Semi Supervised Approach Based Brain Tumor Detection with Noise Removal

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Abstract:- Brain tumor detection and segmentation is the most important challenging and time consuming task in the medical field. In this paper, Magnetic Resonance Imaging (MRI) sample image is considered and it is very useful to detect the Tumor growth. It is mainly used by the radiologist for visualization process of an internal structure of the human body without any surgery. Generally, the Tumor is classified into two types such as malignant and benign. There are many variations in tumor tissue characteristics like its shape, size, gray level intensities and its locations. In this paper, we propose a new cooperative scheme that applies a semi-supervised fuzzy clustering algorithm. Specifically, the Otsu (Oral Tracheal Stylet Unit) method is used to remove the Background area from a Magnetic Resonance Image. Finally, Semi-supervised Entropy Regularized Fuzzy Clustering algorithm (SER-FCM) is applied to improve the quality level. The intensity, shape deformation, symmetry and texture features were extracted from each image. The usefulness and significance of this research are fully demonstrated within the extent of real-life application.

Keywords:- *Image Segmentation, Magnetic Resonance Imaging, Semi- supervised Fuzzy Clustering, Otsu (Oral Tracheal Stylet Unit) method.*

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I. INTRODUCTION

The Brain Segmentation is one of the most important and necessary step to analyse any image in order to get valuable information for medical diagnosis support systems and other recognition tool. In the view of medical Systems, segmentation in brain aims to determine different parts of the brain such as vein, Cerebrum, Cerebellum etc. The low qualities of an MR image is mainly due to noise, low contrast and due to some errors while scanning the image etc. Both these problems will degrade the performance of segmentation performance. The evolutionary algorithms and computational complexity is hard to apply in real time situations.Thus the otsu method helps to convert the gray level image into binary image. The Impulse noise takes place which is caused due to electromagnetic interference.

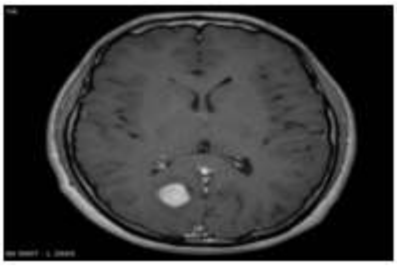

Fig 1.An MR Image affected by brain tumour

The usefulness and significance of this research are clearly demonstrated within the extent of real time applications. The results and experiments show that our proposed system performs accurately to compare with the existing system in MRI image system.

II. LITERATURE SURVEY

Chao-Yu Chen, Thou-Ho (Chao-Ho) Chen, and Tsong-Yi Chen (2006) explained about an adaptive decision-based median filtering algorithm called adaptive pixel-correlation filter (APCF). An adaptive threshold can be designed depends on the global statistical properties by exploiting the correlations between a pixel and its neighbours. Due to the fact both horizontal and vertical correlations for a pixel is more significant than other orientation. The numerical simulations show that APCF is more robust and effective than many other well-known median filtering algorithms.

Anam Usman M and Usman Akram (2011) introduced a method for automatic brain tumor diagnostic system for MR Images. This system has three stages to detect and segment a brain tumor. In the first stage, MR Image of brain is acquired and pre-processing is done to reduce the noise and to sharpen the image. In the second stage, global threshold segmentation is done on the sharpened image to segment the brain tumor. The MR Images are a very useful tool to diagnose the tumor growth in brain but precise brain image segmentation is a difficult and time consuming process. In the final stage, the segmented image is post processed by morphological operations and tumor masking in order to remove the false segmented pixels.

Aswathy S.U,Glan Deva Dhas G and Kumar S.S(2014) concentrated Brain tumor detection and segmentation process is one of the most challenging and time consuming task in medical image processing. The MRI (Magnetic Resonance Imaging) is a medical technique, mostly used by the radiologist for visualization of internal structure of the human body without any surgery. The MRI provides plentiful information about the human soft tissue, which helps in the diagnosis of brain tumor. The absolute segmentation of MRI image is important for the diagnosis of brain tumor by computer aided clinical tool. After appropriate segmentation of brain MR images, tumor is divided into two types such as malignant and benign which is a difficult task due to complexity and variation in tumor tissue characteristics like its shape, size and gray level intensities with location.

Albert Murtha et al (2013) explained an Automatic Brain Tumor Segmentation (ABTS) method for segmenting multiple components of brain Tumor using four magnetic resonance image modalities. These method consist of four stages involve automatic histogram multi-thresholding and morphological operations with geodesic dilation .This paper presents a fast, automatic and accurate method for segmenting brain tumors. As it automatically identifies thresholds based on the histograms of intensities present in the images. The ABTS method is easily able to effectively segment images produced from different protocols and scanners.

