Segmentation of Brain Tumor from MRI Using Skull Stripping and Neural Network

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***Abstract* - Brain tumor is an alarming disease if not noticed on time. Several researchers have done their researches in this field to discover some new methods of brain tumor detection. In this paper, we present a method of brain tumor detection from MRI images. Segmentation is done by using Self-Organizing Map (SOM) and Neural network (NN). Stationary Wavelet Transform (SWT) is used to extract the features from an input image before the training process for segmentation. We proposed a new skull stripping algorithm for the purpose of effective skull stripping. We used BRAINIX medical images as a dataset for our method. The proposed method performs better than the methods discussed in the literature. It is easy to implement and robust.**

***Keywords* - Brain Tumor, Neural Network (NN), Segmentation, Self-Organizing Map (SOM), Stationary Wavelet Transform (SWT).**

I. INTRODUCTION

Image segmentation is the process of isolating an image into number of sections which are known as segments. It is used to partioned an image on the basis of region of interest (ROI). It is utilized to take out a section from an image. Segmentation of image is one of the essential and demanding steps in the digital image processing. It has also its application in the field of medical imaging and is also used to detect brain tumor from magnetic resonance images (MRI). Brain tumor detection is an application of MRI. There are so many imaging techniques which are employed to study Tumors such as Computer Tomography (CT), PET, MRI, Single photon emission computer tomography etc.

Brain tumor is a dreadful disease. A brain tumor occurs when abnormal cells forms inside the brain.Brain tumor may also referred as intracranial neoplasm. When the set of abnormal cells which starts in the brain, then the tumor take place in the brain. Brain tumor have almost 120 kinds that makes complicated treatment. There are mainly two kinds of brain tumor namely cancerous tumor and benign tumors. A number of different imaging techniques are developed to study Tumors such as Computed Tomography (CT), Positron emission tomography (PET), Magnetic Resonance Imaging (MRI), Single photon emission computer tomography etc. Currently, CT and MRI are the most widely used techniques because of their High resolution images ability. Magnetic Resonance tomography is a medical imaging technique used by radiologists to visualize the internal structure of human body in detail. MRI can create more detailed images of human body than possible with X-rays.

II. LITERATURE SURVEY

Mathew C. Clark, et al., [1] proposed an automatic tumor segmentation method depending on knowledge-based approaches. It executes impressive segmentation without human interruption and also allows assimilation of new tools into the extant system. Shiuan He, et al., [2] presented an approach for detecting brain and contours and also create calculation models for EEG (Electroencephalographm) and MEG (Magnetoencephalography). Yong Fan, et al., [3] proposed an active model method based on parallel genetic-algorithm for segmentation of brain MR images. It provides durable and sturdy segmentation. segmentation. The proposed method also expands the extant techniques. Raquel Valdes-Cristerna, et al., [5] presented a hybrid method for segmentation. The hybrid-model couples radial-basis network and active-contour model. This hybrid method provides good results. Shan Shen, et al., [6] proposed a segmentation method depending on Fuzzy C-means (FCM) using Neighborhood Attraction. By using this presented approach. Real image and simulated image have different noise level. Hassan Khotanlou, et al., [7] proposed a hybrid method using region and boundary information of the image for the purpose of tumor segmentation. Jinyoung Kim, et al., [8] presented a semi-automatic segmentation method. Moreover, a tailored new edge indicator function has also been discussed. EI-Sayed A. EI-Dahshan et al. [9] discusses the survey on several brain tumor segmentation and classification techniques for MRI and proposed a machine learning based hybrid method for computer aided detection system. Youyong Kong, et al., [10] presented a segmentation method based on information theoretic learning for supervoxel-level segmentation. Selvaraj Damodharan et al., [11] presented a segmentation method for brain tumor based on Neural Network. The Quality Rate (QR) is used to calculate the abnormal and abnormal MRI images of the brain. Ayse Demirhan, et al., [12] discussed a segmentation method that segments brain into tumor, edema, GM, WM and CSF.). Guangjun Zhao et al. [13] proposed a segmentation technique for Chinese Visible Human (CVH) brain dataset. The proposed method is based on supervised learning and also used multilayer stacked auto-encoder (SAE) for feature representation.

