Improving Image Segmentation by DFS Algorithm

G. Hemalatha, S. Mary Vennila

Abstract: Medical imagining has proven to be a significant field for examining human tissues non-intrusively. One of the subset of Imaging is the Image segmentation where in an image is split into significant regions which being later used for classification and performing analysis. This process is quiet complex as it involves accurately detecting and removing the affected part of the image containing abnormal tissues which are later being used for analysis. Image segmentation employs numerous techniques and approaches. Though there exist several methods and techniques for image segmentation but all of them can't be implemented on medical images. The existing paper put forwards a complete survey and review concerning the medical image segmentation models, techniques, algorithms along with the challenges faced with the involvement of contrast filtering and large scale image processing perspectives. The technique of Discrete Feature Segmentation (DFS) is adopted for extracting the attributes related to a medical image. For improvising the contrast of an image, the popular method of Histogram equalization is utilized that basically enlarges the dynamic range of intensity. A method is recommended for defining the parameters of the Contrast-Limited Adaptive Histogram Equalization (CLAHE) by utilizing entropy of image. The CLAHE method that projects intensity levels concerning the medical images is backed up by evidence from detection trials and anecdotal evidence. For classifying the diseases in medical image, the prime emphasis is on the FCM (Fuzzy C-Means (FCM) algorithm. Present research paper compares various techniques of image enhancement considering their quality parameters (PSNR, Mean, MSE, Entropy, SN, Variance and RMS).

Keywords: Medical Image Segmentation; Fuzzy C-Means; Histogram Equalization; Graphics Processing Unit; Discrete Wavelet Transform.

I. INTRODUCTION

In recent years Computer aided medical treatment has turned out be more effective and lifesaving in diagnosing a patient. With the help of visualization techniques will the doctors can obtain an improvised and precise understanding with reduced overheads. Since a doctor confronts various challenges from decision making to successful operations, medical imaging can possibly a life savior approach. It assures to be essential in reducing the overheads of the doctor's throughout the world. With the popularity and development of medical imaging, the Clinicians need to be vigilant and comprehend the patient's problems precisely.

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This being quiet relevant in the domain of medical imaging, the accompanying diagnosis and medical treatment. The visualization system being employed must be well-defined yielding in quality imaging to carry out the operations as per required. [1].

The process of Image segmentation involves dividing an image into various regions. Basically the idea being to pay attention on a specific region based semantic object rather than taking into account the entire image in one go. Hence the image segmentation targets to detect those regions that exhibit significant parts of the object, making the analysis much easier [2]. However the image segmentation output gets impacted by multiple issues like intensity in homogeneity of images, texture, spatial characteristics of image continuity, image content and closeness in gray level of various soft tissues. The present paper proposes the algorithm of DFS (Discrete Feature Segmentation) to resolve the above mentioned issues. It performs the segmenting and feature extraction process composes in a single process.

Generally, it's a tedious task, since there occurs difficulty in accurately detecting and extracting the region of the image affected by abnormal tissues, which being required for subsequent diagnosis and analysis. Yet another process is the Gray-Level Image which being the initial step in comparative analysis and responsible for eliminating noise from the medical images. The result being a gray-level image since there is reduction of noise in the image. Thereafter the medical image undergoes the filtering process wherein the Median filter is applied to medical image. Using this filter every pixel's intensity is made the average intensity of it and its direct neighbors'. Then comes the pre-processing of image where there is complete removal of noise that results in a clear image. This is a tedious task, since there occurs difficulty in accurately detecting and extracting the region of the image affected by abnormal tissues, which being required for subsequent diagnosis and analysis.. Then come to the process of Feature Extraction and segmentation by utilizing DFS. The technique of Discrete Feature Segmentation (DFS) is adopted for extracting the attributes related to a medical image. For improvising the contrast of an image, the popular method of Histogram equalization is utilized that basically enlarges the dynamic range of intensity. A method is recommended for defining the parameters of the Contrast-Limited Adaptive Histogram Equalization (CLAHE) by utilizing entropy of image. The CLAHE method that projects intensity levels concerning the medical images is backed up by evidence from detection trials and anecdotal evidence. The present paper recommends a high speed parallel FCM (fuzzy c-means algorithm) to enhance the functionality of FCM (fuzzy c-mean) algorithm. The algorithm recommended has the benefits of both the sequential FCM and parallel FCM.

