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A STATE OF ART HIERARCHICAL CLUSTERING METHOD FOR SEGMENTATION OF BRAIN TUMOR IN MRI IMAGES

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ABSTRACT – Magnetic Resonance Imaging (MRI) is widely used to identify tumors from brain region. The process of differentiating tumor area from the brain is termed as segmentation. The segmentation process is the extraction of tumor tissues such as active, tumor, necrosis, and edema from the normal brain tissues such as white matter (WM), gray matter (GM), as well as cerebrospinal fluid (CSF). There are a number of segmentation techniques but the segmentation process is sensitive to noise. In the proposed method, the noise in MRI image is reduced using a non-linear digital median filter. The resultant image is enhanced using a combination of Discrete Wavelet Transform (DWT) and Stationary Wavelet Transform (SWT) boosted with bicubic interpolation. The tumor area is segmented using multi-level clustering techniques.

Keywords –Segmentation, DWT, SWT, FCM, K-means, and Binarization

I.INTRODUCTION

In medical diagnosis, the early detection and recognition of brain tumors accurately are very vital.This study addresses the problems of segmentation of abnormal brain tissues and normal tissues such as GM, WM, and CSF from MR images using denoising techniques and multi-level clustering. The tumor is basically an uncontrolled growth of cancerous cells in any part of the body, whereas a brain tumor is an uncontrolled growth of cancerous cells in the brain. A brain tumor can be benign or malignant. The benign brain tumor has a uniformity in structure and does not contain active (cancer) cells, whereas malignant brain tumors have a nonuniformity (heterogeneous) in structure and contain active cells. The gliomas and meningiomas are the examples of low-grade tumors, classified as benign tumors and glioblastoma and astrocytomas are a class of high-grade tumors, classified as malignant tumors.

To detect infected tumor tissues from medical imaging modalities, segmentation is employed. Segmentation is anecessary and important step in image analysis; it is a process of separating an image into different regions or blocks sharing common and identical properties, such as color, texture, contrast, brightness, boundaries, and gray level. Brain tumor segmentation involves the process of separating the tumor tissues such as edema and dead cells from normal brain tissues and solid tumors, such as WM, GM, and CSF with the help of MR images or other imaging modalities.

MRI scanners use strong magnetic field and RF waves to attain the images of the brain. When the electrical current in the wires of the gradient magnetic field is increased, the main magnetic field opposes it and generates huge noise. Such noise reduces the visibility of certain characteristics of the image. A non-linear median filter is used to remove the noise in MRI images and preserve the boundaries of the image.Every pixel of the image is related to the neighbor pixels to determine the representative of its surroundings. The median of theneighboring pixel value is to be determined to modify the pixel values. The median value will not be affected with anaberrant single pixel in a neighborhood. So the median is more relevant choice than themean. Using this approach to save sharp edges in MRI brain tumor images, the filter will not generate improbable pixel values. Using the median filter the substantial noise is withdrawn from the MRI Brain image.

It is very necessary to enhance MR images before further processing or analysis can be conducted. The resolution of the image is enhanced using the combination of DWT and SWT along with bicubic interpolation. The high-frequency components of the MRI image are eliminated using stationary wavelet transform method.

The discrete SWT divides the MRI image into Low and High-frequencysubbands [4][5][6]. Bicubic interpolation is then used on subband images to achieve re-sampling. The re-sampled images obtained are stable. The proposed SWT with Bicubic interpolation method generates sharper high-resolution MRI image [7]. The enhanced high-resolution MRI image is to be analyzed using segmentation and clustering algorithms.

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II.RELATED WORK

Zhang et al [8] proposed a hidden Markov random field model, which is a stochastic processgenerated by an MRF whose state sequence cannot be observed directly but which can be indirectly estimated through observations.The advantage of the HMRF model derives from the way in which the spatial information is encoded through the mutual influences of neighboring sites. To fit the HMRF model, an EM algorithm is used. They showed that by incorporating both the HMRF model and the EM algorithm into anHMRF-EM framework, an accurate and robust segmentation can be achieved. Because of the large variance in brain MR images in terms of their intensity ranges and contrasts between brain tissues, it cannot be ensured that the thresholding procedure will yield accurate results.

Ahmedet al. [9] presented an algorithm for adaptive fuzzy segmentation of MRI images and determination of intensity disparities. These disparities are a result of problems with the MRI scanner. Their algorithm was adaptive to these errors byusing fuzzy inference rules.

Tolba et al. [10] achieved the segmentation based on EM algorithm and the multiresolution analysis of images. The EM algorithm cannot utilize the spatial relation between neighbor pixels. To better the performance of EM algorithm, themultiresolution analysis was used. The original image is broken into low-resolution images by theGaussian filter. The drawback of this algorithm is that when it is applied to the boundary pixels it leads to a high misclassification rate.

