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Expounding the MRI Sequences for Computer Aided Diagnosis for Detection of Brain Tumors

Ashwini S. Shinde
Research Scholar
Department of E&C
GIT, Belgavi, Karnataka, India

Veena V. Desai, PhD
Professor Department of E&C
GIT,Belgavi,
Karnataka, India

ABSTRACT
Abnormal and uncontrollable growth of the cells causes tumors .Early diagnosis by the physician and proper treatment of the tumors are essential for the prevention of permanent damage of the affected area and so also prevents death. The soft tissues of the body get affected by tumors, brain is one of the commonly affected areas with tumor .The Magnetic Resonance Imaging (MRI) is one of the power full techniques mainly used for detection of tumors. It is a radiation-based technique which represents the internal structure of the body in terms of intensity variations that are radiated by the biological system when exposed to Radio Frequency (RF). When the brain images are inspected or interpreted one should be aware of the image contrast since the entire information about brain is mapped into intensity variations of the brain MRI images captured during image acquisition the artifacts introduced affect the quality of analysis the physician also needs the quantification of the tumor area [1] hence it is required to an efficient rectifying methodology for removal of these artifacts present in the image before diagnosis. Here in this paper attempt is made to explain the different Sequences of Brain MRI and also enlighten the different computer aided techniques used for segmentation, and bring forward one of the method for tumor detection after Preprocessing.

General Terms
Sequences, Computer aided, Segmentation, Tumor detection.

Keywords
Magnetic Resonance Imaging, T1/T2weighted, FLAIR, Preprocessing Thresholding, Noise Removal.

1. INTRODUCTION
People at any age can be affected by Brain Tumors. The accumulated abnormal cells cause tumors. which can be classified in various grades, at the early stage it is the Benign which might not be a serious issue as it might be non cancerous which do not spread over other body parts or other tissues and are non destructive in nature, where as Malignant tumors are the type of tumors that cause cancers and originate from the brain and they have a faster growth and can spread to any other tissues in the body. The Tumor progress changes regarding the shape of the tumor its location and volume among different patients and even for the same patient. This grading of the tumor can either be a Benign or a Malignant and is mostly identified during Biopsy Pathological Brain Tissue. Magnetic Resonance Imaging (MRI) is one of the power full techniques which are mainly used for acquisition of brain images for identification and Diagnosis of the tumors. Using the Magnetic Resonance Imaging the internal structure of the body can be visualized in a safe and invasive way. The Magnetic Resonance Imaging represents the internal structure of the body in terms of intensity variations of the radiated wave generated by the Biological system when exposed to the Radio Frequency (RF) pulses. It is useful for detecting brain abnormalities and tumors ,the Magnetic Resonance Imaging radiation is harmless for health tissues unlike the X-Rays it provides high tissue information. Mainly MRI is used to identify the structural features of the brain with high spatial resolution since all the information about the brain is mapped into intensity variations therefore there is a need to pre-process in order to remove the extra marks and labels present in the image, the image so captured consist of noise and excessive parts like the skull, brain ventricles and soft tissue edema. To read and understand the different form of Brain MRI images is a very important factor as wrong prediction might lead to life threats so in the first part of the paper make attempt is made to give certain guide lines of how to read and understand a Brain MRI image sequence, Secondly a overview of commonly used segmenting techniques is done and also one of the segmentation technique is proposed as it is important either for extraction of parameters or for measurements on the images for visualization and representation[3].

2. ORIENTATION AND SEQUENCES OF THE BRAIN MRI
The Brain MRI is extremely helpful for evaluation of the brain acute and chronic process, for analysis of the brain to detect tumors. MRI images of the brain are captured in various sequences and cuts termed as T1 weighted and T2 weighted. Within a sequence water and fat are of opposite signal intensities and between sequences T1 vs T2, a given substance will have opposite signal intensities. To Recognize T1 images it has the following features .Fat is bright, water is dark, and the Cerebrospinal Fluids (CSF) is bright. To Recognize T2 images it has the following features. Fat is dark, water is bright, blood flow is dark.

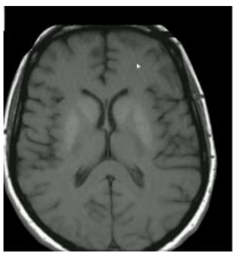
Fig.1: Brain MRI T1

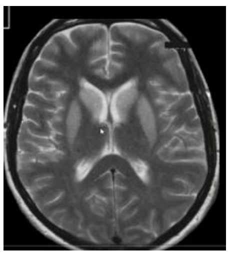
Fig.2: T2 Image

Another most important sequence is the Fluid Attenuation Inversion Recovery (FLAIR), basically it is of the type T2 but here the free flowing fluid is dark, non free flowing is bright and the fat is dark. This yields a better job of delineation of lesions near the ventricles since Edema is bright as the CSF is dark this does a better job to improve the grey-white differentiation.

