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Abnormality Extraction of MRI Brain Images Using Region Growing Segmentation Techniques

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Abstract: Medical image processing is one of the most stimulating and emergent field in medical diagnosing system. Processing of MRI Human brain images is one of this field. This paper describes the major diagnosis depending on the abnormality extracted from the MRI (Magnetic Resonance Image) sliced images. Abnormality extraction is the series of image processing steps. Such as, Image enhancement, Segmentation, Morphological operations and classification. Here, the paper mainly focuses on the segmentation part to segment the affected region properly. Region based segmentation and multilevel threshold segmentation techniques are used for abnormality extraction, which gives the enhanced results compared to other segmentation techniques. After the abnormality extraction the diagnosis is performed based on the metric values of images. Abnormality can be of Brain tumor, Hemorrhage (stroke), Edema (Brain swelling) and Hydrocephalus (water on the brain). These classifications of different abnormalities are identified based on metric values and the classified region clearly gives a result on the type of abnormality.

Key words: MRI Brain image, Thresholding, Region Growing Segmentation, Brain Tumor, Blood clot.

I. INTRODUCTION

Major abnormality in the brain can be of brain tumor, stroke, Brain swelling and Hydrocephalus. Brain tumor and Brain stroke are one of the main cause's deaths among people. It is evidence that the chance of survival can be increased if tumor and stroke is detected correctly at its early stage. Brain tumor can be of two type's benign tumor and malignant tumor. And the cerebrovascular disease is commonly known as Brain Stroke or Hemorrhage. Stroke is caused by blood vessel blocks or Leakage of blood. Brain swelling is known as edema. It is nothing but brain vessels are larger and rounder than usual due to blood pressure or injury of brain. Hydrocephalus is nothing but water on the brain i.e. unusual liquid formed on the brain it causes head ache. These kind of abnormality are detected by applying the MR Images into various image processing operations.

A. Magnetic Resonance Imaging (MRI)

Protons of the hydrogen atom of the human body act as a magnetic dipole. In the absence of an external magnetic field, magnetic dipoles are randomly oriented, resulting into zero net magnetic fields. The introduction of an external magnetic field (B0), forces the magnetic dipole to align in one of the two states: parallel (low energy) or anti-parallel (high energy). A small excess in the parallel direction results in a nonzero net magnetic field (M). For convenience, B0 is along the z axis, so M is also along z axis. The transverse plane is perpendicular to the main field and contains x and y axis. For spin-echo imaging, 90-degree RF pulse is applied. M is flipped from the z axis to transverse plane. This transverse component of the M is entirely responsible for the MRI signal. M is returned to the equilibrium state by releasing energy called T1 relaxation (longitudinal). Immediately after the 90-degree RF pulse, the magnetic moments are located in the transverse plain. Transverse (x, y) magnetization suddenly decays constitute T2 relaxation (transverse). Fluid Attenuating Inversion Recovery (FLAIR) imaging technique is used to enhance the contrast.

B. Image Processing

The image processing methods that will helps the development of Diagnostic Imaging System are Filtering, Restoration, Segmentation, Reconstruction, Registration and Pattern Recognition. Proper filtering methods can be adopted to remove the unwanted signal intensities and motion artifacts. Normally MRI scan sequence lasts for half an hour to two hours. It is very difficult to make the scan without motion artifacts. Because of the patient movement, blur images, overlapped or unclear images may result. One of the options is to repeat the scanning process. If the motion artifact is not severe then Image Restoration methods can be used. If some abnormalities are found by using image registration or some other means, then from each slice of axial, coronal and sagittal planes, the abnormalities can be segmented and reconstructed to get correct size and shape of abnormalities. Normal slice thickness is 5mm. Count the number of slices in axial, coronal and sagittal direction where the abnormalities are present. Then multiply the number of slices with the slice thickness in axial, coronal and sagittal direction will give volumetric information of the abnormalities. By using the segmented abnormalities from each slice and slice thickness we can reconstruct the abnormalities. This will help the surgeon in his surgery. The image registration is done on a slice image with same slice image with contrast. This will give clear cut information about the abnormalities present in that slice, if the slice image is abnormal. By using pattern recognition we can recognize whether the abnormality is a tumor or infarction or edema or hemorrhage. It can also be realized whether the tumor is malignant or benign. Benign tumors are well circumscribed tumors.