III. PROPOSED WORK

There are some problems in detecting brain tumor, these are: 1. Low PSNR which means signal strength is not good, hence to overcome this problem a new skull stripping algorithm has been proposed that improves the result and the PSNR also gets improved by using weiner filter. The new proposed skull stripping algorithm is applied on the image to extract the outer regions of the brain. Then segmentation algorithm is applied to segment the tumor region from the brain MRI.

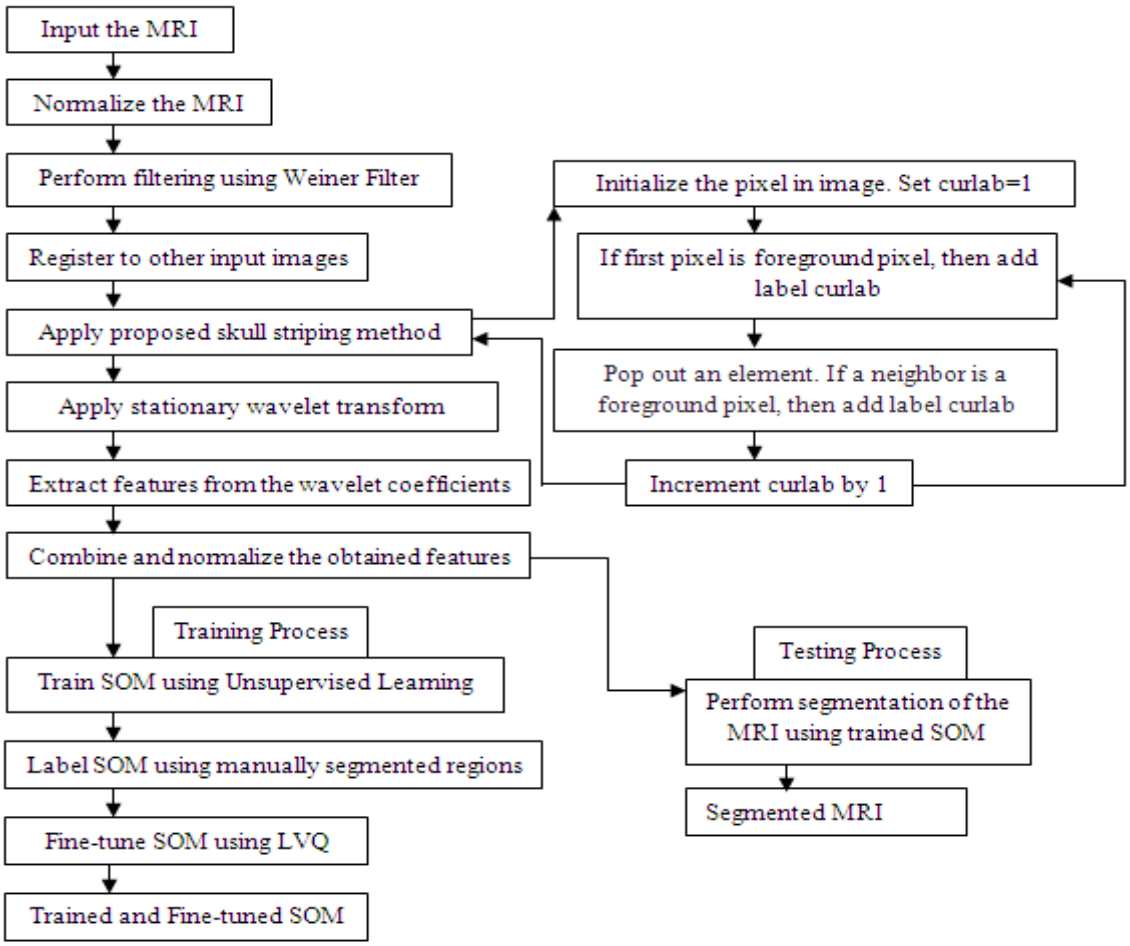

Fig. 1 Flowchart of Segmentation and Proposed Skull Stripping Algorithm

Normalization and Noise Removal

It is one of the preprocessing step in which image can be converted into normalized form. Basically, by normalization means, the process of removing the noise, distortion, illumination etc from the image. The major purpose of normalization is to get a normalized image by elimination the noises which are produces within the environment in which the image is taken.

