ANALYSIS

28(104), February 1, 2015

ISSN 2278–5469 EISSN 2278–5450

Discovery

Qualitative Analysis of Brain tumor MRI

Vidyasagar K[1], Bhujangarao A[2], Madhu T[3]

1.Dept. of E.C.E, SSIT, Sathupally, E-mail: vidyasagar818@gmail.com
2.Instrument Technology, Andhra University, E-Mail: dr_abrao@yahoo.co.in
3.Swarnandra Institute of Engg. & Tech., Narsapur, E-Mail: tennetimadhu@yahoo.com

Publication History
Received: 11 December 2014
Accepted: 24 January 2015
Published: 1 February 2015

Citation
Vidyasagar K, Bhujangarao A, Madhu T. Qualitative Analysis of Brain tumor MRI. *Discovery*, 2015, 28(104), 65-71

ABSTRACT
Magnetic Resonance Imaging (MRI) techniques are used to scan images of brain tumors. The extracted MRI image is sensitive to noise which limits the visibility of certain characteristics of the image. This unwanted noise can be disintegrated and curtailed from the original Image by using the non linear digital median filter. The intensification is achieved by using the combination of discrete wavelet transform (DWT) and stationary wavelet transform (SWT) augmented with Bi-cubic interpolation algorithm. The quality of the resolute image is analyzed with the possible static parameters. Segmentation and clustering approaches are applied on the resultant sharpened high resolution image to estimate the tumor area. In this paper the results obtained with proposed Optimized Hybrid Clustering (OHC) algorithm is compared with the existing K-Means, Pillar K-Means and Fuzzy C-means (FCM) approaches. The tumor sensitivity and accuracy of the test parameters with the OHC approach are estimated. In-order to deliver the drug to kill the aberrant tissue the number of tumor cells are estimated against its radius. The Proposed method exhibits reliable values when compared with existing approaches.

Key words: Denoise, DWT, SWT, Bi-cubic Interpolation, Segmentation, Tumor area

1. INTRODUCTION

The cells in a human brain will develop in a controlled manner. The old and flawed cells will be recovered with new cells. The cell division grows in undisciplined manner and form as an aberrant tissue labeled as Tumor. Tumors are classified as primary and secondary tumors. Treatment of the tumors depends on its type, area and location. Magnetic Resonance Imaging (MRI) is adopted as reliable and superior approach to trace the brain tumors. MRI Scan is a non invasive procedure that uses strong magnetic field of

21.1 Tesla augmenting with radio frequency waves as pulses to attain the images of the brain. Three gradient magnets used in MRI labeled as X, Y, Z. Each gradient field aligned at different plane of the organ. The gradient magnetic field focuses on the distinct area of the slice and work in association with radio frequency pulses to produce the image. The sequence of X, Y, Z gradients used to generate image of the slices in any orientation. This is one dominant component forced to adopt MRI as a diagnostic tool.MRI image consists of Grey and white pixels. The grey pixels represent both signal intensity and noise. By increasing the electrical currents in the wires of the gradient magnetic field the main magnetic field opposes it and generates huge noise. And irregular measurement of electronics also introduces significant noise. This noise minimizes the visibility of certain characteristics of the image. Noisy image may introduce inadequate allotment of Gray level pixels