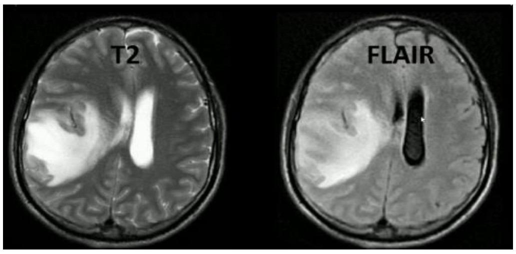

Fig.3:Brain Image showing the difference between T2 and FLAIR.

Gradient Echo (GRE) Imaging:

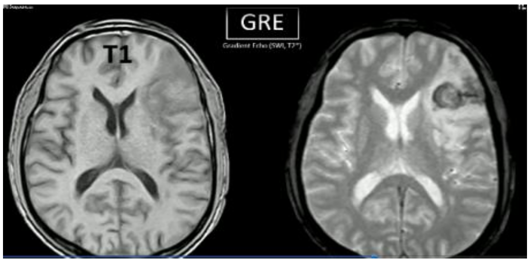

Fig.4: Brain Image Showing the difference between T1 and GRE.

In the GRE the Paramagnetic Substances are dark eg: Blood, Calcium, Copper deposition etc these images are useful for detection of early Hemorrhage.

Diffusion Weighted Imaging (DWI):
This is the very important and only sequence that can pick up early Ischemia here the fluid restricted area is bright that would be the Cytotoxic Edema, DWI measures the Brownian movement of the water molecules. The cells in the affected area of the Ischemia start swelling due to which the extra cellular space starts shrinking due to which the water molecules diffusing around the space gets less space to move around and hence the fluid is restricted to flow .This is useful to detect Ischemia ,Abscess and Seizures.

3. REVIEW ON SEGMENTATION TECHNIQUES

Here a survey is made on the various segmentation techniques used for medical imaging where some of the hybrid techniques are presented in the tabular form given in Table 1[1]. Mohsen, H., El-Dahshan [4] applies the Feed pulsed coupled Neural Network here the input experiences the feedback shunting that is not uniform for the entire input, this is used for segmentation. Jafari, M., & Kasaei, S [5] uses a hybrid segmentation technique of seeded region growing + connected component labeling here they start by the detection of brain regions from the scalp and then detect the tumor tissue from the brain region in the Brain MRI.

Table. 1: Segmentation techniques used for medical Imaging.

Author	Segmentation Technique	Additional Features
Masulli and Schenone (1999)	Possibilistic neuro fuzzy C-means algorithm(PNFCM)	Segmentation of the tumor area by Combining the Possibility approach of clustering by assuming that the membership function of a point in a fuzzy set is absolute.
Demirhan and Guler (2011)	Self-organizing map (SOM)+Learning vector Quantization(LVQ).	The T1-weighted Brain MRI are segmented into grey matter, white matter and background regions. The class regions for the data sets are defined.
Zhang, Ruan,Lebonvallet,Liao,and Zhu(2011)	Support Vector Machine(SVM)+Region growing	To learn the brain tumor and select the feature from MRI to automatically segment the tumor and then refine the tumor contour region by Region growing technique.
Dubery,Hanmandlu and Gupta(2009)	Stable 3D Level Set	Semi-automated segmentation for brain tumor volume measurements based on brain MRI replacing the constant propagation term in level set by a statistical force for a stable solution.
Ratan Sharma,and Sharma(2009)	Basic Watershed	Segmentation of tumors in 2-D and 3-D MRI where the differences in the intensity level between tumor and non tumor regions.
Kuwazuru et al	Artificial Neural Network (ANN)and Controlled level set method	Automated Segmentation Scheme for multiple Sclerosis (MS) lesions in MRI.
Chao, Chen, Lin, Shih, and Tsang (2009)	Boosted decision tree	Brain tissue classification in magnetic resonance (MR) imaging using a boosted decision tree segmentation algorithm Improved the accuracy rate of MR brain tissue segmentation
Ortiz, Gorriz, Ramırez, and Salas-Gonzalez (2013)	Self Organizing Map & The second method proposed consists of four stages including MRI brain image acquisition,	Two unsupervised approaches for brain image segmentation. The first one is based on the use of relevant information extracted from the whole volume histogram which is processed by using SOM. The second method proposed consists of four stages including MRI brain image acquisition,

4. THE PROPOSED METHODOLOGY

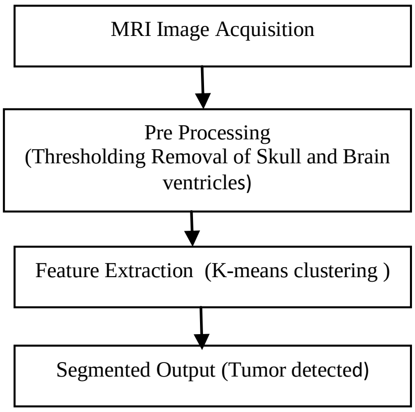

Fig.5: Flow Chart for the Proposed Technique.