An input image can be normalized within the intensity range of [0 1] by dividing the intensity values of the pixels by the minimum and maximum value of the range. The equation for normalization is as:

$$I_n = \frac{I}{\max(I)}$$

In this paper, Weiner filter is used to improve the PSNR value by eliminating the noise from the image. There is another filter named Anisotropic Filter is also used to remove the noise from the image but this filter is not capable to improve the PSNR ratio. In this case of anisotropic filter, PSNR ration is less. The comparison between anisotropic and weiner filter illustrates our result as shown in the graph:

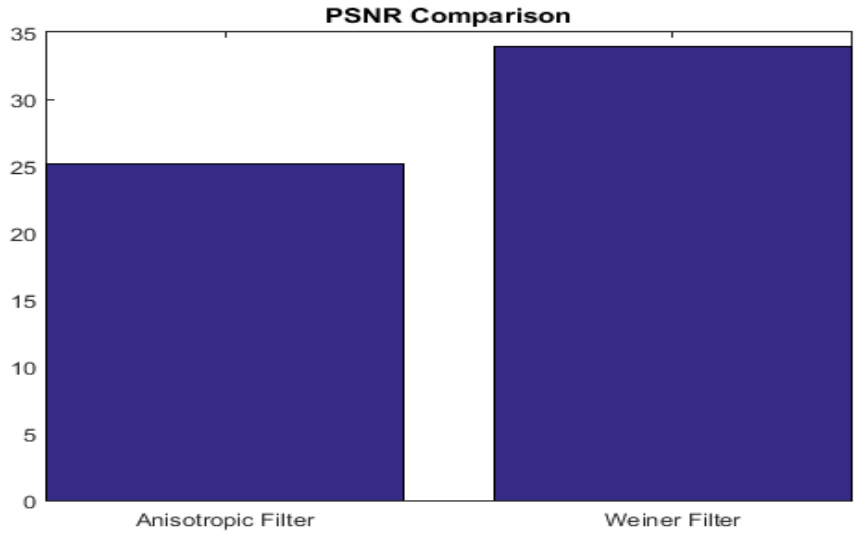

Fig. 2 Comparison between Anisotropic Filter and Weiner Filter on the basis of their PSNR

Thresholding

Thresholding is the common and significant approach for pixel based segmentation. This method is used to produce a binary image from the grayscale image. In segmentation method, let us assume a threshold value x. then for generating a binary image, the pixels of an image having intensity value less than threshold value are converted to black and the pixels having intensity value greater than threshold value are converted to white color pixels. In order to calculate the threshold value, Otsu's method has been used. This calculated threshold value is converted to binary image. It is as follows:

$$\sigma_w^2(t) = w_0(t)\sigma_0^2(t) + w_1(t)\sigma_0^2(t)$$

Find maximum value of $\sigma_w^2(t)$ where,

$$w_0(t) = \sum_{i=0}^{t-1} p(i)$$

$$w_1(t) = \sum_{i=t}^{L-1} p(i)$$

Skull Stripping

Skull stripping is one of the most significant steps during brain tumor segmentation. It eliminates skull, fat, skin and the regions of brain which are not required. Additionally some extra portion from the brain is also being removed to simplify the segmentation process. Here in this paper, we are using blob detection and labeling method for the purpose of skull striping.

