Comparison of Different Filters and Segmentation Techniques for Brain Tumor Detection Using Image Processing

Amrita Naik, Saaylee Diuker, Richa Naik, Dayesh Naik Mamlekar
Professor[1], Students[2,3,4]
Don Bosco College Of Engineering, Fatorda Goa[1,2,3,4]
amritametri@gmail.com, saaylee.diuker@gmail.com, richanaik111@gmail.com, nykdoysh89@gmail.com

Abstract-Image processing algorithms and techniques find its applications in a wide number of domains. Detection of brain tumor and overall internal structure of the brain is one of the main applications in the field of medical imaging. Magnetic resonance imaging (MRI) technique is one of the many imaging modalities that are available to scan and capture the internal soft tissue structures of the body. The challenge of accurately interpreting MRI scan reports and determining whether the tumor is present or absent, motivated us to explore and work on the field of detection on brain tumor using MRI scan.

Index Terms-Brain Tumor, MRI Images, Pre-processing, Segmentation.

1. INTRODUCTION

Detection of brain tumor was conventionally done through Biopsy, Expert Detection, CT Scan etc.
Human prediction can never be always correct. An expert can sometimes make an error and hence requires another expert to provide efficient results. Detection of brain tumor from Automated Techniques provides better results than the conventional non automated techniques. We begin detection of tumor with initially pre-processing the image which involves conversion of image to gray scale, removal of noise and image enhancement. After pre-processing we segment the image followed by morphological filtering, feature extraction and finally detecting whether tumor is present or absent. In this paper we present a comparative study of the two filters that is used for removal of noise in pre-processing phase and two different segmentation techniques that is used for segmenting the image based on the property and functioning.
Filtering is the initial operation performed on any biomedical images in image pre-processing phase before any other operation is applied on it. It helps in de-noising the image and improves the quality of an medical image.
The output of pre-processing is than segmented using segmentation techniques.

2. LITERATURE SURVEY

Detection of brain tumor from MRI images starts with image enhancement process. The choice of image enhancement technique has direct impact on the final result since the image quality has great impact on the subsequent analysis. Next the enhanced image is segmented so that various features can be extracted from the image required for detecting the presence of tumor. In this literature we briefly discuss the various filtering techniques and the segmentation techniques.

2. 1 Image Pre-processing

Pre-processing techniques are used for improving the quality of the MRI image. In pre-processing the MRI image of brain is first converted to gray scale to covert the RGB components if any to black and white pixels. The main aim of pre-processing is to remove the noise from the image and enhance it. This phase provides correction in irregularities of data and removes unwanted atmospheric noise thus making the image ready for use in the next phases. The filters used for removal of noise includes median filter, Gaussian filter.

2.1.1 Median Filter

The median filter is a nonlinear digital filtering technique, often used to remove noise. In median filtering the value of output pixel is determined by the median of the neighbourhood input pixels, rather than the mean. It is widely used to preserve the edges. Median filter is able to remove the outlier without reducing the sharpness of the MRI image.

2.1.2 Gaussian Filter

A Gaussian filter is a smoothing filter, defined by the Gaussian kernel. This filter shows lower blurring effects compared to simpler averaging filter. The key point of Gaussian filter is that it not only corrects the spectral coefficients of interest, but also all the amplitude spectrum coefficients that lies within the filter window. Gaussian low-pass filters generally compute a weighted average of pixel values in the neighbourhood, in which the weights decrease with distance from the neighbourhood centre.

2.2 Segmentation

Segmentation separates region of interest from the background and from each other. Segmentation of brain tumor is the most important task of classification that is because all decisions depend on the segmented tumor. Various techniques for segmentation include Fuzzy C-means, K-means clustering, Otsu's Thresholding, etc.

2.2.1 Fuzzy C-means Clustering

Developed by Bezdek in 1981 as a result of work of Dunn, the FCM algorithm is a fuzzy reallocation algorithm, wherein the classes are represented by prototypes or centers of gravity. Its application therefore provides for each observation to classify a degree of membership between 0 and 1 to each class, thereby producing a fuzzy partition. As with most of the other partition by classification algorithms, FCM is based on minimizing a criterion in an iterative process.