In case of large image size the algorithm performs very quickly with minimum execution time. Also they can work with minimum processing speed with least need for accessing secondary storage.

The FCM algorithm reduces the computation cost and enhances the performance by searching a better group of initial cluster centers rather than random ones. Special region based features are being obtained which tends to be quiet effective. Dataset are formed by utilizing these features. Fuzzy c-mean is adopted for similarity matching. The existing paper reviews multiple research works presented to confront the issues at every level of Medical image disease detection and verification. Present research paper compares various techniques of image enhancement considering their quality parameters (PSNR, Mean, MSE, Entropy, SN, Variance and RMS).

II.   RELATED WORK

There exist several segmentation methods that are executed on huge medical datasets which results in increased computational cost. Image segmentation, obtained prior to the operation as well as in the course of the operation must be quick and precise so that it can be significant in clinical setting. Moreover, the quantity of data pertaining to any patient gradually increases (Scholl et al., 2010) [3], hence it's all the more necessary that the segmentation algorithms must be prompt.

Paresh Chandra Barman et.al [4] proposes a new medical diagnosis methodology concerning image segmentation. A new variant of set algorithm is employed with no re-initialization. It makes use of simple finite difference scheme for implementation. For eliminating any noise from the image, thresholding and erosion methods are imbibed. Using this system the initial curve can be depicted anywhere across the image along with the automatic and quick detection of the interior contours (such as tumors).

H.S. Prasantha et.al [5] elaborates numerous image segmentation algorithms. The results are being compared and verified as to which segmentation technique is superior for certain format. The major two components i.e., Correctness and stability are significant for implementing segmentation algorithm across a larger object detection system. Ajala Funmilola A. et.al [6] discusses various methods adopted for medical image segmentation, this includes: Thresholding, Clustering, Classifier, Growing, Region, Markov Random Model, Deformable Model etc...The work is primarily centered on clustering methods, particularly the k-means and fuzzy c-means clustering algorithms. These algorithms are being merged to build a new method termed as the fuzzy k-c-means clustering algorithm, resulting in improvised time utilization. The algorithms are applied and verified with MRI images associated with human brain. The outcome is examined and recorded.

S. Murugavalli et.al [7] employs a neuro-fuzzy segmentation process of the MRI data to identify several tissues such as GM, WM, CSF and tumor. The process of neuro fuzzy based segmentation is employed for identifying brain tumor. The performance of the image is reviewed taking in account the execution time, weight vector and identified tumor pixels. Thereafter the output is compared with the ones that already available ones. A greater value of detected tumor pixels is obtained with the proposed approach in contrast to the rest of the segmentation techniques. Using additional input features weight vector value is obtained for the neuro fuzzy i.e. (6×6). Also by adopting various distance classifier methods, no: of tumor cells and execution time involved is being analyzed for weight vector value. The variation in tumor's growth rate concerning the same patient is examined too. For examining the tumor, a Fuzzy kohonen neural network for medical image segmentation [8] is employed by extracting various attributes like entropy, area, means and standard deviation. Based on these features a tumor can be described. A combination of thresholding and fuzzy rule based segmentation technique[9] is proposed for examining the MRI brain images. These are quick methods (utilizing thresholding as a pre-segmentation) in contrast to Fuzzy c-mean and Neural Networks based approaches. In addition it provides a rule-based interface that blends rules relying upon the humans experience and rules comprehended from the measured numerical data. The proposed method's results are compared with the FCM algorithm on brain MRI dataset, for the purpose of brain tumor image segmentation. Rupali Patil (2016) et al., proposes a method involving segmentation and classification. Segmentation is carried out by utilizing k-means clustering. Once the segmented image is obtained, the desired region is extracted and image features namely color and shape are recognized. Color feature aids in simplifying the identification and extraction of the object. The recommended system is quick, flexible and simple to adopt [10].

Vipra Sharma (2016) et al., proposes to identify the disease by considering the nails features like color and texture and comparing the values with the already specified values of a healthy nail. Image segmentation is employed for extracting the nail color and texture and thereafter examining the segmented region to determine if the body is in a healthy state or not [11].

S. Murugavalli et. al [12] proposes a high speed parallel FCM (fuzzy c-means) algorithm to enhance the functionality of FCM algorithm. Concerning the segmentation techniques for clustering process, the algorithm proposed has the benefits of both the sequential FCM and parallel FCM. In case of large image size the algorithm performs very quickly with minimum execution time. Also they can work with minimum processing speed with least need for accessing secondary storage. The FCM algorithm reduces the computation cost and enhances the performance by searching a better group of initial cluster centers rather than random ones.