II. LITERATURE SURVEY

Many of the researchers proposed many methods to find brain tumor, Stroke and other Kind's abnormalities in human brain using MR Images. Such as follows. Researchers Manoj K Kowar and Sourabh Yadav developed a system called "Brain Tumor Detection and Segmentation Using Histogram Thresholding". This paper presents a novel technique for the detection of tumor in brain using segmentation and histogram thresholding. It provides the result to find only brain tumor not for other kind of abnormalities in brain. Researchers Lee Ming-Sian, Chen Chong-Gang, Chin Chiun-Li, and Liu Shih-Hua proposed a system called "Stroke Area Detection using Texture Feature and iFuzzyLDA Algorithm". In this paper, CT image is used to diagnosis brain stroke and Iterative Fuzzy LDA algorithm is used to find a stroke. Problem in this system is it's only for stroke detection not for any other abnormalities in brain.

Researchers M. Karuna and Ankita Joshi proposed a system called "Automatic detection of Brain tumor and analysis using mat lab " This system incorporates segmentation through Neuro Fuzzy Classifier and problem of this system is to train an image to the neural network it needs many input images, which is used to train the network. It also developed only for tumor detection not for other abnormalities. Researchers Rajesh C. Patil, and Dr. A. S. Bhalchandra proposed a system called "Brain Tumor Extraction from MRI Images Using MATLAB" In this system used segmentation technique called as Meyer's flooding Watershed Algorithm. This system only detect the tumor and it did not classify the tumor which is used for only detecting the tumor area not for classification of tumor types and shapes. Researchers Mukesh Kumar and Kamal K. Mehta developed a system called "Texture based tumor detection and automated segmented system". Problem of this system is a small amount of pixels which are misclassified and the execution time is not sufficient. And also it is only for detecting tumor not for other abnormalities. Many of the researchers proposed many algorithms and segmentation techniques to find abnormalities in the brain using MRI images. Most of them proposed a system to find any one of the abnormality in the brain such as Brain tumor and Stroke. An intelligent diagnosis system needs to classify all kind abnormalities under a single system. This is the key factor to develop a proposed system. Henceforth we proposed a system to find abnormalities using MRI scanned images under single system. Abnormality is classified under three major kinds such as Brain tumor (Benign tumor, malignant tumor), Hydrocephalus (known as "water on the brain") and Hemorrhage (Stroke).

III. PROPOSED SYSTEM

According to the key factors found in existing systems such as all major kinds of abnormalities are extracted and classified under a single system known as proposed system. This system encompasses the following sequence of processes.