4.1 Pre-Processing

Pre-processing improves the quality of segmentation of the input MRI image acquired for detection of brain tumor.

Anisotropic filtering used for pre-processing [6]: The MRI images of the Brain are subjected to different type of noise during image transmission and also during the digitization process. Pre-Processing is the first and the most important step involved in segmentation and detection of the tumors. The pre processing involves the removal of the extra-cranial tissues which might be the bone, skin, air muscles and also fat which can be enhanced by using filters, conventional filters removes noise but can corrupt the very important and unnoticeable details of the image. Using the anisotropic diffusion filter the edges are preserved this is done by the diffusion to control the variable coefficient. The filter ranks the neigh hood pixels based on their intensity values, to determine the median value for pixel under evaluation the central pixel is then replaced by the new middle value. One of the advantages of Anisotropic diffusion filter is it gives the best result for short or impulse type of noise, for extremely high values too [6].

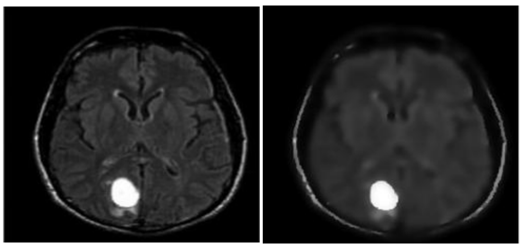

Fig.6.a: MRI Image Fig.6.bAnisotropic diffusion filter

Pre-Processing Using Median Filter: Median filters are non linear filters here a 3x3 median filter is developed by the non linear mapping. It depends upon the type of noise where the median filter can be used .Mostly the type of noise is the salt and pepper type which is caused due to the small density changes within a single tissue. A non derivative low pass filter is the median filter that efficiently eliminates this type of distribution and thus the homogeneous regions become denser that improves the performance of clustering. Mainly the concern of pre-processing here is to make the tissue more homogeneous and reduce noise. [7]

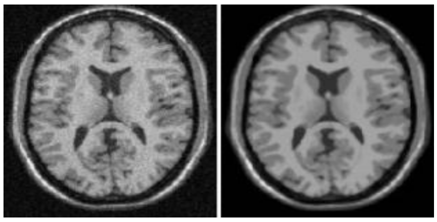

Fig.7:Salt and pepper noise Enhanced Median Filtered Image.

4.2 Feature Extraction

The Region of Interest is determined using the Grey-level Concurrence matrix (GLCM), differentiates between the normal and abnormal tissue on the feature of the pixel contrast and the energy of the region of interest. The properties of the GLCM are calculated as [6]

$$\text{Energy} = \sum (i,j)\,^\wedge 2 \quad (1)$$

$$\text{Co-relation} = \sum \left((i-\mu i)(j-\mu i) * \frac{P(i,j)}{(\sigma i,\sigma j)}\right) \quad (2)$$

$$\text{Homogeneity} = \sum \left(\frac{P(i,j)}{(1+|i-j|)}\right) \quad (3)$$

$$\text{Contrast} = \sum \left(|i-j|2 * P(i,j)\right) \quad (4)$$

The size of the matrix is decided by the no of grey level and its elements are given by $P(i,j/\Delta x,\Delta y).P(i,j)$ which also includes the location of the pixels. The concept of mother wavelet is given feature of a mathematical function which represents a finite length waveform small waves that are scaled and shifted to produce mother wavelet. And is given by

$$\Psi a,b\,(t) = \frac{1}{\sqrt{a\Psi}} * \frac{(t-b)}{a} \quad (5)$$

4.3 The selection of the seed point.

There is an automatic selection of the seed point, depending upon the appearance of the tumor with respect to the location there is a intensity variation. It is observed from the different

The tumor intensities are either higher or lower values compared to the normal tissue of the brain that depends upon the type of image either T1 or T2 .

The following steps are involved for segmentation after preprocessing

1. The initial step is the identify the Tumor Detecting Matrix (TDM)
2. Applying Thresholding on TDM.
3. Calculate the edge.
4. Create a counter matrix of edge point.
5. Select a point set.
6. Selecting a seed point.

