IMAGE SEGMENTATION FOR BRAIN TUMOUR PREDICTION USING WATERSHED ALGORITHM

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ABSTRACT

Abstract Background/Objectives *The objective of this paper is to study of segmentation methods implemented in Magnetic Resonance Imaging (MRI) images of Brain using MATLAB and compare time and accuracy of various segmentation techniques.* ***Statistical Analysis/Findings*** *Pre-processing is required for better segmentation, as it removes noise and makes images as better quality. De-noising is necessary to reduce the affect of noise on the image results. In this paper for de-noising, I have studied various morphological filters and used that filters and some techniques to predict the brain tumour .Segmentation using fuzzy C-Means and watershed Algorithm, these two methods is performed and compared with time and accuracy of that segmentation. Some techniques are used in order to get segmented image have higher accuracy. These techniques are Median Filter, Bias Field, Gaussian Mixer Model and Fuzzy Local GMM.* ***Application/Improvement*** *Segmented tumour with higher efficiency leads to help doctor in anatomy and pathology to classify tumour detection. So that treatment could be started accordingly as soon as possible.*

Keyword: - *Magnetic Resonance Imaging (MRI), Median Filter, Bias Field, Gaussian Mixture Model (GMM), Fuzzy Local GMM (FLGMM), Watershed Algorithm*

1. INTRODUCTION

Image Processing is a technique to enhance raw images received from cameras/sensors placed on satellites, space probes and aircrafts or pictures taken in normal day-today life for various applications. Various techniques have been developed in Image Processing during the last four to five decades. Image Processing systems are becoming popular due to easy availability of powerful personnel computers, large size memory devices, graphics software's etc. Image Processing is used in various applications such as Medical Imaging, Textiles, Film industry, Graphic arts, Printing Industry etc., [1].

1.1 BRAIN TUMOR

Tumour is defined as the abnormal growth of the tissues. Brain tumour is a mass of cells that have grown and multiplied uncontrollable. It will spread among the brain cells. Sometimes this malicious tissue replaces the original brain cells and causes what is called the primary tumours. Figure 1 shows the MRI image with Brain Tumour. Primary tumours do not transfer from the brain region to any other organ in the body; these tumours may be malignant or benign tumours. But, secondary brain tumours are always malignant tumours.

Types of Tumour

There are three common types of tumour: 1) Benign; 2) Pre-Malignant; 3) Malignant (cancer can only be malignant) [2].

a) Benign Tumour - A benign tumour is a tumour is the one that does not expand in an abrupt way; it doesn't affect its neighbouring healthy tissues and also does not expand to non-adjacent tissues. Moles are the common example of benign tumours.

b) Pre-Malignant Tumour - Premalignant Tumour is a precancerous stage, considered as a disease, if not properly treated it may lead to cancer.

c) Malignant Tumour - Malignancy (mal- = "bad" and -ignis = "fire") is the type of tumour, that grows worse with the passage of time and ultimately results in the death of a person. Malignant is basically a medical term that describes a severe progressing disease. Malignant tumour is a term which is typically used for the description of cancer.

Fig -1: Brain MRI with Tumor

1.2 MAGNETIC RESONANCE IMAGING (MRI)

Medical image processing is the most challenging and highly wanted field. Brain tumor detection in magnetic resonance imaging (MRI) has become an emerging field of medical image processing. Segmentation of images is one of the most difficult tasks holds an important position in image processing which determine the quality of the final result. Image segmentation is the process of dividing an image into different regions. The aim of this paper is to provide a review on automated tool for brain tumor segmentation using MRI scanned image datasets. detection and extraction of tumor from MRI scan images of the brain is done by MATLAB software [3].

2. PROPOSED METHODOLOGY

The proposed work aim is to achieve a high accuracy in discriminating the tumour through a combination of several techniques for image de-noising, find the gray, white and black values, image segmentation, feature extraction, comparison and Prediction. According to the need of the next level, the preprocessing step converts the image. It performs filtering of noise and other artifacts in the image and sharpening the edges in the image. It includes a median filter for noise removal. In the disease detection and classification step, the tumor area is calculated using the binarization method making the dark pixel darker and white brighter. That is the image having only two values either black or white (0 or 1) [4]. Here 200x200 JPEG image is a maximum image size. Segmentation is carried out by Fuzzy C-Means Algorithm and Watershed Algorithm. These two results are compared on the basis of time and accuracy. The flow is shown in the figure 2.

2.1 IMAGE ACQUISITION

Images are achieved using MRI scan and these scanned images are showed in a two dimensional matrices having pixels as its elements. These matrices are related to matrix size and its field of view. Images are kept in MATLAB and displayed as a gray level image of size 256*256. The entries of a gray level image are ranging from 0 to 255, where 0 shows complete black color and 255 shows completely pure white color. Entries within this ranges vary in intensity from black to white.