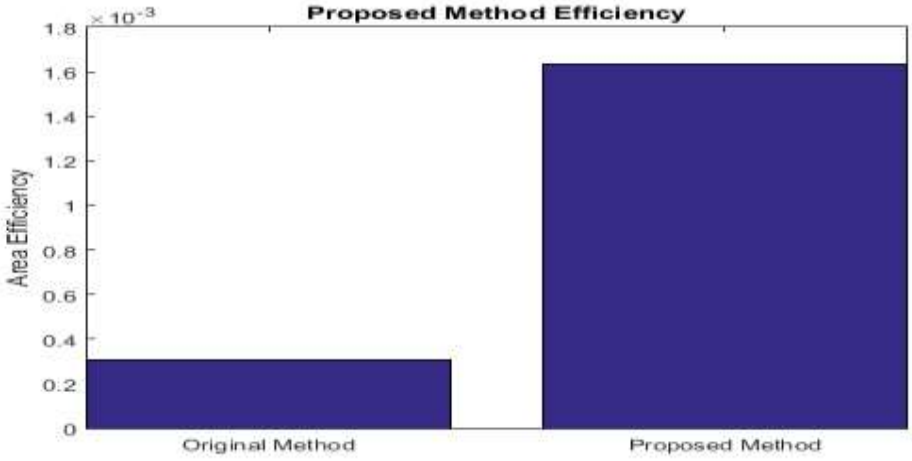

Fig. 3 Efficiency of the original and proposed method

Feature Extraction

In this step, features are extracted from the input image and wavelets are used to partition data into different frequency components. In Discrete Wavelet Transform (DWT), problem of translation-invariance occurred. But SWT overcome the problem of DWT by dismissing the up and downsamplers in the DWT. We calculated the coefficients up-to second order. And also four parameters such as energy, entropy, mean absolute deviation and standard deviation has been discussed.

Sr. No.	Feature Name
1.	Energy
2.	Entropy
3.	Mean Absolute Deviation
4.	Standard Deviation

Fig. 4: Statistical Parameters

Segmentation

Segmentation is the process of isolating an image into number of sections which are known as segments. It is used to extract the region of interest from an image. In order to detect the tumor region, self-organizing map is used. The self-organizing map is a kind of artificial neural network. It is trained using unsupervised learning and Learning Vector Quantization (LVQ) is used to fine tune the SOM network.