George Lampropoulos et al (2012) presented a multi-modality framework for automatic tumor detection including T1-weighted, T2-weightedand T1 with gadolinium contrast agent. The intensity, shape deformation, symmetry and texture features were extracted from every image. The Multi-modal MR images with simulated tumor have been used to train and validate the detection technique. The preliminary results on simulated and patient MRI show 100% successful tumor detection with average accuracy of 90.11%.

Eduard Montseny et al (2010) proposed a fully automatic and unsupervised brain tumor segmentation method. The expert knowledge and the features derived from the MR images are joined to define heuristic rules which aim to the design the fuzzy approach. The intensity-based objective measures are defined and membership functions of MRI data are introduced. The advanced approach is quantitatively comparable to the most accurate existing methods; even though the segmentation is done in 2*D*.The brain tumor segmentation approach also introduced a new way to automatically define the membership functions from the histogram.

Aboul Ella Hassanien et al (2010) introduced an image segmentation scheme to segment 3D brain tumor from MRI images. The human brain segmentation with three-dimensional magnetic resonance imaging (MRI) has gained a lot of importance in the field of biomedical image processing since it is the main stage for the automatic brain disease diagnosis. The clustering is achieved using K mean algorithm to link the similar clustered objects in all2D slices. This paper presents the 3D object segmentation algorithm using the k-mean and the connected component labelling algorithms. This classification system can be used for diagnosis and medical image analysis.

Subhranil Koley and Aurpan Majumder (2011) proposed segmentation of brain MRI for the purpose of determining the exact location of brain tumor using CSM based partitional K means clustering algorithm. CSM has attracted much attention as it gives best result as a self merging algorithm compared to other merging processes and the effect of noise is also less and the probability obtaining the exact location of tumor is more. This algorithm is the simplest method to obtain the efficient segmentation with less computational complexity.

Logeswari T and Karnan M (2010) described segmentation method has two phases. The Image Segmentation is very important and challenging factor in the medical image segmentation. In the first phase, the MRI brain image is acquired from patient’s database. In this, least level of weight vector, a higher value of tumor pixels, computation speed is achieved by the HSOM with vector quantization. This paper is used to give more information about brain tumor detection and segmentation.

Baidya Nath Saha et al (2007) proposed a straightforward, real-time technique to find a bounding box around the brain abnormality in MR image. Tumor segmentation from magnetic resonance imagery (MRI) can play a significant role in cancer research and clinical practice. This algorithm exploits left-to-right symmetry of the brain structure. This detection algorithm can play a useful role in indexing and storage of bulk MRI data.

Laxman Singh et al (2009) developed a tumor characterization technique using Marker Controlled Watershed Segmentation method. The parameters extracted are area, major and minor axis length, eccentricity, orientation, solidity and perimeter. This method is quite versatile, fast and simple to use. This can be applied to all type of 2D MR Images. The selection criteria for choosing the value of threshold are highly dependent on the shape and size of tumor.

Thirumurugan P, Sasikumar S (2014) studied various denoising filter algorithm of impulse noise reduction. Finally, they have several drawbacks also discussed for various image with variety of denoising filter methods and also comparative results study with psnr values and reconstructed image in this survey.

Thirumurugan P and Shanthakumar P (2016) proposed the segmented brain tumor region is diagnosed into mild, moderate, and severe case based on the presence of tumor cells in the brain components such as Gray Matter (GM), White Matter (WM), and Cerebro Spinal Fluid (CSF). The altered spatial fuzzy c mean algorithm is used to segment brain tissues. The performance of the brain tissues

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segmentation system is analyzed in terms of sensitivity, specificity and accuracy. The severity of brain tumor is diagnosed into mild case if the segmented brain tumor is present in the Grey Matter. The severity of brain tumor is analysed into moderate case if the segmented brain tumor is present in the white Matter. The severity of brain tumor is diagnosed into severe case if the segmented brain tumor is present in the CSF region. The immediate surgery is needed for severe case and medical treatment is preferred for mild and moderate case.

Amir Ehsan Lashkari (2010) introduced a novel automatic brain tumor detection method that uses *T1, T2*_weighted and *PD, MR* images to find any abnormality in brain tissues. Here, has been tried to give clear description from brain tissues using Gabor wavelets, energy, entropy, contrast. This reflected many statistic features such as mean, median, variance, correlation, values of maximum and minimum intensity.