2.2 PREPROCESSING

In this step image is enhanced so that finer details are improved and noise is reduced from the image. Most frequently used enhancement and noise reduction methods are applied that can give best possible results. Many filters are used to extract the noise from the images. Here, Median filter is used to extract the noise. In the median filter the pixel value is determined by the median value of the neighboring pixels [5].

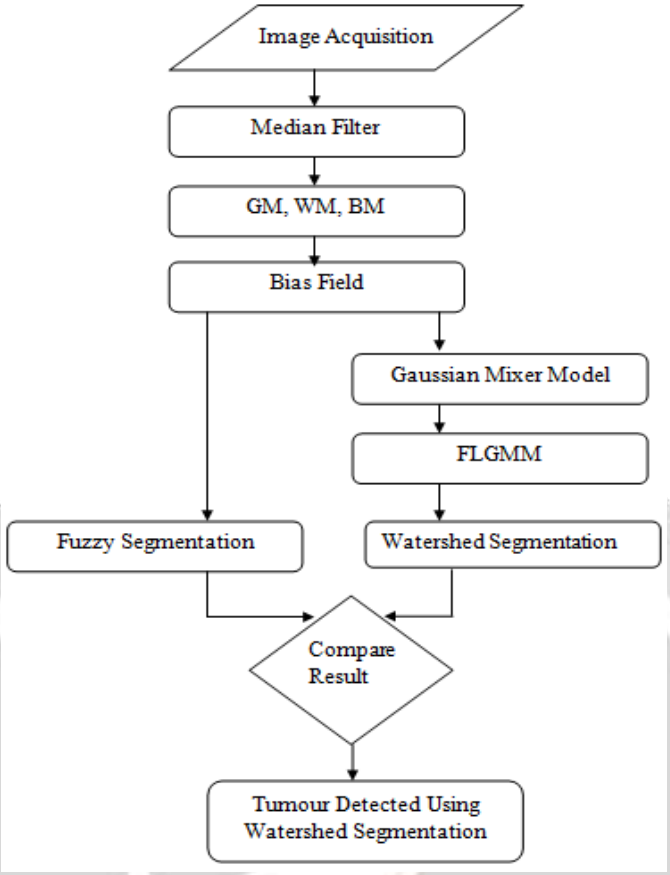

Fig -2: Flow Diagram of Proposed Methodology

2.3 FUZZY SEGMENTATION

Fuzzy c-means (FCM) 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. For example, a certain data point that lies close to the center of a cluster will have a high degree of belonging or membership to that cluster and another data point that lies far away from the center of a cluster will have a low degree of belonging or membership to that cluster. It starts with an initial guess for the cluster centers, which are intended to mark the mean location of each cluster. The initial guess for these cluster centers is most likely incorrect. Next, FCM assigns every data point a membership grade for each cluster. By iteratively updating the cluster centers and the membership grades for each data point, FCM iteratively moves the cluster centers to the right location within a data set. The core is a fully member of the fuzzy set. The support is non membership value of the set and boundary is the intermediate or partial membership with value between 0 and 1 [6].

Mathematical representation

Fuzzy c-means (FCM) is the clustering algorithm which allows one piece of data may be member of more than one clusters. It is based on reducing the following function which is represented in Equation (1),

$$Y_m = \sum_{i=1}^{N}\sum_{j=1}^{C} M_{ij}^{m}\left\|x_i - c_j\right\|^2 \longrightarrow \quad \cdot(1)$$

Where, m- any real number greater than 1,

Mij - degree of membership of X; in the cluster j,

Xi - data measured in d-dimensional,

Cj - dimension centre of the cluster,

2.4 GAUSSIAN MIXTURE MODEL AND FUZZY LOCAL GMM

Gaussian Mixer Model is used for the Edge detection which very useful for segmentation. Each image is Mixer of Gaussian. To find the Gaussian Mixer for a given image is using the Expectation Maximization (EM) Algorithm. It will find the Means and Variances of each Gaussian distribution and pixels are labeled according to the distribution number.

Let X is a random variable that takes these values. For a probability model determination, we can suppose to have mixture of Gaussian distribution represented in the equation (2),

$$f(x) = \sum_{i=1}^{k} p_i N(x|\mu_i, \sigma_i^2) \longrightarrow (2)$$

Where k is the number of regions and pi> 0 are weights such that $\sum_{i=1}^{k} p_i = 1$, the mean and standard deviation is represented in the equation (3),

$$N(\mu_i, \sigma_i^2) = \frac{1}{\sigma\sqrt{2pi}} exp \frac{-(x-\mu_i)^2}{2\sigma_i^2} \longrightarrow (3)$$

Whereμi , σi are mean, standard deviation of class i. the parameters are θ =(p1,…, pk, μ1,……, μk,σ2 1,……..2 k and we can guess the number of regions in GMM by histogram of lattice data.

