Preprocessing of Brain Magnetic Resonance Images

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ABSTRACT: This paper describes the preprocessing techniques towards brain MR Image segmentation. Preprocessing is an important step in enabling accurate measurement of brain structures. Due to large amount of noise and non brain region, the accuracy cannot be correctly obtained. Hence the preprocessing techniques are used, the image intensities are firstly standardized using the pixel histograms and Morphological operations are applied to eliminate the non-brain regions or tissue, skull, scalp, dura from brain. The experimental result shows accuracy structure of Brain MR Images.

KEYWORDS: Image processing, Magnetic resonance images (MRI), Preprocessing, and Standardization.

I. INTRODUCTION

Brain is an important organ of a human body. Mainly it consists of following four parts-Gray matter (GM) white matter (WM), cerebrospinal fluid (CSF) and background. Thus, any input brain image is divided into these four classes [3]. MR imaging was widely applied in biological research, medical field and diagnostics, primarily because of its excellent soft tissue contrast, non-invasive character, high spatial resolution and easy slice selection at any orientation. MRI scan is diagnostic test of choice for brain cancer. Electromagnetic energy produces detailed computer images of the brain from different angles. It can detect edema (swelling of brain tissue) and hemorrhage (bleeding). Use magnetic fields and a computer to obtain an image of the brain. This test produces more detailed images than CT scan, especially when tumors are located near bony structures. Doctor use computer guidance to exactly locate and remove the tumor. A head frame, to which a MRI scanner is attached, is attached to the patient's skull, and with the aid of the computer imaging, the radiologist is able to pinpoint the tumor.

MRI is a way of creating pictures of your body that does not use X-rays or radiation. The MRI machine makes pictures by organizing and collecting the magnetic fields that naturally occur within the body. MRI pictures show the soft tissues of the body (muscles, nerves, brain, discs, ligaments etc). In many situations MRI offers unique information to help your doctor better plan your treatment and care. MRI is a highly successful diagnostic imaging modality, largely due to its ability to derive contrast from a number of physical parameters. MRI is an imaging technique used primarily in medical setting to produce high quality images of the inside of the human body. MRI, or Nuclear magnetic resonance imaging (NMRI), is primarily a medical imaging technique most commonly used in radiology to visualize the structure and function of the body. It provides detailed images of the body in any plane. MRI provides much greater contrast between the different soft tissues of the body than computed tomography (CT) does, making it especially useful in neurological (brain), musculoskeletal, cardiovascular, and cancer imaging. MRI is the state-of-the-art medical imaging technology which allows cross sectional view of the body with unprecedented tissue contrast. MRI plays an important role in assessing pathological conditions of the ankle, foot and brain. It has rapidly evolved into an accepted modality for medical imaging of disease processes in the musculoskeletal system, especially brain due to the use of non-ionizing radiation. The images produced by an MRI scanner are best described as slices through the brain. MRI has the added advantage of being able to produce images which slice through the brain in both horizontal and vertical planes [5, 6, 7, and 8]. MRI is a diagnostic imaging technique used for the early detection of abnormal changes in tissues and organs in the body [2]. It possesses good contrast resolution for different tissues. Since the brain is the most

complex organ in human body, segmentation of brain MR images is an important method for facilitating image-based diagnosis, especially the when we are doing analysis of brain tumors. Medical images always contain considerable uncertainty and noise, and can lead to difficulties with segmentation. A major problem with MRI is that the signal intensities do not have a fixed value, even in the same body region of the same patient using the same scanner [4]. This indicates that the same tissue type may have different scales of signal intensity in the different images. Therefore, standardization procedure using the pixel intensity histogram is applied, to ensure the signal intensities of different tissues are uniform. Since our major interest is the human brain, non-brain regions including the skull, meninges etc, which are not required, may influence the segmentation results. Morphological analysis was use to remove non-brain regions before any traditional segmentation techniques.

II. LETRATURE REVIEW

The image segmentation is a challenging task that has received an enormous amount of attention by many researchers. In the recent years there has been a fair amount of research on. Jaya et al [1] proposed tracking algorithms for de-noising of MR images. They focus on application of preprocessing techniques towards segmenting and labeling the brain images. Shan shen et al [2], present a preprocessing and segmenting procedure to deal with brain MR images. Mona Choubey et al [3], proposed algorithm shows method for segmentation of the brain tumor in Brainy MRI in different types of image types. In his paper MRI images are taken as input and that are processed by using modified random walk method. L.G.Nyul et al [4], described a method for standardizing MR image intensity scale. Bhandarkar, S.M. et al [6], explored a comparative study of three methods of automated medical image segmentation which can be used to find brain tumor in MR Images. Gonzales & Woods [9] defined different mathematical morphological operations .During preprocessing, the MR image intensities are standardized using pixel histograms. Morphological operations are used to remove skull or tissue or non brain regions. Future work will involve an assessment of performance evaluation of different segmentation techniques on MR images. During different segmentation techniques brain tissue are segmented.