Thirumurugan P and Sasikumar S (2013) discussed a Edge Preserving methodology used to detect the impulse noise affected pixels in a simplified manner and those detected pixels are removed using cloud algorithm. The experimental results show that this technique preserves the edge pixels and achieves better performances in terms of quantitative evaluation and visual quality.

The MRI provides plentiful information about the human soft tissue, which helps in the diagnosis of brain tumor. There are many horizontal and vertical correlations for a pixel which is more significant than other orientations. The importance of accuracy is significant in medical application area. It is understood that the complexity seems to be high. All the above papers have many steps and iterations and also used for specific application. All the above methods consume more time. This prposed method rectifies all the defects in the previous survey papers.

III. MATERIALS AND METHODS

A. Materials. In this paper, we have used three different dataset to test our proposed brain tumor segmentation algorithms.

A.1. *Davies–Bouldin (DB method)*: It will relate to the variance ratio criterion, which is based on the ratio between the distances.

A.2. *Physics Based Model (PBM)*: It is based on the distance of the clusters and the distance between the clusters.

A.3.*IFV Unit***:** It helps to evaluate the accuracy

B.Methods. the following methods are used to test our proposed brain tumor segmentation results.

B.1. *Oral Tracheal Stylet Unit*: This method used to remove the background area from an Magnetic Resonance image. This method has the advantage of fast processing. It can efficiently determine the background/ main parts of the pre-processing step.

B.2.*Fuzzy Clustering*: This helps to remove the structural area from the results of the previous steps. The achieved membership matrix is then used for the initialization of the Semi Supervised fuzzy clustering algorithm. This solves the problem of current semi-supervised algorithms.

B.3. *eSFCM*: This algorithm helps to clarify and improve the results being achieved by above step with pre-defined membership matrix being taken from the previous step.

There are three basic types of additional information:

• Must-link and cannot-link constraints: a must-link constraint requires two elements that must belong to the same cluster, whereas a cannot-link constraint indicates two elements which are not in the same cluster (which must be in 2 different clusters);

• Class labels: a part of data is labeled and others are unlabeled;

• A pre-defined membership matrix.

Some studies regarding image segmentation often use the membership matrix as additional information. Semi-Supervised Algorithm with Standard Fuzzy Clustering (SSSFC) – it is the algorithm by mixing the membership function into the entire clustering process. The new algorithm named as eSFCM-Otsu would obtain more reliable and higher accuracy than other clustering methods.The basic structure organized as follows:

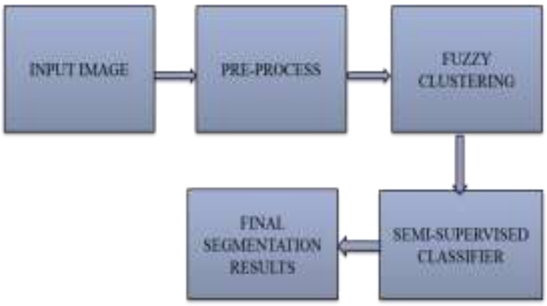

Fig 2.Conventional method

After selecting the input image, the pre-processing system helps to refine or enhance the image for the needs of the paper like filtering, noise removing and resizing etc. Fuzzy clustering helps to segment the image. Then moving to the semi-supervised classifier, the defective data was identified.Atlast, the final segmented results were obtained. This is shown in Fig.2.

IV. PROPOSED METHODOLOGY

A. cooperative framework. The Fig.3 shows the cooperative framework. A given brain image has some user defined parameters such as the number of Clusters (C), Fuzzifier (m), the Otsu Threshold (T) and the stopping threshold (ε) is inputted in the framework. If so, the Otsu method is applied to remove the Background area from the image.

This method has the advantage of fast processing and can efficiently determine the background/ main parts

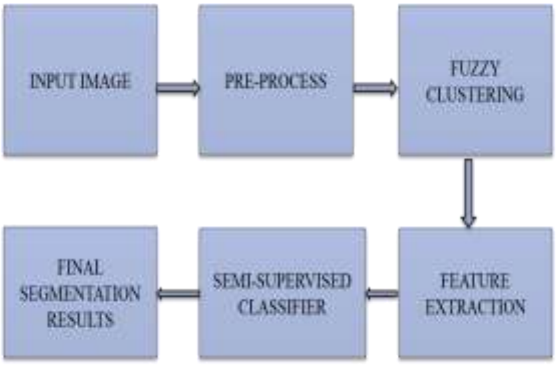

Fig.3 Block diagram of proposed system

The outcomes of this process are the final centres and the membership matrix U and last step of the eSFCM – Otsu framework measure the performance of a validity indices.