A. **Proposed System Architecture Design**

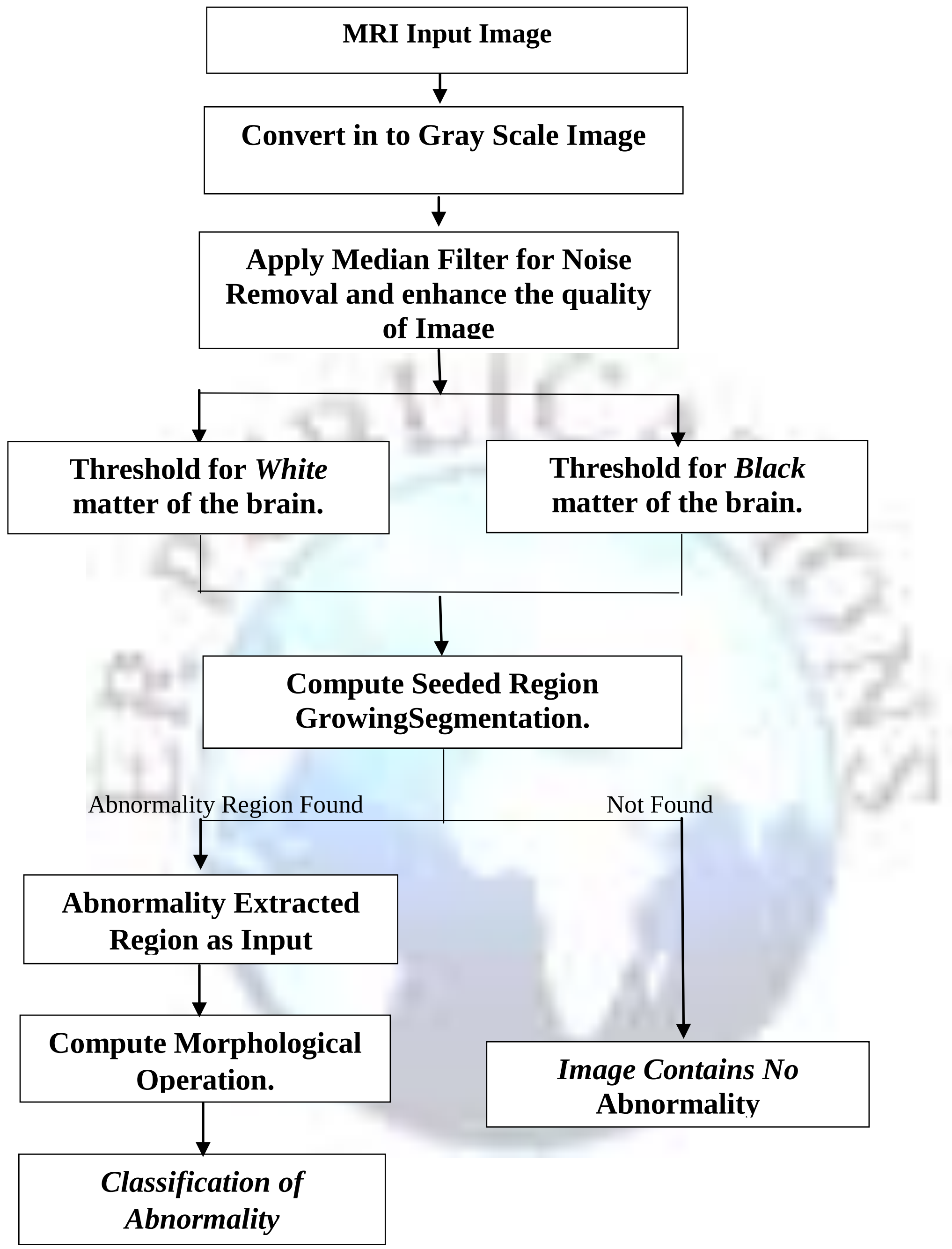

Figure.1: Proposed System Design.

B. **Image Acquisition and Image Enhancement**

Image acquisition is the first step of digital image processing. Here, MRI slice image is a digital image and it is given as an input image for image preprocessing operations. Here some of the image acquisition and enhancement techniques are applied such as follows.

C. Grayscale Conversion of Digital Image

Input of MRI digital image can be converted into gray scale image, because segmentation and other process or based on gray scale values. Each pixel in the gray scale image is a single sample for segmentation process. Each pixel contains the value from 0 to 255 various intensity values such as black to white.

D. Median Filtering for Noise Removal and Image Enhancement

Median filtering is used to remove salt and pepper noise from the converted gray scale image. It replaces the value of the center pixel with the median of the intensity values in the neighborhood of that pixel. Median filters are particularly effective in the presence of impulse noise, also called 'salt – and – pepper' noise because of its appearance as white and black dots superimposed on an image. For every pixel, a 3x3 neighborhood with the pixel as center is considered. In median filtering, the value of the pixel is replaced by the median of the pixel values in the 3x3 neighborhood. For Example consider the following

F(x, y) = [5 3 4] [3 10 5] [3 4 5].

So, the median filtered output signal x2, y2 will be,

E[X2, y2] = Median [3 3 3 4 4 5 5 5 10] = 4

3, 3, 3, 4,**4**, 5, 5, 5, 10

5	3	4
3	10	5
3	4	5

5	3	4
3	4	5
3	4	5

E. Image Segmentation

Segmentation algorithms are based on one of two basic properties of gray values or texture. Normally MRI image provides the brain image of two basic colors. Such as black and white. It is converted into grayscale image of 0 to 255 Grayscale intensity levels. It provides clear description about the brain tissues in different levels. Such as, brain tumor are mostly of white pixels and blood clot or stroke are black pixels or near to black pixels. So, the input image can be threshold in to two different pixel levels and the abnormality region can be extracted by applying seeded region growing techniques.

Image Thresholding

1. Computing threshold for white matter of an input image.
2. Computing threshold for Black matter of an input image.

a) Threshold for white matter

Threshold for white matter is implemented to identify the abnormality which contains the high intensity gray values or nearest to the high gray level called as white. Which is developed with the predefined pixel value A. Such as follows.

If Pi < = A, (A is Belongs to Black) && Pi > A, (Belongs to White).
Here,
A – is the pixel value which is predefined for white matter thresholding,
Pi – is the pixel values of grayscale image other than the predefined value.

b) Threshold for Black matter

Threshold for black matter is implemented to identify the abnormality which contains the low intensity gray values or nearest to the low gray level called as black. Which is developed with the predefined pixel values A and B.? Such as follows.
If Pi> A, (A is Belongs to Black) && Pi> B, (Belongs to White).
Here, A and B – is the pixel values which is predefined for two different low levels for black matter thresholding,Pi – is the pixel values of grayscale image other than the predefined value.