III. IMAGE PREPROCESSING

A. STANDARDIZING INTENSITY SCALES OF MRL

Due to the use of non-standard signal intensities in MRI, the intensities in different images cannot be compared, which restricts the usefulness of the method. Therefore, a standardizing step is required, for the usefulness of meaningful intensities. The images were employed: simulated brain images downloaded from Brainweb. [14] (*http://www.bic.mni.mcgill.ca/brainweb*).

A simulated -weighted MR (181X 217X 181) image was downloaded from Brainweb.
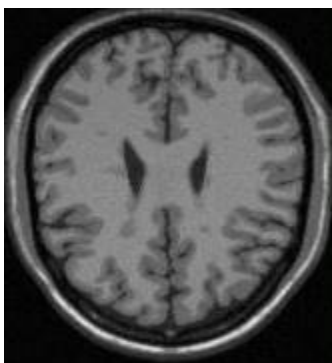 Fig 1 shows Brain MRI. Fig. 2 (a) shows a histogram of above a MR image.
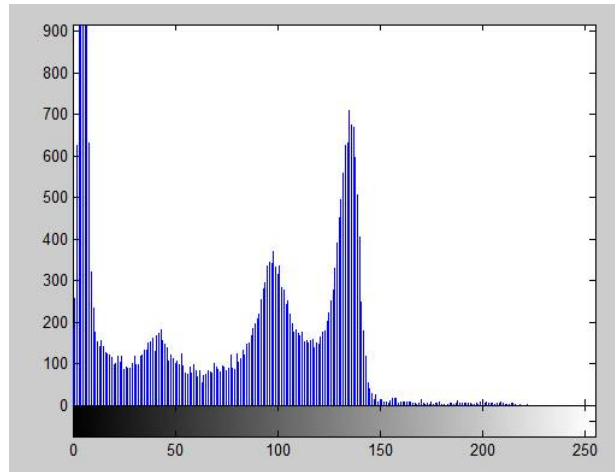

Fig. 1. Brain MRI

Fig. 2. Histogram of Brain MRI.

Histogram represents the number of pixels i.e background pixel and foreground pixel. The background pixels must be cut or ignore from the standardization, because they cannot be useful in standardization generally, the background pixel is approximately 5% of the maximum intensity of the image. May be foreground can be larger or smaller. To improve accuracy, this percentage needs to be adjusted interactively. We are eliminating background peak or pixel.

In this paper we adjust percentage of signal intensities of images near about 5 to 10%. If images having less than 100 intensity values then it set to 0 & all other keep remain.

We calculate the mean and standard deviation of the foreground signal intensities of MR image.

The standard deviation is defined as-

$$\sigma = \frac{\sqrt{\sum_{i=1}^{N} (x_i - \mu)^2}}{N} \qquad \text{eq. (1)}$$

Where x_i (i=1 . . . N) is the pixel signal intensity, p is the mean of signal intensities of the image, and N is the number of foreground pixels [12, 13]. For standardized signal intensities having zero mean and a standard deviation of unity, eq. (1) can be transformed as,

$$1 = \frac{\sqrt{\sum_{i=1}^{N} \frac{(x_i - \mu)^2}{\sigma}}}{N} \qquad \text{eq. (2)}$$

Applying this transformation, the intensity distribution of each image is very similar. After using this transformation it gives intensity values of image between **-1** to 1. We cannot got better displaying result of image with different tissues.

By changing the values of or adjusting the values of σ_s & μ_s for good scale result of the image so standardized signal intensities become

$$x_{si} = \frac{\sigma_s}{\sigma}(x_i - \mu) + \mu_s \qquad \text{eq. (3)}$$

In our paper we use the value of σ_s =0.02 and μ_s =0.04 for standardization of an image. After standardization process obtained image undergo morphological operation for non brain region, dura, skull removal process.

B. Non-brain Region Removal using Morphological operations

Morphological techniques probe an image with a small shape or template called structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighborhood of pixels. An essential part of the dilation and erosion operations is the structuring element used to probe the input image. A structuring element is a matrix consisting of only 0's and 1's that can have any arbitrary shape and size. The pixels with values of 1 define the neighborhood [9]. Two-dimensional, or *flat*, structuring elements are typically much smaller than the image being processed. The center pixel of the structuring element, called the origin, identifies the pixel of interest -- the pixel being processed. The pixels in the structuring element containing 1's define the neighborhood of the structuring element. These pixels are also considered in dilation or erosion processing. The most basic morphological operations are dilation and erosion. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image.

Following are basic concepts consist of

Erosion:

Morphological erosions on the image to remove small areas identified as objects that are not a part of the brain. It then performs a search for the largest 2D region within the image, which should be the brain it erases everything outside this region and then performs another morphological operation, dilating the brain image back to approximately its original size and shape before the erosion.