B.The Otsu method. The Otsu method changes an original image to binary image. It was introduced in 1975 and also used segmentation purpose. An inputted image can be divided into 3 regions by distributing density:

(i) The region with the lowest density corresponding to the background or soft area

(ii) The medium density areas corresponding to the bone and

(iii) The highest density areas corresponding to the veins.

The density of the veins gets close to the bones so that the two regions of a brain (Background/Main parts) can be used in the Otsu method. This Otsu is a typical method of thresholding. There are many methods to get the threshold. The simplest technique in thresholding is to partition the image into two regions based on a global threshold T.

C.PIC microcontroller. The name PIC initially referred to Peripheral Interface Controller. Early models of PIC had read-only memory (ROM) or field-programmable EPROM for program storage.

The hardware capabilities of PIC devices range from 6-pin SMD(Surface Mount Device), 8-pin DIP(Dual In-line Package) chips up to 144-pin SMD chips, with discrete I/O pins, ADC(Analog to Digital Converter) and DAC(Digital to Anlog Converter) modules, and communications ports such as UART(Universal Asynchronous Reciever/Transmitter),USB(Universal Serial Bus). Low-power and high-speed variations exist for many types.

PIC16F877A:

(i)They are reliable and malfunctioning of PIC percentage is very less.

(ii)Performance of the PIC is very fast because of using RISC architecture.

(iii)Programming is also very easy when compared to other microcontrollers.

Fig 4.PIC16F877A microcontroller

The LCD has 16 pins. 1-gnd, 2-5v, 3-variable voltage, 4 to 6-register select, read/write enable, 7 to 14-data inputs, 15,16- LED. PIC microcontroller needs only 5v so that the step down transformer step downs 230v into 5v.

The main function of rectifier is to convert an alternating current into a direct one. After conversion the given voltage is filtered by the filter capacitor. Hence voltage regulator is used to maintain a constant voltage level.

MAX232 is used to interface both pc and microcontroller where pc's are RS232 logic and the given microcontroller is a TTL (transistor-transistor logic). An serial converter is used to connect both pc and microcontroller. The working time of PIC depends on crystal oscillator.

D.Input Image. The input image was resized and filtered through pre-processing system.

Thus pre-processing system helps to refine or enhance the image like resizing, filtering etc. Input will be loaded in the form of image.

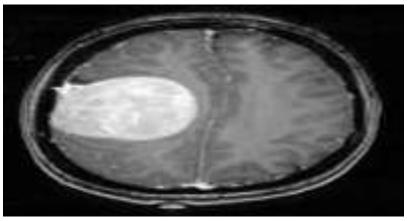

Fig.4 (i) Input Image

E.The Otsu Method. Otsu (oral tracheal stylet unit) method is used to convert gray scale image into binary image. Thus otsu method is used to perform clustering based image thresholding.

Fig.4(ii) Otsu image

F.Simulated Output. After conversion the input was clustered and then segmented with the help of semi-supervised fuzzy clustering method. It is an well-known unsupervised learning technique that can be used to reveal the underlying structure of the data based on similarity measure includes distance, connectivity and intensity etc. The Similarity measure may be chosen based on the data.

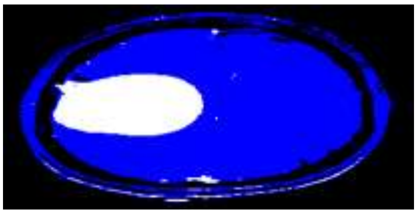

Fig.4 (iii) Sub- sided Image

F.Performance Parameters

(i)Davies–Bouldin (DB): relates to the variance ratio criterion, which is based on the ratio between the distance inner group and outer group.

Especially, quality of partition is determined by the following formula:

$$DB = \frac{1}{k}\sum_{l=1}^{k} D_l \qquad \text{----(1)}$$

$$D_l = \max_{l \neq m}\{D_{l,m}\} \qquad \text{-----(2)}$$

$$D_{l,m} = (\overline{d_l} + \overline{d_m}) / d_{m,l} \qquad \text{----(3)}$$

Where $\overline{d_l}, \overline{d_m}$ are the average distances of clusters l and m respectively and $\overline{d_{l,m}}$ is the distance between these clusters.

(ii)Physics Based Model (PBM): based on the distance of the clusters and the distance between the clusters and is calculated by the formula:

$$PBM = \left(\frac{1}{K}\frac{E_1}{E_k}D_k\right)^2 \qquad \text{----- (4)}$$

$$E_1 = \sum_{i=1}^{N} \| X_i - \overline{X} \|, \; E_k = \sum_{l=1}^{k} \sum_{X_i \in C_l} \| X_i - \overline{X_l} \| \qquad \text{----- (5)}$$

$$D_k = \max_{l,m=l....k} \| \overline{X_l} - \overline{X_m} \| \qquad \text{----(6)}$$

Hence the best partition indicates when PBM get the highest value, D_k maximizes and E_k reaches minimization.