Region Growing Segmentation

Region growing is a process grouping pixels or sub regions into larger regions based on predefined criteria for growth. The basic idea is to start with seed points. Then from these seed points regions are grown by joining to each seed those neighboring pixels that have predefined properties similar to the seed. The growth mechanism:

- At each stage k and for each region $R_i(k)$, i = 1… N, we check if there are unclassified pixels in the 8-neighbourhood of each pixel of the region border.
- Before assigning such a pixel x to a region Ri(k),we check if the region similarity:
  P (Ri (k) U {x}) =TRUE , is valid
- The arithmetic mean m and standard deviation std of a region R having n =|R| pixels
- Arithmetic mean (m)

$$m(R) = \frac{1}{n} \sum_{(r,c)\in R} I(r,c)$$

- Standard Deviation (std):

$$std(R) = \sqrt{\frac{1}{n-1} \sum_{(r,c)\in R} (I(r,c) - m(R))^2}$$

- The predicate P: |m(R1) – m(R2)| < k*min {std(R1), std(R2)}, is used to decide if the merging of the two regions R1, R2 is allowed, i.e.,
- if|m(R1) – m(R2)| < k*min{std(R1), std(R2)}, two regions R1, R2 are merged.

IV. EXPRIMENTAL RESULTS OF IMAGE PREPROCESSING AND SEGMENTATION

A. Image Pre-processing

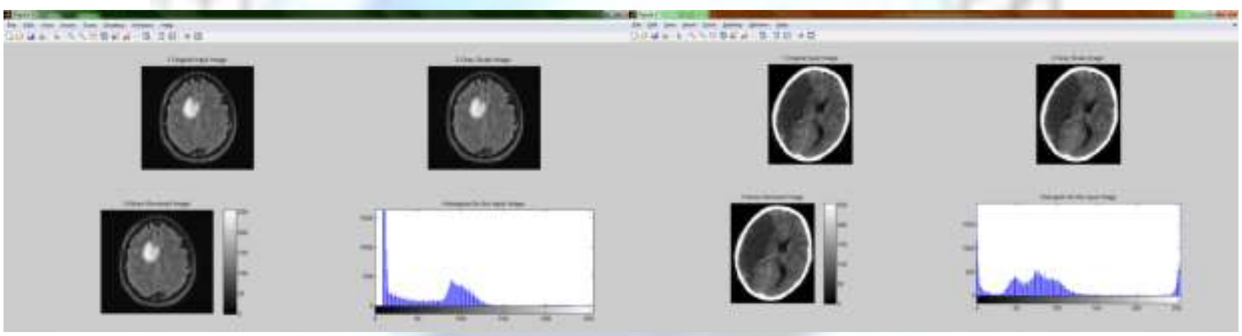

Figure 1. MRI Brain Tumor and Clot image(1) is converted into grayscale image (2) and then the image is applied to noise removal (3) and then histogram (4) is performed with various intensity levels.

B. Image Segmentation (Thresholding):

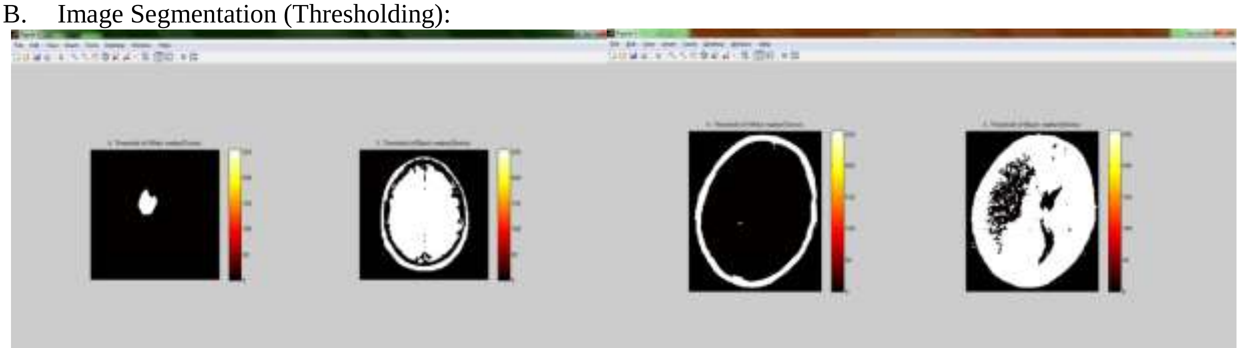

Figure 2.Threshold for white matter (4) as well as black matter (5) of brain tumor and Clot images. C Image Segmentation (Region Growing Segmentation)