III.PROPOSED ALGORITHM

The noise in MRI images can be reduced by using spatial filters. The median filter is a non-linear filter which can eliminate salt and pepper noise from MRI images. The median of theneighboring pixel value is determined to refine each pixel value of the MRI Image. The median filter is considered to be edge secure. The estimated median value will substitute the pixel examined with the center pixel value. If the considered neighborhood has an even number of pixel points, the average of the two center pixels is used.

$$T(x,y) = I\frac{(nxn)}{2}$$

WhereI(nxn)/2 is the center intensity pixel value.Since edges have significant information for segmentation, amedian filter is used for preserving significant details in MRI image.

Discrete wavelet transform and Stationary wavelet transform are used to enhance the resolution of the Low-resolution MRI input image. If the image is enhanced by using interpolation, then the information is lost on its edges i.ehigh-frequency components are generated. Preserving the edges is important and hence DWT is used to preserve the high-frequency components of the image.

To acquire the redundancy and shift invariance the discrete wavelet transform coefficients are basically interpolated. Consequentially DWT is utilized to break down the MRI Image into sub-band images. The high-frequency components of the image named as subbands LH, HL, HH. For interpolating data points on a two-dimensional regular grid, Bicubic interpolation is utilized as a part of theprocess to achieve asmooth surface. A growth factor of ‘2’ for Bicubic interpolation is enforced to high-frequencysub-band images.

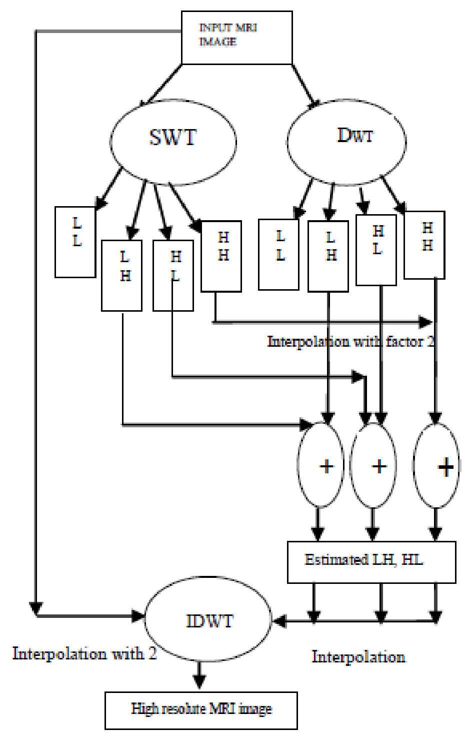

Fig 1 Resolution Enhancement of MRI Images

Stationary wavelet transform (SWT) is adjusted to compensate the information loss in the Subbands due to down sampling. The MRI Brain tumor image breaks down into various subband images by utilizing aStationary wavelet transform, Low-low (LL)), low-high (LH), high-low (HL), and high-high (HH).

The SWT High-frequency subbands and interpolated high-frequencysub-bands are combined each other. Further intensification is accomplished by interpolating the estimated High-frequency subbands. The authentic high-resolution input image is having excellent information than low-frequencysubbands. Consequently,the interpolation is again applied on the input MRI image Low-frequencysubbands [7] [11].

The segmentation is done by optimizing the k-means clustering with the fuzzy algorithm.

K-means Clustering

1. Initially,we will choose the number of centroids haphazardly i.e., depends on a number of clusters.
2. Now, partition the objects within each cluster.
3. It discovers partitions to such an extent that pixels inside each cluster are as close to each other as could be expected under the circumstances, andas different from objects in other clusters as could reasonably be expected.
4. The objects are in the cluster or not will be computed by measuring the distance between thecluster pixels. At the point when the calculated Euclidean distance has minima value then the pixels will begrouped with the respective cluster.
5. Do the above procedure for remaining clusters also. At that point, we will get three clusters with theircomparable pixels.
6. Now, calculate the mean of each cluster and replace the mean values with the centroids.
7. Repeat the similar procedure with these new centroids by giving the number of iterations until unless the convergence occurrence i.e., the mean value of clusters = cluster centroid value.

IV.HYBRID KFCM ALGORITHM

Here in this segment, we depict our proposed hybrid fuzzy k-means (FKM) clustering in brief.To begin with, the preprocessing has been finished utilizing amedian filter, which is utilized to remove the noisefrom digital images and will enhance the quality of the image. At this point the output of thefirst stage willbe given to the k-means clustering which gives the segmented output of thede-noised image. Presently,fuzzy clustering will be applied for the k-means segmented output to enhance the segmentationaccuracy and correct detection of thetumor from MR brain images. At last, binarization will be utilizedto compute the size of the tumor in light of typography and digital imaging units [12].