The following is the algorithm for Fuzzy C-Means:

1. Set the parameters:

a : The number of class K.

b : The threshold ξ representing the convergence error.

c: The blur level m, usually taken equal to 2.

2. Initialize the centers of K classes randomly.

3. Updating the matrix U degrees of membership by

$$\mu_{ki} = \sum_{l=1}^{K} \left(\frac{\| X_i - v_k \|}{\| X_i - v_l \|} \right)^{\frac{-2}{m-1}}$$

4. Updating the vector V of cluster centers by formula

$$v_k = \frac{\sum_{i=1}^{N} \mu_{ki}^{m} X_i}{\sum_{i=1}^{N} \mu_{ki}^{m}}$$

5. Repeat steps 3 and 4 until satisfaction of stopping criterion:

$\| V^{(t)} - V^{(t+1)} \| < \xi$, t is the tth iteration.

2.2.2 Otsu's Thresholding Method

The simplest greyscale image segmentation technique to comprehend is segmentation by thresholding. A threshold is an intensity value which is used as the boundary between the two classes of a binary segmented image. One approach, proposed by Otsu in 1978[4], attempts to create a measure of "goodness" or optimality of a threshold using statistical analysis, which can be used to determine the optimal threshold for an image. The threshold which results in the best separation of classes is considered to be optimal. Class separation is described in terms of statistical analysis as either high between-class variance, low within-class variance, or a combination of both. The process requires iteratively evaluating all possible thresholds, to eventually determine the optimum. As such, discrete threshold values are required, a situation ideally suited to traditional bitmap images, in which each pixel describes a discrete intensity value.

Given an image X, made up of N pixels, (xj , j = 1, . . . , N) with intensity values from R = (1, 2, . . . , L) ⊂ Z, we say that the probability distribution of intensity value i ∈ R in X is:

$$p_i = \frac{n_i}{N}, \quad p_i \geq 0, \quad \sum_{i=1}^{L} p_i = 1$$

3. COMPARISON

Table 1. Comparison of filters

Sr no.	Filter Name	Advantage	Disadvantage
1	Median Filter	Able to remove the outlier without reducing the sharpness of the image.	Removes noise. While smoothing the edges and boundary, It erases the detail.
2.	Gaussian Filter	Removes Noise.	Reduces the detail of the image. Gives blurred output.

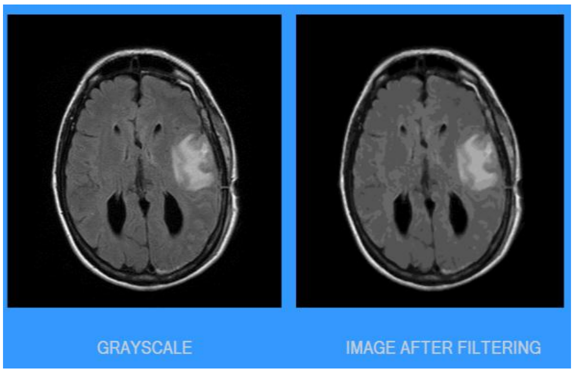

Fig 1: Image After Applying Median Filter

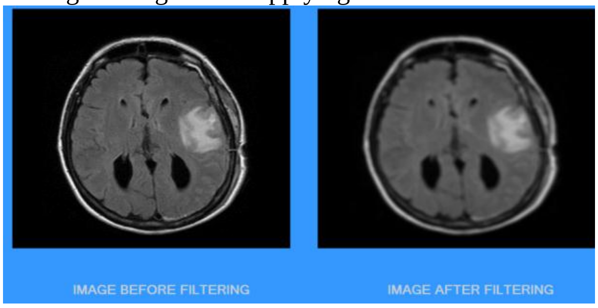

Fig 2: Image After Applying Gaussian Filter

Table 2. Comparison of segmentation techniques

Parameter	**Segmentation Techniques**	
	Fuzzy C-Means	**Otsu's Thresholding**
Output Image	Black-White	Black-White
Speed	Moderate	Fast
Accuracy	Less	Good