This is a morphological transformation that helps to peel away the boundary of connected objects. Let A be a binary image, A= [a], where a can

$$A \Theta B = \{\forall a : a \cap b \neq b \Rightarrow a = 0, otherwise \quad a=1\} \qquad - [10]$$

Erosion is used to remove noise and other small objects, collapse the weak connections between objects, and increase the size of holes within an object. It reduces the size of images by removing the 'on' pixels from the boundary of objects and increases the size of holes by removing the pixels around the perimeter of the holes.

Dilation:

This is the opposite operation to erosion. It helps to grow a layer onto the boundary of connected objects and is defined as; its function can be regarded as enlarging. It fills small holes and cracks, and thickens the connections between objects. Dilation is used to enlarge the size of regions by around the perimeter of the holes.[10,11]

$$A \oplus B = \{\forall a : a \cap b \neq \Phi \Rightarrow a = 1, otherwise \quad a=0\} \qquad - [11]$$

Create binary image by selecting threshold. In this paper we set threshold value to 0.345.By using threshold dura, skulls are separate from brain.

After obtaining the binary image, erosion operation can be performing. The structuring element of disk shape can be used for erosion consist of strel value is [4, 0].

The next step is labeling. Labeling is an operation that finds the no brain region and isolates it from other regions. The third step is dilation. Because after erosion thins down the boundary, dilation works on the labeled image to recover it. The SE of dilation is a little larger than used in erosion. The structuring element of disk shape can be used for dilation consist of strel values is [8, 0]. Hence, the dilated non-brain region is slightly larger than the corresponding one in the binary mask.

OR operation can be performed on dilated and labeled image. Result of image is multiply by grayscale image and finally we got resultant image.

IV. RESULT

Skull Stripping or removing along with image enhancement is the two important preprocessing stages in brain segmentation as well as brain tumor classification. It helps to avoid non brain region or tissue from input MR images and to enhance the quality of the image.

No doubt the preferred result can be achieved with the morphological operations of "Erosion" and "Dilation" to remove skull or non brain region.

Fig (3) shows original 100th slice of T1 weighted brain MRI. Fig (4) shows image after skull removing using the process of "Erosion" and "Dilation" and enhanced using histogram equalization.
Fig (5) shows original 80th slice of PD weighted brain MRI. Fig (6) shows image after skull removing.
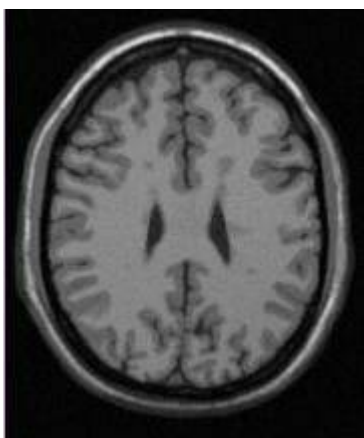

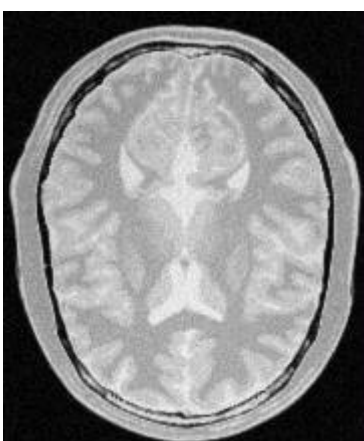**Fig.3- Input Brain MRI**

Fig.4-After removing skull

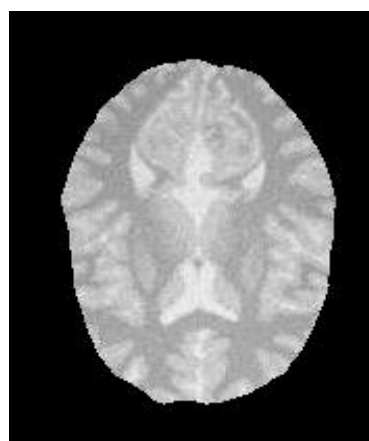**Fig.5- Input Brain MRI**

Fig.6-After removing skull

V. CONCLUSIONS

In this paper we present preprocessing process on MRI brain images. Because of noise & variances in intensity of MRI we need to remove noise & standardize signal intensity of MR images. In this paper we use the standardized mean (0.04) and standard deviation (0.08) of the signal intensities are selected because they can supply the best contrasts among different tissues in MR images. After standardize signal intensity of MR images next stage is non-brain region removal. The brain MRI includes the whole head image, but only the brain is require for further work like segmentation. The non-brain region requires to be removed before segmentation; otherwise it will affect the final

results. Morphological operations have been performed in that erosion and dilation for removing non brain region or skull from brain.

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