Shi Juan He et.al [13] illustrates an MRI brain image segmentation algorithm that involves two steps. First is the histogram-based FCM method and second is the multi-scale connectivity-restrained clustering algorithm that segments the brain image in 3 main classes i.e., GM, WM and CSF.

Initially, the histogram based FCM algorithm is employed to segment the images. The segmented output is then refined using connectivity restrained clustering. Though the method is a bit complex but the output achieved is satisfactory.

III. PROPOSED WORK

The paper proposes the DFS and FCM algorithm for tissue identification via medical Images. For tissue identification multiple processes are being implemented on medical image such as preprocessing, segmentation, future image. At first, pre-processing is carried out to obtain Gray-Level Image which basically removes noise from the medical image, next the filtering process utilizes median filter which aims to deliver a clear image by making use of the ROI. Then for enhanced segmentation, the DFS algorithm is recommended. Eventually, the FCM classification technique is adopted considering various quality parameters for improvised classification (PSNR, Mean, MSE, Entropy, SN, Variance and RMS).
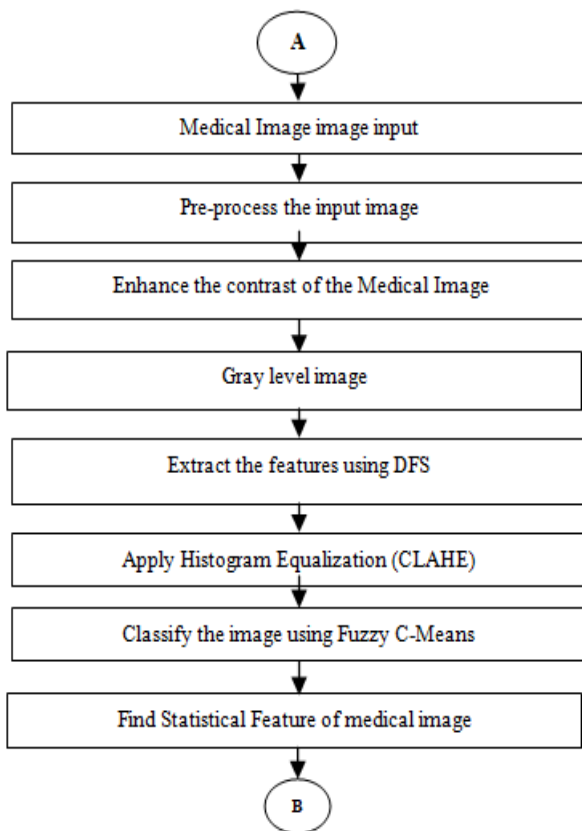
1. Pre-processing

The pre-processing works on the medical image acquired from the datasets. The paper examines the pre-processing for dividing the medical image thereby recognizing the clear medical image. Pre-processing reappearance splits the given image into significant sections that defines structures in the MRI, like bigger continuous bright and dark patches of same intensity. By smoothing the image in pre-processing minimizes the amount of unnecessary parts.

2. Contrast Filtering

The process of contrast filtering is being implemented for normalization that implies for color formatting techniques for clearly recognizing the medical image disease. Gray scale imaging is also referred to as 'black and white', which actually is misnomer i.e., true black and white, usually termed as halftone, with the only potential shades of pure black and pure white. To achieve the gray shading in a halftone image the images must be considered as a grid of black dots on white background (or vice versa) and the individual dot sizes decides the visible lightness of the gray in their neighborhood. The lightness of the gray is directly proportional to the number signifying the brightness levels of the colors.

Basically, with Contrast filter the gray scale images are sharpened which helps in retrieving minute details of the highlighted image. Moreover, it's utilized for edge detection too. The filters sharpen the images by generating a high contrast overlay that stress on the edge in the image. Hence the improvised image is the outcome of combination of actual image and the scaled version of the line structure and edges in the image. Contrast filter maintains the frequency details pertaining to the image. Edges define boundaries which of basic significance in image processing. Edges in images are basically regions with bold intensity, leaping in intensity from one pixel to the other. Edge detecting remarkably minimizes the amount of data thereby filtering unnecessary details, at the same time conserving the necessary structural properties of the image.