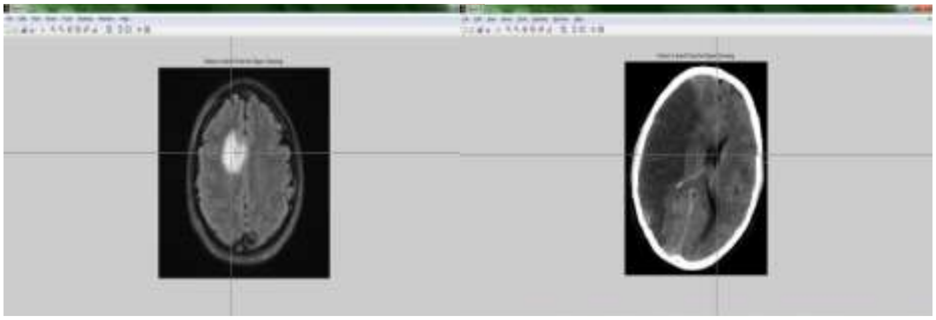

Figure 3: Seed point selection of MRI Brain image (Tumor and Clot) for region growing. D Seeded Region Growing and Region Extraction (Segmented Image):

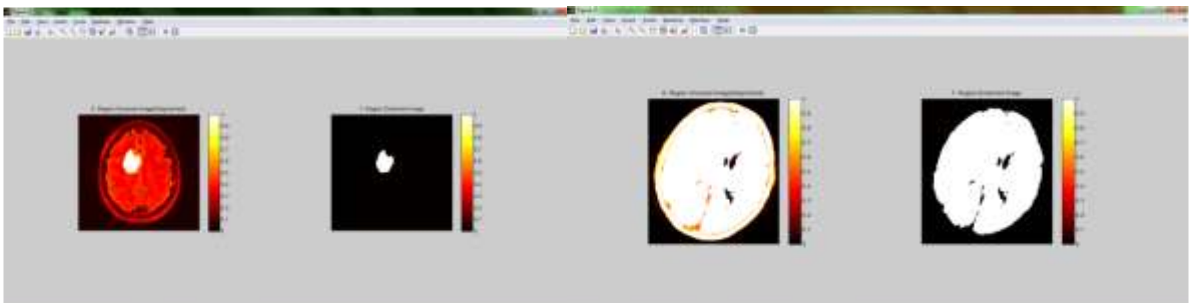

Figure 4: Selected region is gowned (6) and the region is extracted (7) from the MRI Brain tumor and clot image.

V. IMAGE CLASSIFICATION

Image classification is the process of applying morphological operation and the abnormality is finally classified with the extracted region by measuring of corresponding pixel intensity values.

Morphological Operation

It is the process of image enhancement such as filtering, Nosie removal and intensity to binary image conversions. Some of the basic morphological operations are performed after extraction of MRI image. Which help us to calculating of area of abnormality, Boundary of extracted region and position of abnormality is found based on the MRI images taken with angles.

Abnormality Classification

Classification is a vast process to find and match the pattern or similarity of image features. Features can be of shape based or intensity based or Texture based. Here intensity based feature is useful for classification and it gives a clear result about what kind of abnormality is found from the MRI brain images. Classification is based on the calculated values of extracted region intensity levels. This is performed by calculating the metric values of extracted regions. Based on the metric values the abnormality is found. Such as follows.

- If Metric > 0.90 then it is Benign Tumor,
- If Metric <0.90 and > 0.75 then it is Malignant Tumor,
- If Metric <0.75 and > 0.30 then it is Hydrocephalus,
- If Metric < 0.30 Then it is Hemorrhage (Stroke).

Metric calculation of all the abnormality slices of particular patient must be done prior to the decision making .the range of metric of majority of the slices must be considered for decision making process. Various classification techniques can be used for classification of abnormality, here we can use PDA (Principal Component Analysis) or LDA (Linear Discriminant Analysis) or SVM (Support Vector Machine) techniques to classify the abnormality and are very suitable for intensity based classifications.

CONCLUSION

The algorithm for region growing segmentation technique is developed and we got abnormality results of brain tumor and blood clot regions from MRI brain images. It gives clear intensity features to calculate metric values for the corresponding abnormalities. It is very useful to extract and classify abnormality based on various image features. Classification of abnormality is a big part in MRI brain image diagnosis system. Here, intensity metric values are calculated from the extracted region and according to the metric values the abnormality is classified. Multiple region growing segmentation is the future development process for this work.

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