as white level pixels. The visibility of the low contrast MRI images can be improved by removing the noise with a median filter. A Non linear digital median filter used to remove the noise in MRI images and safeguard the edges of the image. Each pixel in the image relates with nearby neighbours to determine the representative of its surroundings. The median of neibouring pixel value is determined to modify the pixel values. The median value will not be affected with aberrant single pixel in a neighbourhood. So the median is more potent average than mean. Using this approach to save sharp edges in MRI brain tumor images, the filter does not generate improbable pixel values. The substantial noise is withdrawn from the MRI brain image with median filter [1][2]. Image enhancement in MRI images is used to resolve the problem of low resolution and to increase the contrast and sharpness of the image. The de noised image is further enhanced using combination of discrete wavelet transform (DWT) and stationary wavelet transform (SWT) with applied bicubic interpolation approach to generate sharp high resolution images. The high frequency components of the MRI image are perpetuated using stationary wavelet transform method. The loss of report arises by virtue of down sampling in discrete wavelet transform (DWT) begin in respective to sub bands. SWT is used to curtail the information loss. The discrete stationary wavelet transform disintegrate the MRI image into low and high frequency sub bands. [3][4][5][6] Bicubic interpolation is then applied to sub band images. Bicubic interpolation is achieved using nearest neighbour image resampling. The re-sample images obtained are stable. The proposed SWT with Bicubic interpolation method generates sharper high resolution MRI image [7]. The enhanced high resolution MRI image quality is analyzed with static parameters. The quantitative analysis concludes that the combination of DWT+SWT with applied bi-cubic interpolation results reliable resolute image. Which was further processed using segmentation and clustering algorithms. The Optimized hybrid clustering (OHC) algorithm enforced to cluster the tumor associated pixels. These pixel values are used as optimum values to estimate the area of the tumor from MRI images.

2. TECHNICAL REVIEW

2.1 De-noising

Transform domain and spatial filtering approaches are adopted for MRI images. The compelling noise in MRI images is curtailed by adopting spatial filters. Mean and wiener filters are linear and median filter is nonlinear. The salt and pepper noise in MRI images is curtailed with non linear digital median filter. While removing the noise the filter safeguards the edges. An array of MRI Pixel points are glanced to elect the representative of its surroundings. The median of neighboring pixel value is to be determined to refine each pixel value of the MRI image. The median filter is alleged to be edge secure. The estimated median value will substitute the pixel examined with the center pixel value. If the considered neighbourhood has an even number of pixel points, the average of the two centre pixels is used.

$$T(x,y) = I\left(\frac{(n\times n)}{2}\right)$$

$$I_1 \le I_2 \le I_3 \le \cdots \le I_{n\times n}$$

Where, T is the threshold value and $I(n \times n/2)$is the centre pixel intensity value. As edges contain important information for segmentation, median filter is used for preserving significant details in MRI image. Using wiener filter compelling noise in an image is to be diminished by correlate with desired noise free image. Mean wiener and median filters are used for comparative study of MRI brain tumor images. Wiener filters update the pixel value by averaging of its neighborhoods.

The Maximum signal power to the maximum signal noise is indicated as peak signal-to-noise ratio (PSNR). The PSNR is determined using the following equation

$PSNR_{db} = 10 \, Log_{10} 255^2 / MSE$

Where, $MSE = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} [I(x,y) - I'(x,y)]^2$

Where , M = Number of rows in an image

N= Number of columns in an image

MSE is mean squared error, I is an input image and **I'** is output image [1][2].

2.2. Image intensification

Discrete wavelet transform and Stationary wavelet transform are used to resolute the Low resolution MRI input image. The information loss on its edges i.e high frequency components may arise by applying the interpolation for image intensification. Safeguard the edges is imperative. DWT has been hired to safeguard the high frequency components of the image. In-order to obtain the redundancy and shift invariance the discrete wavelet transform coefficients are essentially interpolated. Hence DWT is used to disintegrate the MRI image into sub band images. The high frequency components of the image labeled as sub bands LH, HL, HH.

For interpolating data points on a two dimensional regular grid, Bi cubic interpolation is used in order to obtain smooth surface. A growth factor of '2' for Bi cubic interpolation is enforced to high frequency sub band images. Stationary wavelet transform (SWT) is adapted to negotiate the information loss in the Sub bands due to down sampling. The MRI brain tumor image disintegrates into different sub band images by using stationary wavelet transform, low-low (LL)), low-high (LH), high-low (HL), and high-high (HH). The SWT High frequency sub bands and interpolated high frequency sub bands are combined each other. Further intensification is achieved by interpolating the estimated high frequency sub bands. The authentic high resolution input image is having admirable information than low frequency sub bands. Hence the interpolation is again applied on the input MRI image Low frequency sub bands [3][4][5][6].