3. Gray-Level Image

Gray-level imaging can be jointly termed as the variations in shades of gray. Medical image disease undergoes pre-processing that results in a gray scale image by eliminating noisy data from the available input image. Basically noise removal indicates eliminating unnecessary objects/data linked to the concerned image. Gray-level image techniques are a popular image technique yielding in clear image using ROI.

4. Discrete Feature Segmentation

Edge detection which is an image processing technique is employed for identifying an object's boundaries in a given image. Basically it identifies the discontinuity in brightness. This technique is adopted for image segmentation and data extraction concerning fields like image processing, machine vision and computer vision. Object boundaries from the given MRI images can be detected using Edge detection techniques. In recent years the technique of Image segmentation has achieved immense popularity because of its varied applications in the domains of computer vision and medical imaging. The process of segmentation divides the given image into various parts such that one among them is of significant interest. This type of region is termed as RoI (Region of Interest) and being essential concerning numerous medical imaging problems. For enhancing the performance of such techniques, it's proposed to leverage the power of GPU (Graphics Processing Unit).

By utilizing RoI (Region of Interest) precise attributes can be extracted from the oral disease image yielding in increased classification accuracy. Preprocessing aims to retrieve the disease affected area accurately for feature effective extraction. Additionally, feature extraction eliminates variations affected because of rotation and translation. The statistical features are computed for every cancer affected area (sub bands) thereafter computing energies to minimize the no: of coefficients.

Discrete Feature Segmentation

Step 1: Filtered image

Step 2: concern mask *Dx,Dy* to the filtered image

Step 3: concern edge detection method and the gradient

Step 4: Masks operation of *Dx,Dy* independently on the filtered image

Step 5: Results united to find the absolute gradient magnitude

$|D| = \sqrt{(Dx^2 + Dy^2)}$

Step 6: absolute magnitude is the output edges

Step 7: Load Segmented Image File ();

Step 8: Initialize Input matrix ();

Step 9: Convolution by scaling vector ();

Step 10: Down sample by_2 ();

/*Thresholding */

Step 11: Initialize threshold value ();

Step 12: compute dead value ();

Step 13: Perform thresholding on the transform

Step 14: Matrix ();

Step 15: Up sample by_2 ();

Step 16: Convolution by wavelet vectors ();

5. Histogram Equalization

This method is adopted for enhancing the global contrast of various images, particularly if the required image data is depicted by close contrast values. With this amendment, the intensities can be distributed effectively on the histogram. Regions of lower local contrast can acquire a higher contrast. This is achieved by the Histogram equalization through efficiently distributing the most recurring intensity values. Images having both the backgrounds and foregrounds as dark or bright can benefit from this method. It gives enhanced view of bone structure concerning x-ray images and improved detailing of the photographs that are wither over or under-exposed. Histogram equalization can be considered as a spatial domain method that yields resultant image with even distribution of pixel intensity which implies that the histogram of the output image is flattened and stretched in a systematic manner [14]. This technique typically works for image enhancement models as it's easy and comparatively better than rest of the traditional approaches. In situations where gray scale distribution is intensely localized, it's not desirable to convert low contrast images using this approach. In such circumstances, aligning the curve involves segments with high slopes of two gray scale can be mapped to considerably to different grayscales. Histogram Equalization can solve the above issue by restricting the contrast by utilizing the CLAHE - Contrast

Limited Adaptive Histogram Equalization technique [15]. The paper focuses on precise output, such a degree of brightness preservation is insufficient to discard annoying artifacts. It's clearly revealed that increased level of brightness preservation is essential for the images for preventing unlikely artifacts, hence occurs the need of Enhanced Histogram (CLAHE).

6. Disadvantages

➤ It may result in increased noise since this technique amplifies the noise.
➤ It's not successful in reducing the brightness according to the input image.
➤ Increased level of brightness preservation isn't feasible to discard unnecessary artifacts.

7. Statistical Feature

Peak Signal to Noise Ratio: The PSNR-peak signal to noise ratio denotes the ratio amidst maximum possible power and corrupting noise that impacts the image representation. PSNR is denoted as a decibel scale and is generally utilized as a measure of quality reconstruction of image. The signal represents the actual/original data and the noise denotes the error introduced. Higher the PSNR value, higher is the image quality.

Mean Square Error: MSE (Mean square error) is assessed to measure the difference amidst estimated values and the true quality being certificated. It denotes a risk function resembling the expected value of squared error.

Entropy: Entropy yields in measure of image complexity and this complex texture increases the entropy.