The Fuzzy Local GMM (FLGMM) algorithm, assumes that the local image data within the neighbourhood of each pixel follow the GMM, in which the mean of each Gaussian component is approximated as a tissue dependent constant multiplied by the bias field estimated at this pixel for brain MR image segmentation. The objective function of this algorithm is defined as the integration of the weighted GMM energy functions over the entire image.

2.5 WATERSHED ALGORITHM

Watershed segmentation is a gradient-based segmentation technique. The segmented regions are called catchment basins. Watershed segmentation solves a variety of image segmentation problem. It is suitable for the images that have higher intensity value. [7].

It is one of the best routines to gathering pixels of a image on the premise of their intensities. Pixels falling under comparative intensities are assembled together. It is a decent segmentation system for separating a image to partition a tumor from the image. Watershed is a numerical morphological working device. Watershed is regularly utilized for checking yield as opposed to utilizing as an information segmentation method on the grounds that it typically experiences over segmentation and under segmentation [8].

2.6 COMPARISION OF RESULTS AND TUMOR DETECTION

The result got from both the fuzzy segmentation and the watershed segmentation will be compared. The aim of a fuzzy clustering analysis is to divide a given set of data into a cluster, which represents subsets or a group. Watershed deals with group of pixels, and it is an algorithm based on integrator. Watershed algorithm is based on morphological process mixed with edge based segmentation to yield a hybrid technique. The result yields watershed segmentation finished within less time compare to fuzzy c means.

After these techniques applied, the tumor portion is detected in MRI Brain Image which is shown in the figure 3.

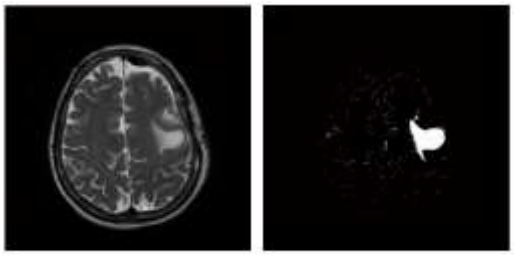

Fig -3: (a) MRI Brain Input Image, (b) Tumor detection

3. EXPERIMENTATION AND RESULT

In this section, the experimental results of proposed model watershed segmentation technique are presented. This process contains four stages, First Stage is Pre-processing, Second Part is Segmentation, Third one is Comparison and Fourth one is Tumor Prediction. The preprocessing is shown in the figure 4

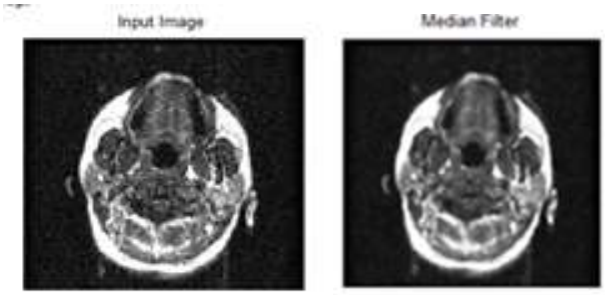

Fig -4: (a) Input MRI Brain Image, (b) Noise removed by Median Filter

Brain tumor is predicted by using the Fuzzy C-Means segmentation, the tumor area is extracted for the analysis the stage and position of tumor. The segmentation of brain tumor is shown in the figure 5.

(a) **(b)**

Fig -5: (a) Fuzzy Segmentation (b) Watershed Segmentation

In this comparison graph shown in Figure 6, X-axis represents the unit Level to process the brain image in each stage. Y-axis represents the time indicates, how fast this algorithm finishes the segmentation process. This comparison shows that watershed having the highest performance, where the Fuzzy C Mean having the lowest performance. The conclusion of this comparison is the proposed watershed gives the segmentation with accuracy in less time.

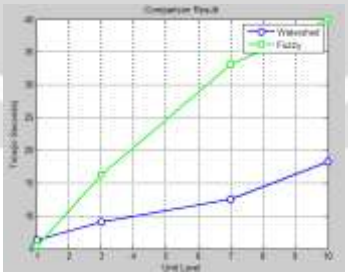

Fig – 6: Comparison of FCM with Watershed, It shows Watershed is best

4. CONCLUSIONS

In this paper, brain tumor is detected by using fuzzy segmentation, watershed based segmentation method and with the help of some morphological operators. Watershed segmentation gives very good segmentation results, and meets the criteria of less computational complexity. This will help the physician in surgery. As the future work, the techniques will be compared on the basis of other parameters such as state of tumor and color image of tumor along with the execution time.

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