2.3. Segmentation and Clustering

Image segmentation and clustering practice are imported to estimate the area of the tumor. Image segmentation is classified into Pixel based, regional and edge based methods. In this paper the brain tumor images are sub divided into multiple segments as sets of pixels using pixel based segmentation. The MRI image incorporates white and grey color pixel elements. White color pixel data points are related to tumor cells and the Gray color pixel data points relate to normal cells. Collection of data point of the pixels that belongs to the same color will be quantified using Euclidian distance method. The clusters may contain large number of pixels. The pixels may be either close or far from the cluster centre.

Define the cluster centers and each point is to be set aside to the closest cluster centre. Then every centre is the mean of the pixel points allocated to that cluster. In order to estimate the area of the tumor "Optimized hybrid clustering algorithm" is applied on the Input MRI images.

a) Feature Extraction

A Binary Mask is applied on the MRI input image. Grey and white pixels become brightened. A threshold value is defined to compare with the coefficients of each pixel. If the value lies within the threshold value a 'Zero' is assigned to that coefficient else a 'One' is assigned. The Fuzzy C Means output is the extracted tumor cluster from the MRI image. The magnitude of the coefficients from the extracted tumor cluster is above the threshold value. The threshold value is determined using the MATLAB Command (Global Image Threshold Function) the threshold value is represented as 'T'.

$T = \text{Max}\,[\,f(n_k)\,] + \text{Min}\,[f(n_k)] \,/\, \text{Avg of } f\,(n_k\,)$

The MRI input image is represented as 'f'. Grey level pixels are represented with 'k'. Each pixel in an image 'f' is compared with the threshold value T. The threshold value lies in the grey scale range of 'K'. In-order to define a value to the specific pixel from the output image 'g' a binary decision is applied.[7][8][9].

$$g(n) = \begin{cases} '0' & \text{if } f(n) \ge T \\ '1' & \text{if } f(n) < T \end{cases}$$

b) Approximate Reasoning

Linearization method is adopted to estimate the area of the tumor. The MRI image comprises of two pixel values either grey or white (0 or 1). The size of the image is considered to be 256×256. The aggregate of white and black pixels represents the Binary image. [7][8][9].

$$I = \sum_{x=0}^{255}\sum_{y=0}^{255}[f(0) + f(1)]$$

Pixels= Width * Height = 256*256

f(0) = black pixel '0'

f(1)= White pixel '1'

$$\textit{Total White Pixels}\ (W_p) = \sum_{x=0}^{255}\sum_{y=0}^{255} f(1)$$

Where,

W_p = number of white pixels

1 Pixel value is equated to 0. 264 mm

The equation to estimate the tumor area is

$$\textbf{Tumor Size}\ (S) = \left(\sqrt{W_p} * 0.264\right)$$

3. PROPOSED METHODOLOGY

Optimized Hybrid Clustering (OHC) algorithm is a combination of pillar k-means and Fuzzy C means approaches. The combination of these algorithms favorably reduces the difficulties occurred in previous segmenting algorithms. The membership values to the pixels are considered -1, 0, and 1 using cluster centroids cause to minimize grey level similarity limitation with FCM alone. The floating points obtained with K-Means due to mean calculation for new centroid updating in some iterations has been favorably curtailed by considering the maximum data set point value. The OHC Algorithm substantiates the implication of MRI brain tumor image segmentation and clustering to estimate the tumor area. This approach endorsed optimized results.