Mean: Represents the average value of image intensity.

Standard Deviation: It signifies the square root of the variance. SD is the approximate of the mean μ square deviation of gray pixel value from its mean value.

Variance: variance is the square root of SD (standard deviation).

Root Mean Square (Rms): The Root mean square calculates the RMS value related to each row or column of the input, with vectors of a defined dimension of the input, or even the whole input.

8. Evaluation metrics

To evaluate the performance and measure of system stability some parameters are calculated and analyzed. Some of them are mentioned here. The proposed approach performance is evaluated with Root Mean Square Error (RMSE), recall, precision, F-score, probability of the misclassification error (PME) and accuracy of the training set, testing set and overall performance was analyzed by using the equations (1-6) respectively where Yi is actual and Ri is the result of the ith diagnosis of skin cancer disease attribute obtained, True Negative (TN) is the prediction for the patients without skin cancer disease that were found to have no skin cancer disease,

False Negative (FN) is the prediction for the patients without skin cancer disease that were found to have a skin cancer heart disease, the True Positive (TP) is the prediction for the patients with a skin cancer disease that were found to have a skin cancer disease, and the False Positive (FP) is the prediction for the patients with a skin cancer disease that were found to have no skin cancer disease.

- ➤ True Positive (TP): If the instance is positive and it is classified as positive
- ➤ False Negative (FN): If the instance is positive but it is classified as negative
- ➤ True Negative (TN): If the instance is negative and it is classified as negative
- ➤ False Positive (FP): If the instance is negative but it is classified as positive

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(Y_i - R_i)^2} \qquad (1)$$

$$Recall = \frac{TN}{TN + FP} \qquad (2)$$

$$Precision = \frac{TP}{TP + FP} \qquad (3)$$

$$F - score = 2 * \frac{Recall * Precision}{Recall + Precision} \qquad (4)$$

$$PME = \frac{FP + FN}{TN + FP + TN + FN} \qquad (5)$$

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} \qquad (6)$$

IV. RESULT AND DISCUSSION

Medical image segmentation and classification by making use of DFS and FCM techniques assures enhanced output compared to rest segmentation and classification approaches. Specifically, DFS method yields superior outcome than Thresholding and Watershed segmenting methods. Raw medical input data is provided and verified using the combination of DFS and FCM. The output achieved offers precise tissue identification on medical image. Figure 2: presents the comparison results of existing and recommended techniques, it's revealed that the proposed technique yields better output.
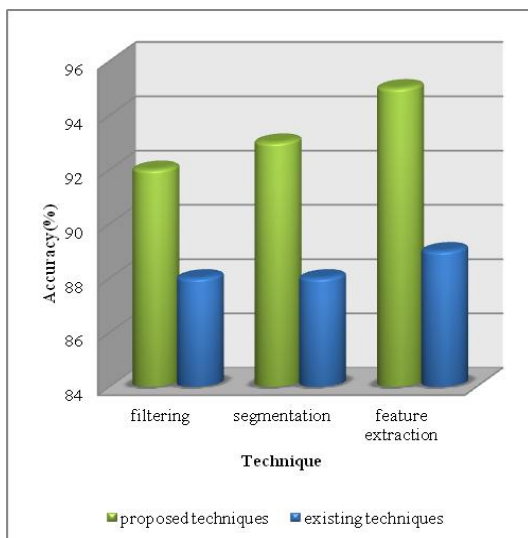

Figure 2: Performance of Proposed Techniques.

Image segmentation has a promising future since it's considered as the universal segmentation set of rule and has transformed the importance of modern research. Among various existing techniques for segmentation process, the paper proposes DFS method concerning medical image segmentation. Segmentation performance results are compared amidst DFS and Watershed and Thresholding methods.