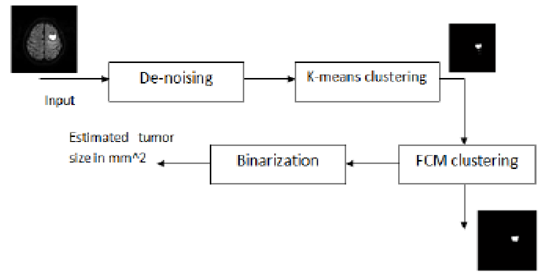

Fig 2 Proposed hybrid clustering algorithm

While calculating the mean of cluster centroid pixels in some cases wemight get the floating values, yet the pixel values in an image will always be integers which doesnot have decimal values. So, we proposed a novel algorithm in figure 2 to rectify this problem. In theproposed approach, segmented k-means output will be additionally segmented by fuzzy clustering forenhanced accuracy. At this point after, the binarization strategy will be applied to calculate the size oftumor which has been distinguished by using proposed hybrid clustering algorithm.

Binarization is used to ascertain the tumor area. Here, we considered the images of size 256 x 256and the pixels in the segmented image having just two values i.e., either black or white, wherethe pixel value 0 means the black and 1 indicates the white. Thus, we can represent thesegmented output image as a summation of aggregate number of white and black pixels.

V.EXPERIMENTAL RESULTS

The algorithm was implemented in Matlab and the results are presented in this section. Salt and pepper noise was introduced in the database images.

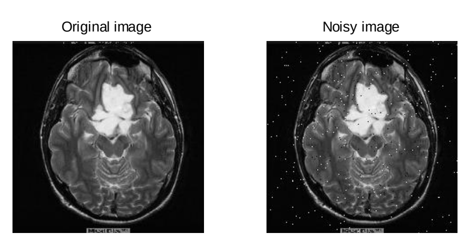

Fig 3 Salt and pepper noise

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The filter output is shown in the below figure.

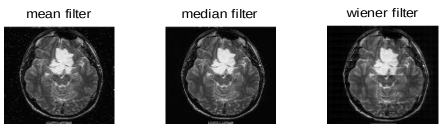

Fig 4 Filtering of images

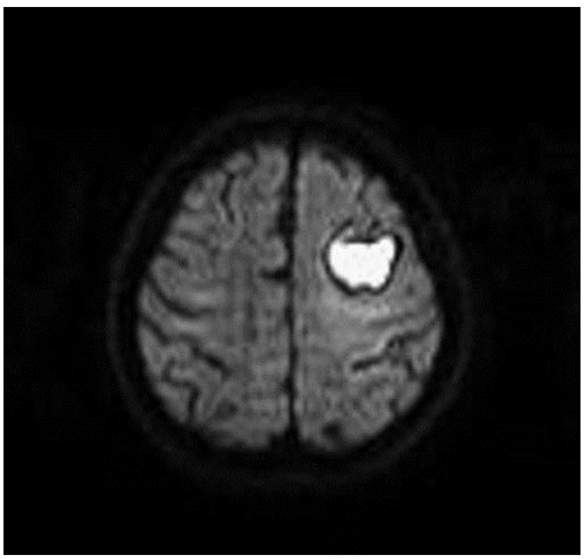

Fig 5 The enhanced resoluted images

The below figure shows the final segmented image using the proposed algorithm.

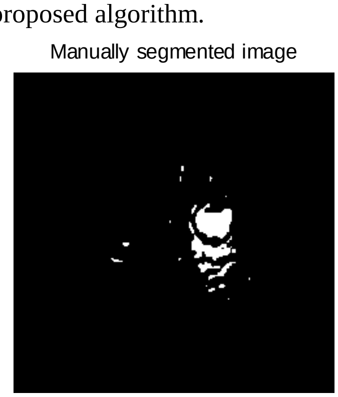

Fig 6 Segmented Image

VI.CONCLUSION

Here in this paper, we had proposed a novel MR brain image segmentation for distinguishing thetumor and to find the area of the tumor with enhanced accuracy and lessened computational time.This paper deals with the new shaft algorithm for reducing the computational time andbinarization method to calculate the area interms of 112 based on the typography and digitalimaging units. We compared the simulation results with the existing algorithms with the proposedshaft algorithm then after we found the area of tumor and calculated the CPU computational time.At last, we can say that the proposed algorithm has performed far better than the existing algorithms withdecreased computational time.

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