3.1 Optimized Hybrid Clustering Algorithm

Step 1. Normalize the Input image into 256*256 sizes.
Step 2. Convert the image into double precision values.
Step 3. Reshape the image into data sets of column vector for segmentation.
Step 4. Determine the number of clusters i.e. centroids.
Step 5. Calculate the distance between input data set points and set points of the centroids.
Step 6. Find the data set points which are neighboring to the centroid.
Step 7. Select the centroid with minimum distance then move the data set points to the closest relevant centroids
Step 8. Re compute the centroids by selecting the maximum pixel value from the set of relevant centroid data points.
Step 9. Repeat the process until the new centroids and the previous centroids are symmetrical.
Step 10. Allocate the membership values -1, 0 and 1 to each pixel of the cluster centroids
Step 11. Estimate the global threshold value T.
Step 12. Determine the data set points with similar membership value and then reform the new clusters.
Step 13.Apply the binary decision to obtain the resultant cluster image g (n)
Step 14. Estimate the square of number of white pixels (W_p)
Step 15. Compute the area of the tumor "S" using linearization method

4. RESULTS & ANALYSIS

An innovative procedures based on Median Filter, wiener filter and mean filters Algorithms are adopted for effectively de noise the MRI brain tumor images and for preserving the edges. While preserving high quality of restored image the noise abolition across an ample range of noise quantity about 30 to 98% is considered. This is mainly due to median filter used for the MRI images. Considering significant number of MRI brain tumor images, Wiener filter deteriorated to preserve the fine point pixel values and edges of the MRI image. The PSNR estimated values for the above three filters are tabulated. Table 1 and Fig.6 shows the median filter produced favorable PSNR Results when compared with other filters. The median filter applied to different MRI images caters satisfying results. The DWT and SWT used augmenting with Bi-cubic interpolation is enforced to enhance the de-noised tumor image. Testing with interpolation factor 2 applied on DWT and SWT to resolute the image influenced on the high frequency components. Considering fig 1(c), fig 2(c) introducing the SWT information loss due to down sampling in DWT is considerably reduced. DWT has been selected to preserve the high frequency components of the MRI image. The image size of 256*256 is used for enhancement with an interpolation factor of 2.The Qualitative parameters of the image are tabulated. Table 3 and fig 5 summarizes the quality of the resolute images. The laplacian mean square error Results less than 1.2 for the tested samples. The normalized absolute error results '0.5'. Less than 1 considered as a best value. The maximum difference and average difference values are approximately closes to zero. The peak signal to noise ratio is also favorably good for all the tested samples. Low level structural information i.e within 3.0 when compared with input image and resolute image. The value of SSIM represents '0' labeled as zero correlation and '1' labeled as exact correlation. The table 4 concludes the SSIM values for all the tested samples are 0.99. I.e. 99 percent of the exact correlation is achieved. Table 2 summarizes the estimated Area of the tumor for sample 1, sample 2. Manual segmentation and Fuzzy C-Means procedures produce unfavorable results. Pillar K-means produced the tumor area for sample 2 is 14.7013mm2. But, the proposed "optimized hybrid clustering approach" proved itself as reliable result for sample 2 with 10.9679 mm2. Table 2 and fig 5 concludes that OHC approach produces the optimum tumor area for all the tested samples. While comparing the fig1(d), 2(d), The OHC approach produced the output exactly matched with the actual tumor shape. The total white pixels are precisely detected causes to estimate the true area of the tumor. This approach achieved the precision level at about 98% closest to the true tumor size.