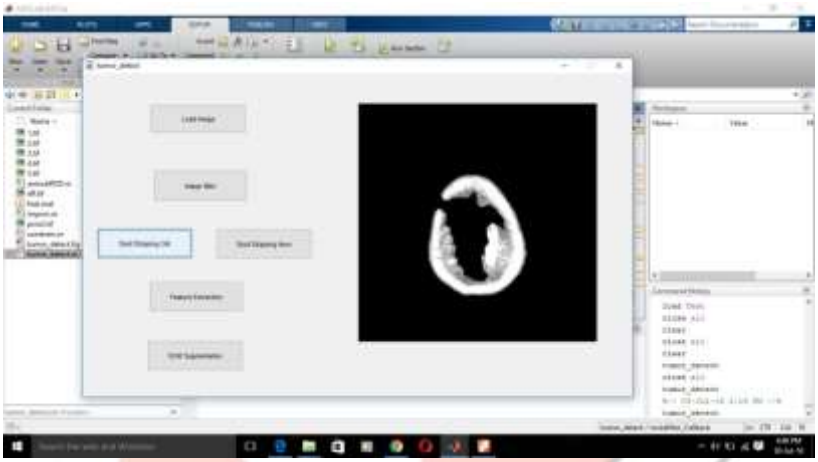

Fig 4. Skull stripping results of base method

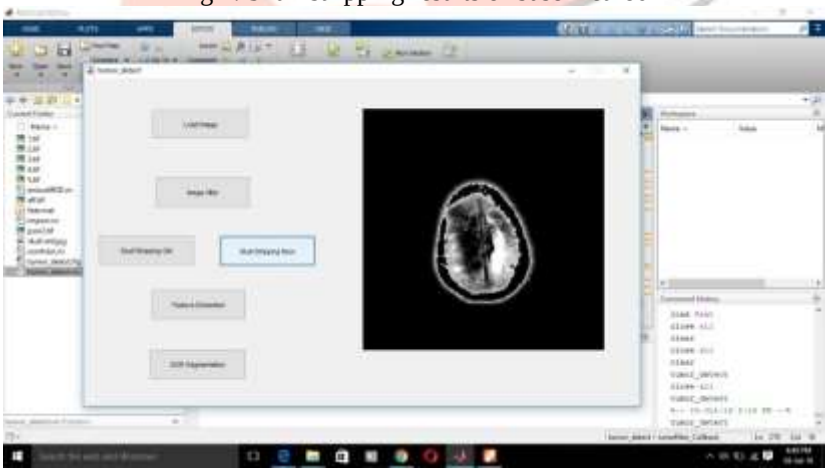

Fig 5. Skull stripping results of proposed method

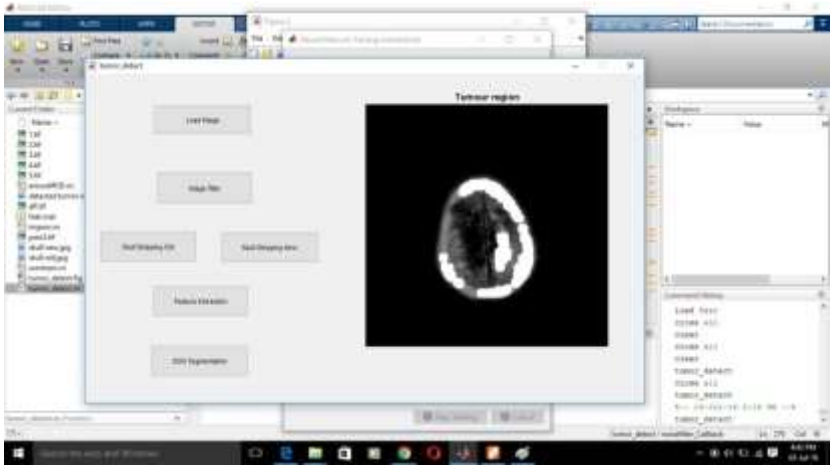

Fig 6. Segmentation results of base method

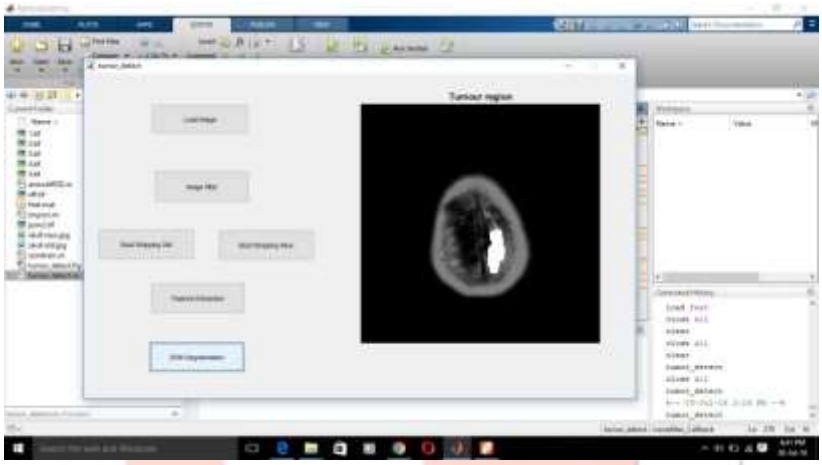

Fig 7. Segmentation results of proposed method

IV. Conclusion and Future Scope

In this paper, we proposed a brain tumor segmentation algorithm for skull stripping along with weiner noise filtering that segments the brain and skull and detects the tumor region. We used weiner filter for noise removal that improves the PSNR. We also proposed a new skull stripping algorithm based on connected component analysis and labeling method. According to the proposed skull stripping algorithm, each closed portion in an input MRI image is considered as a connected component. Then starting from the outer side, we labelled each connected component moving inward. This method effectively performs skull stripping as compared to the method of morphological operations using erosion and dilation.

We implemented our method on BRAINIX medical image dataset using MATLAB. Our method performs better than other methods as discussed in the literature. It is also concluded that weiner filter performs better than anisotropic filter. The proposed method effectively strips out the skull portion resulting in better segmentation. In future, the work is required to further improve the efficacy of the skull stripping method as there are still some traces (very less) of skull's outer region remains in the image. Though this is the outer region and does not affect much as we can see in the results, we still need to clear it out in order to get better skull stripping.

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V. References

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