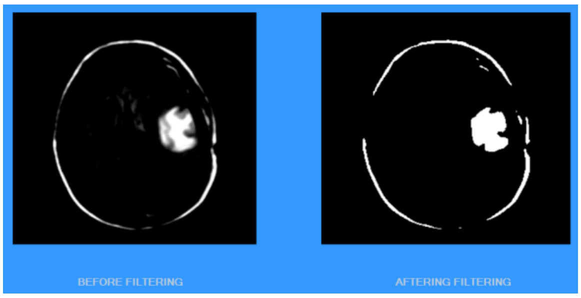

Fig 3: Image After Segmentation (Otsu's Thresholding)

4. PERFORMANCE ANALYSIS

We have trained the system using 175 images and tested against 70 images.

Table 3. Tumor and Non Tumor Detection Result

Data Sets	**Analysis Using Median Filter**	**Analysis Using Gaussian Filter**
Tumor Images	Total: 40 Detected: 24	Total: 40 Detected: 15
Non Tumor Images	Total: 30 Detected: 22	Total: 30 Detected: 17

Based on the result obtained from testing the following evaluation parameters were calculated using the number of true positives (TP), true negatives (TN), false positives (FP), false negatives (FN).

Table 4. Comparison of Median and Gaussian Filters Based on Different Evaluation Parameters

Evaluation Parameters	**Using Median Filters**	**Using Gaussian Filters**
Accuracy	60%	46%
Sensitivity	60%	37%
Specificity	73%	57%

5. CONCLUSION

In this work we have taken MRI images of brain. Two filtering techniques have been applied for enhancement of MRI images. It is observed that the Gaussian filter gives a blurred output and the image details are reduced.

The Median filter removes the noise without reducing the details of the image. Also, we can see that the accuracy is higher if we use Median Filter.

In this comparative study, segmentation techniques like Otsu's thresholding and Fuzzy C-means are described and comparison is done. These techniques are suitable for medical image application. These techniques can be used to detect brain tumor from MRI images. After analysis of these two techniques, it is observed that Otsu's Thresholding method is the best method for segmentation of the image. After analysis of these two techniques, it is observed that Otsu's Thresholding method is more accurate and gives proper output as compared to Fuzzy –c means segmentation. Also, Otsu's Thresholding method takes less time to segment the image than Fuzzy C-Means.

REFERENCES

[1] Azzeddine Riahi, D. 2015, Image Segmentation Techniques Based on Fuzzy C-Means and Otsu, Applied to the Brain MRI in Tumor Detection.

[2] Neha Jain, D S Karaulia, S.2014, A Comparative Analysis of Filters on Brain MRI Images.

[3] Pallavi Tambe, Jenitor Thomson, Neha Surti, F. 2016, Comparative Study of Segmentation Techniques for Brain Tumor Detection.

[4] Anisha, Dr J Venugopala Krishnan, C. 2015, Comparison of Various Filters for Noise Removal in MRI Brain Images.

[5] Vipin Y. Borole , Sunil S. Nimbhore , Dr. Seema S. Kawthekar 2015, Image Processing Techniques for Brain Tumor Detection: A Review.

[6] SivaSankari.S , Sindhu.M , Sangeetha.R , ShenbagaRajan.A 2014, Feature Extraction of Brain Tumor Using MRI.

[7] Ed-Edily Mohd. Azhari , Muhd. Mudzakkir Mohd. Hatta , Zaw Zaw Htike and Shoon Lei Win 2014, Tumor Detection In Medical Imaging: A Survey.

[8] Kishore Gunna 2016, Implementation and Comparison of Different Segmentation Techniques for Medical Images.

[9] Prof. Vrushali Borase. Prof. Gayatri Naik. Prof. Vaishali Londhe 2017, Brain MR Image Segmentation for Tumor Detection using Artificial Neural.