Tested Results

Sample1

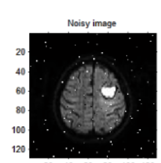

Fig.1(a) Noisy image

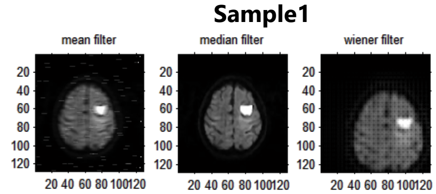

Fig.1(b) De noised images

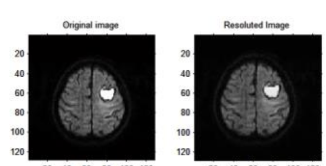

Fig.1(c) Resolute image

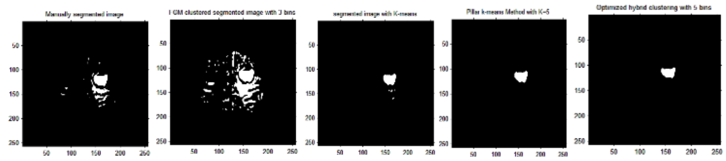

Fig.1 (d) Segmented and clustered image results for sample 1

Sample 2

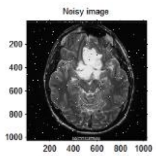

Fig 2(a) Noisy image

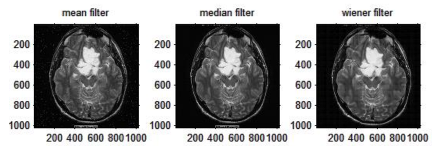

Fig.2 (b) De noised images

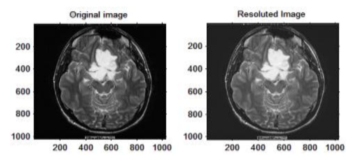

Fig 2(c)Resolute image

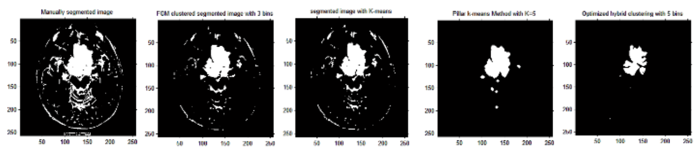

Fig 2(d) Segmented and clustered image results for sample

Table 1 PSNR values for various filters

S.No	Filter Type	PSNR (db)	
		Sample1	Sample2
1	Average	47.99	50.77
2	Weiner	38.34	41.93
3	Median	53.17	57.75

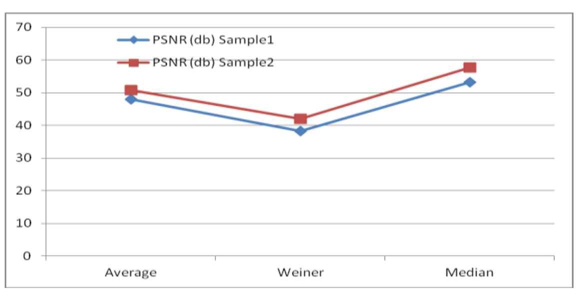

Figure 3 PSNR values for various filters

Table 2 Area estimation for various algorithms

S.No	Algorithm	Area of the tumor(mm^2)	
		Sample1	Sample2
1	Manual	7.7914	23.2185

2	Fuzzy C-Means	14.6276	17.6998
3	K-Means	6.4451	18.3304
4	Pillar K-Means	5.9853	14.7013
5	OHC	5.4935	10.9679

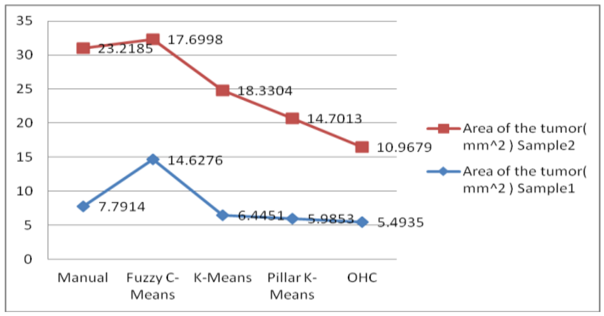

Figure 4 Comparison of various area estimation

Table 3 Quality analysis for various sample images

Quality parameter	Sample1	Sample2
PSNR(db)	65.00784	69.202903
AD	0.04021	0.09785
SC	3.644875	3.956706
NCC	0.468780	0.494208
MD	0.000000	0.007843
LMSE	1.168932	0.899748
NAE	0.564376	0.507452
SSIM	0.99842	0.99685

