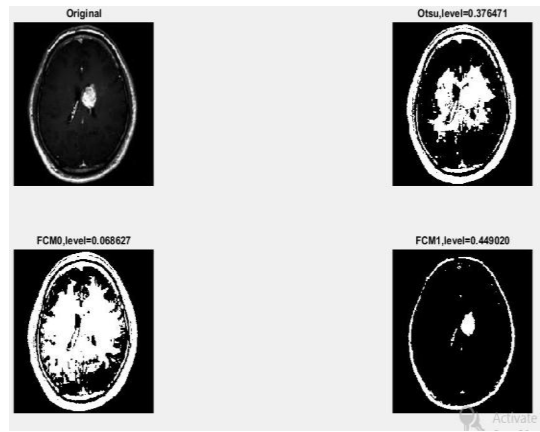

Fig 3(b): Clustered FCM image

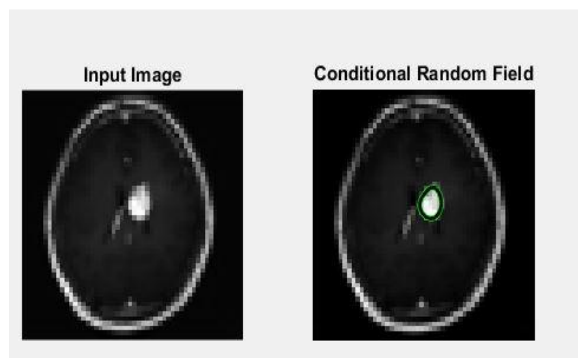

Fig 3(c): Identified tumor boundaries using CRF method

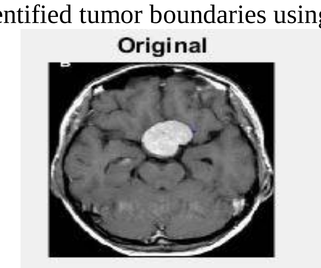

Fig 4(a): MRI input image

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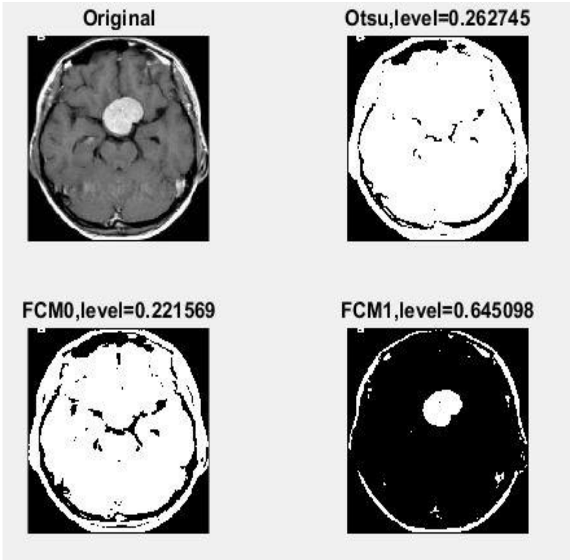

Fig 4(b): FCM level image

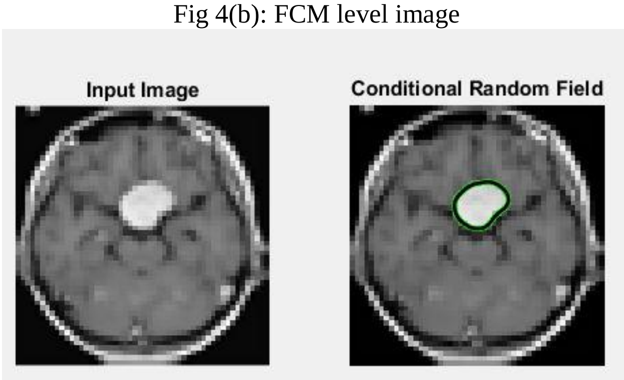

Fig 4(c): CRF output image

The performance of the CRF techniques is also validated through quantitative analysis with various parameters. The parameters considered for validation of the proposed method are Peak Signal to Noise Ratio (PSNR), Sensitivity, specificity, accuracy, Jacard coefficient and Dice coefficient. The parameters calculated for the above three MRI images using CRF technique are given in Table 1.

Table1: Various parameters of CRF method

Parameters	MRI Image in Fig 2	MRI Image in Fig 3	MRI Image in Fig 4
PSNR	9.30	13.92	7.83
Sensitivity	99.47	67	96.79
Specificity	100	100	100
Accuracy	99.73	86.24	98.52
Jacard coefficient	0.99	0.67	0.96
Dice coefficient	96.12	92.58	96.83

VI. CONCLUSION

This research paper proposed an automatic method for detection and segmentation of tumor in MRI images using CRF method. This suggested method does not include any previous notions in relation to the form and dimension of the tumor region. This frame work includes information of both international and local level. This technique also utilizes T1-weighted information, which improvises performance level and assists in improvising the boundaries.

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