(iii)IFV UNIT: It helps to evaluate the accuracy

$$IFV = \frac{1}{C}\sum_{j=1}^{c}\left\{\frac{1}{N}\sum_{K=1}^{N} Ukj^2 \left[\log 2c - \frac{1}{N}\sum_{k=1}^{N}\log 2Ukj\right]^2\right\} \qquad \text{-----(7)}$$

$$SD_{\max} = \max_{k \neq j} \| V_k - V_j \|^2 \qquad \text{----(8)}$$

Here the terms k and j represents the pixel values. The main objective is to evaluate the accuracy of segmentation of all algorithms.

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Table 1.Comparison Table

BASE WORK	PROPOSED WORK I	PROPOSED WORK II
DB_value =3.3145	DB_value 1 = 3.3145	DB_value 2 = 0.0032
PBM_value= 7.6089e+03	PBM_value 1= 7.6089e+03	PBM_value 2=4.1998e+09
IFV_value = 18.6162	IFV_value 1= 240.0556	IFV_value 2 = 346.7526

The lower value of DB criterion is better. The PBM criteria must be higher so that it gives higher algorithm performance.

Atlast the maximal value of IFV indicates the better performance. Also the IFV value is used to evaluate the accuracy level.

G. Performance comparison. The following graph represents the performance comparison of cluster validity measurements. The lower value of DB criterion is better. It is based on the ratio between the distance inner group and outer group.

The maximal value of IFV indicates the better performance. The main objective is to evaluate the accuracy of segmentation of all algorithms.

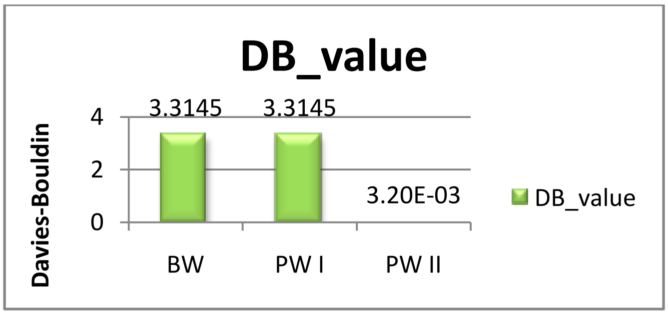

Fig.6 (i) Davies Bouldin Measurements

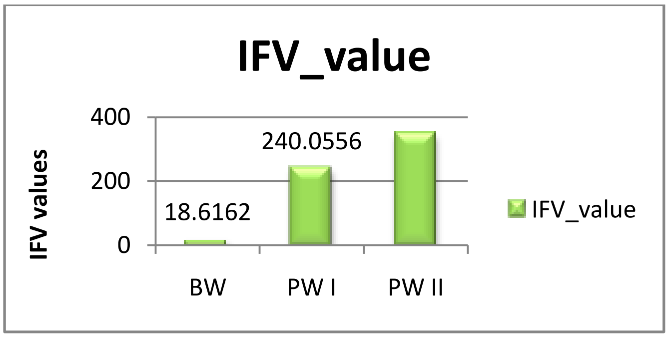

Fig.6 (ii) IFV Measurements

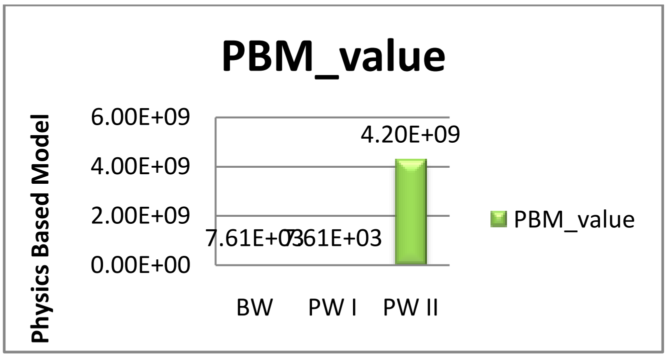

Fig.6 (iii) Physics Based Model Measurements

V. CONCLUSION

Brain tumor detection is one of the most dominating and time consuming task in medical image processing and Adaptive pixel-correlation filter (APCF) act as a noise detector. The experimental results show that the method will perform well in enhancing, segmenting and extracting the brain tumor from MR images. However, when this approach is extended to 3*D* classification, the accuracy will be improved.

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