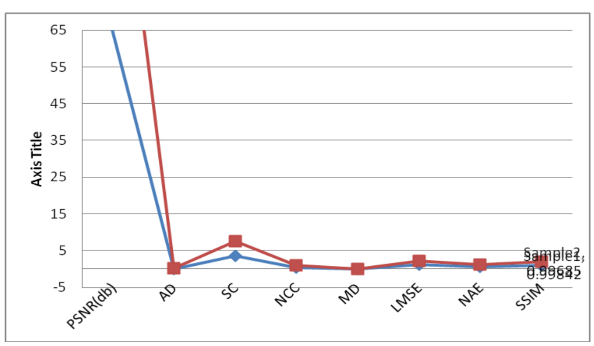

Figure 5 Quality parameters for resolute images

5. CONCLUSION

The experiments were conducted on primary brain tumor MRI images. The median filter method is produced favorable PSNR value and justified as an optimum denoising method for MRI images. The combination of DWT-SWT in conjunction with bicubic interpolation approach results intensified quality image analyzed with static quality parameters. Based on the statistical parameters the resolute image is evincing acceptable quality image. The proposed "OHC" approach proved as a refined and respectable method to estimate the absolute area of the tumor. This Proposed OHC algorithm can be applied to any MRI image for estimating the tumor area and volume. The number of tumor cells are estimated w.r.t its radius. Specifically the extreme dependence on MRI to detect the tumor cells, with the advances in tumor diagnosis, can increase the survival of tumor patients. Reckoning the tumor area, volume, and number of aberrant tissue cells will play a vital role to treat the tumors. Subsequently the location of the tumor may be determined in addition with the size i.e. area of the tumor. Precisely the Qualitative and quantitative analysis of the tumor will play a vital role for applying the radiation to annihilate the tumor cells.

ACKNOWLEDGEMENT

I thank to Dr. K. Krupasagar, Dr. Srujana Ulavapati for their valuable guidance and Sincere thanks to Dr. Anil For providing the Brain MR Images and guidance.

REFERENCE

1. Govind N Sarage, Dr sagar Jambhorkar," Magnetic Resonance Image Denoising Using Laplacian Filtering Technioque" International Journal of Advanced Ressearch in computer science and software Engineering Vo 2, 2012.
2. Rajanand Gupta, "Algorithm for Image Processing using improved median filter and comparision of Mean, Median and Improved Median Filter" International Journal of soft computing and engineering,Vol1, 2011
3. Sunaya U.Shirodkar," Image Resolution Enhancement using various wavelet Transfors", International journal of advances in science Engineering and Technology, Vol1, 2014.
4. V.C.Miaindargi, A.P.Mane "Decimated and Un-Decimated Wavelet Transforms based Image Enhancement"International journal of industrial Electrical, Electronics, Control and Robotics, Vol.03, Issue.05, 2013
5. B.Sivakumar, S.Nagaraj "Descrete and stationary wavelet decomposition for image Resolution Enhancement" International Journal of Engineering trends and Technology , Volume4 ,2013
6. Mr.G.M.Khaire, R.P.Shelkikar," Resolution Enhancement of images with interpolation and DWT –SWT Wavelet domain components" , International Journal of Application or Innovation in Engineering and Management , Vol 2, 2013.
7. S. Ray, R.H. Turi, "Determination of number of clusters in K-means clustering and application in colthe image segmentation", Proc. 4th ICAPRDT, pp. 137-143, 1999.
8. P. Dhanalakshmi, T. Kanimozhi," Automatic segmentation of brain tumor using k means clustering and its area calculation" International Journal of advanced electrical and Electronics Engineering, volume 2, issue 2, 2013
9. Rohit S Khabade ,M.S.Gaikwad ," Segmentation of Brain tumor and its area calculation in brain MR images using K mean Clustering and fuzzy C mean algorithm", International journal of Computer science and Technology, Vol 4, No.05, May 2013.