Table 1: Comparison Techniques with DFS

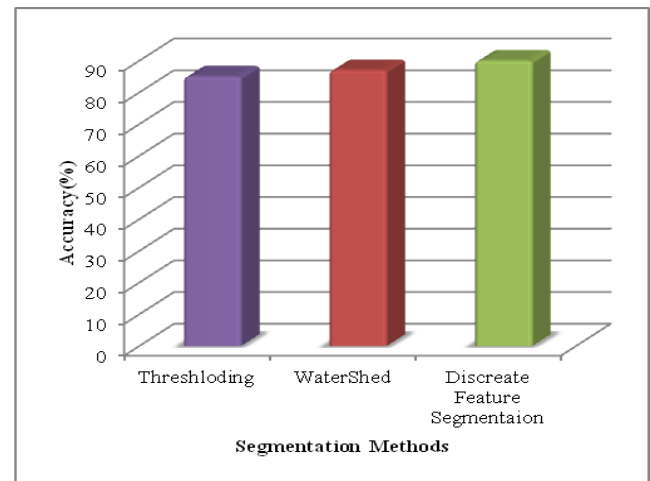| S.No	Techniques	Accuracy (%)	Efficiency (%)
1	Thresholding	81	88
2	watershed	86	90
3	DFS	89	92

Figure 3: Segmentation Performance of Proposed Techniques.

Figure 3 and Table 1, presents output of proposed DFS technique in comparison with Thresholding and Watershed methods. DFS yields greater accuracy than the other methods. For simulation, the datasets are assembled from BENCHMARK datasets and MATLAB is deployed for the development process. MS-Access is used for managing the entire dataset along with storage of results obtained which is given Figure.4
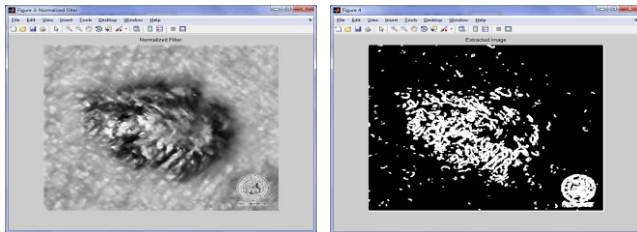
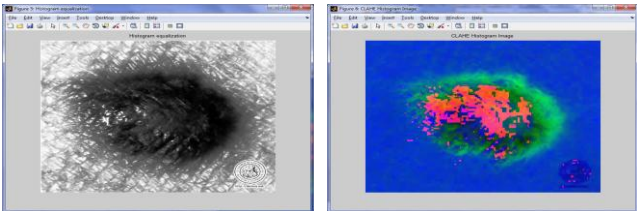**Figure 4: Skin Cancer Detection Process**
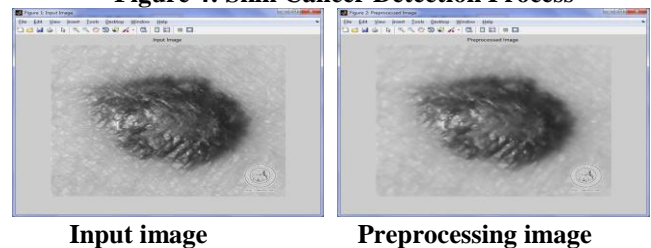
Input image   **Preprocessing image**
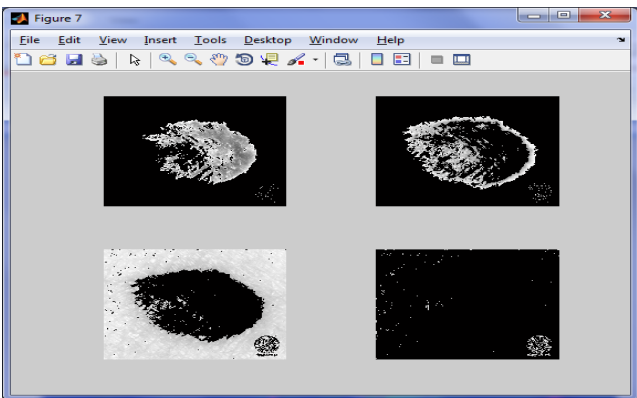
Improving Image Segmentation by DFS Algorithm

Filtering image

Extracted image

Histogram Equalization

CLAHE Histogram image

Classify affected disease areas

V. CONCLUSION

In the current research work numerous medical images are examined relying upon the combination of DFS and FCM methods. Pre-processing and contrast filtering methods are implemented for noise removal from input image and enhancing the quality of the image quality for further use. Both the processes are of utmost consideration as medical image distortion will further affect analysis process such as segmentation and classification. For achieving best quality segmentation, DFS method is employed. For analyzing the performance result of the proposed method, raw input medical image is being considered thereafter comparing the output with rest of the existing segmentation methods. CLAHE is being employed for assigning displayed intensity levels in medical images which enhances contrast level of input image. Eventually, for the identification of tissue on input medical image the FCM classification method is employed. It offers four types of classification output yielding in better accuracy of classification process.

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