Fig.8: Segmented out put

The above mentioned Algorithm can be implemented by the doctors for detection of tumors, with good speed and improved accuracy .with an effect that reduces the man power that is used for labeling of the MRI images manually. This is the most important factor considered by the physicians.

As a result of thresholding an intensity image is converted to binary image, with the values of intensity of 0 and1 as shown. The intra class variance of the binary pixels is minimized by the gray thresh function which uses Otsu's method. The function reshape is used convert a multidimensional array to a 2-D array. This gray thresh function eliminates any nonzero imaginary part of an image [8]. The next step involved is the K-means Clustering which desires to divide the observations into k clusters where the observation belongs to the nearest mean of the cluster. As a result the data space is divided into Voronoi cells. The clustering problem is solved by this algorithm which has a simple procedure that classifies a set of given data through defined no of clusters (say 'k' clusters). By doing this the numbers of 'k' cancroids are defined. Which are placed in a very tricky manner to avoid result complications that's why it is always better to locate them as far as possible from each other, next step follows to locate the centroid by comparing each point of the given data set defined earlier when all the points are covered the initial step is completed and groups are formed now the recalculation of the 'k' new centroids is done as barycenters as a result of the earlier step. Now a new binding of the same data set is to be done with the k new centroids , a loop is created and there is the change of location of the centroids till no more changes take place. Ultimately in this algorithm we aim to minimizing an objective function, which is a squared error function [9].

5. EXPERIMENTAL IMPLEMENTATION AND DISCUSSION

The Algorithm is implemented on the Dataset of Normal as well as affected images .The data set consist of axial T2 weighted MRI of Brain [10]. With the advantage of computational intelligence and Machine learning techniques it attracts more attention for detection of brain tumor. The results show that this method obtains quite perfect results as given.

6. RESULTS

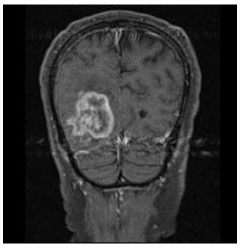

Fig.9: Input Brain Image **Fig.10: Otsu Threshold image**

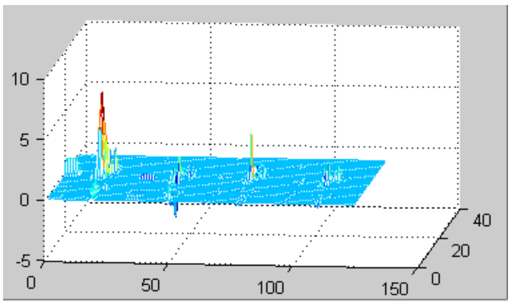

Fig.11: 3-D mesh Surface

Here a wire frame mesh with x,y,z co-ordinates is drawn z determines the color which is proportional to the surface height. If we consider x and y as vectors where the respective lengths are the size i.e (m,n)=size here the intersection of the grid lines represent the columns and rows of z.

Fig.12: Objects in cluster **Fig.13: Segmented Tumor**

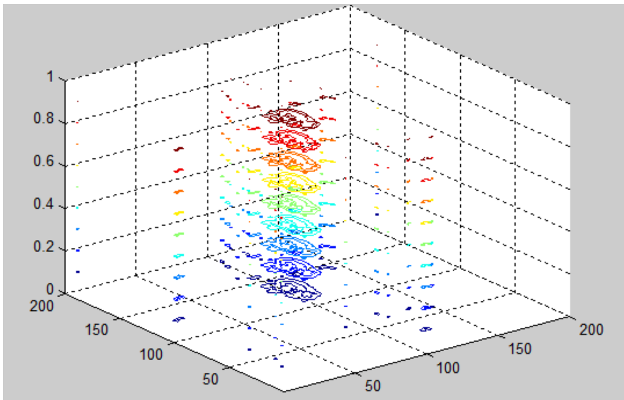

Fig.14: A 3-D Contour Plot

A 3-D plot of the surface of the out put is created on a rectangulat grid by the Contourt. It draws a plot of a matrix z in a 3-D view where z is the height with respect to x-y plane, which is a 2x2 matrix that contains atleast two different values. Based on the minimum and maximun values the number of countour levels are set automatically .The range of x-y are 1:n and 1:m where [m,n]=size of z. [5]

7. CONCLUSION AND FUTURE SCOPE

MRI Imaging is a powerful and widely used means for understanding and diagnosis of the brain anatomy. This paper focuses on the different sequences of the brain MRI which is a big challenge to the physician's, even today, to remove the noise present and detect the tumor. In the work carred out the segmented output is obtained using the pre-processing technique by using Anostropic filtering where the fine details in the image are maintended without corrupting the image and then using the thresholding and clustering.This work can be extended further to detect the volume of the tumor so that it would be easier for the physician to categorize the tumor.

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