International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue IX, September 2017- Available at www.ijraset.com

Comparative Review of Image Denoising and Segmentation Approaches For Detection of Tumor in Brain Images

Harmeet Kaur[1], Navdeep Singh[2]
[1,2]*Department of Computer Engineering, Punjabi University*

Abstract: ***A group of defective cells that grow inside or around the brain referred as Barin Tumor. The number of Brain Tumor cases around the World is increasing day by day. So, it is significant to detect it at anearly stage. Segmentation of brain images holds thesignificant part for detection of Tumor brain. Manual segmentation of brain Tumor tissues cannot be compared with existing high-speed computing machines. Therefore, theemphasisis given on computer aided detection of brain Tumor. This paper provides an overview of various techniques that have been implemented till now to detect the brain tumor. Along with this, these techniques are compared for accuracy, sensitivity, and specificity to detect the Brain tumor. The research findings will help to explore the research in the same field.***

Index Terms: Segmentation, image processing, Brain Tumor, denoising, Magnetic Resonance Imaging.

I. INTRODUCTION

Brain Tumor also called as intracranial neoplasm is the formation of abnormal cells in the brain. The tumors are basically of two types including cancerous Tumor (which is also called as Malignant Tumor) and Benign Tumor. Further, the cancerous tumors are categorized as primary as it startswithin the brain itself. On the other hand, atumorthat gets into the brain from the outside body is termed as secondary. The signs of having a tumor in the brain vary from the place of origin of the tumor [5].

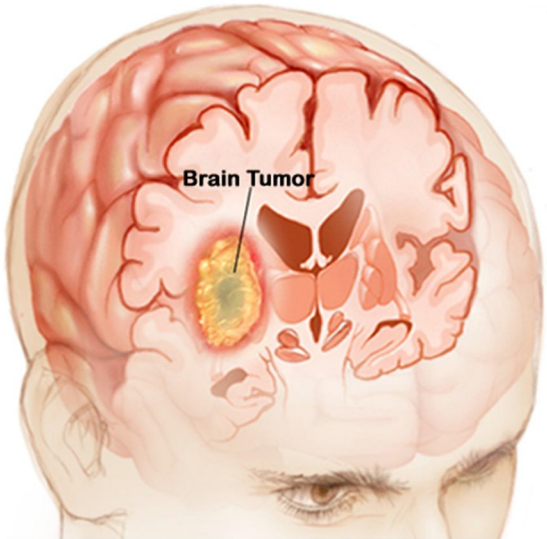

Figure 1:Brain Tumor Source- http://eslamdaro.com/wp-content/uploads/2017/05/Brain-Tumor.jpg

In medical imaging, important information can be extracted from theimage. For this, images are captured, then digitized and processed. After that image segmentation is performed to extract the important information.An alternative method is the manual segmentation of image which is a time-consuming and tedious job. Along with this, manual segmentation produces inaccurate results. Thus, there is ahigh necessity for a computer based efficient segmentation method. The system must precisely define the brain tissue boundaries [2].

There are different symptoms of brain tumor that depends on the location,type, and size of the tumor. But the most common symptoms include walking problems, changes in speech, numbness in the legs or arms, headaches, changes in hearing and vision.

II. EXISTING TECHNIQUES TO DETECT BRAIN TUMOR

The existing techniques used to predict the brain tumorare developed over the time. The old methods like pneumoencephalography and cerebral angiography are found to be dangerous and invasive.On the other hand, latest techniques like Magnetic Resonance Imaging (MRI) and CT scans are preferred nowadays for the detection of tumors. Neoplasm is detectedwith different color masses in the MRI images and CT scans [1].

Benign Brain Tumor often represented as dark color tissues than the brain tissues on CT scans. While on MRI they appeared darker sometimes and sometimes of same intensity on type 1 scans and looks lighter than the brain tissues in type 2 scans in MRI. The characteristic pattern changes can be seen in both MRI and CT scan. The areas which are pressurized by the swelling called peritumoraledemaand diffused neoplasm can be seen due to unclear outline in type 2 weighted scans. The best way to find out the tumor in the human brain is first to do the MRI of the brain. The image then needs to applythresh-holding, increasing the contrast and histogram equalization. After that, the image is processed using k-mean clustering, image segmentation and also c-mean clustering. At last, it is considered whether the tissueis normal or not [2].

III. PROBLEMS WITH EXISTING TECHNIQUES

Although several techniques have been discovered and implemented to predict the brain Tumor, various problems have been found in them. Few of the problems in the existing techniques are described below

A. The earlier techniques for the detection of brain tumors are considered to be dangerous to the tumor patient when used again and again for scanning [4].

B. The 3d volumetric techniques which are used for treatment and detection of brain Tumorare too complex. Manual tracing is very effort demanding and dangerous as well.

C. The automatic recognition of Tumor with high accuracy and fast segmentation is still neededto be developed. The RECIST method is also not effective as one cannot always have the obvious choice of the image part to be reasonable and the difference can be of about 10 percent or more in the choices. Also, the RECIST techniques sometimes completely miss the asymmetric Tumor

IV. IMAGE SEGMENTATION

Image segmentation, as it is clear from the name, is a technique of dividing an image into different segments or parts. The process involves division or partitioning of a single digital image into multiple segments. Segmentation is a technique of locating objects in a digital image. It helps in locating any unusual objects and boundaries in a digital image. The image segmentation is a process of assigning labels to every single pixel of the image so as to see the same pixel with different visual characteristics. The image segmentation helps in making a picture easy to analyze with less hindrance [9]

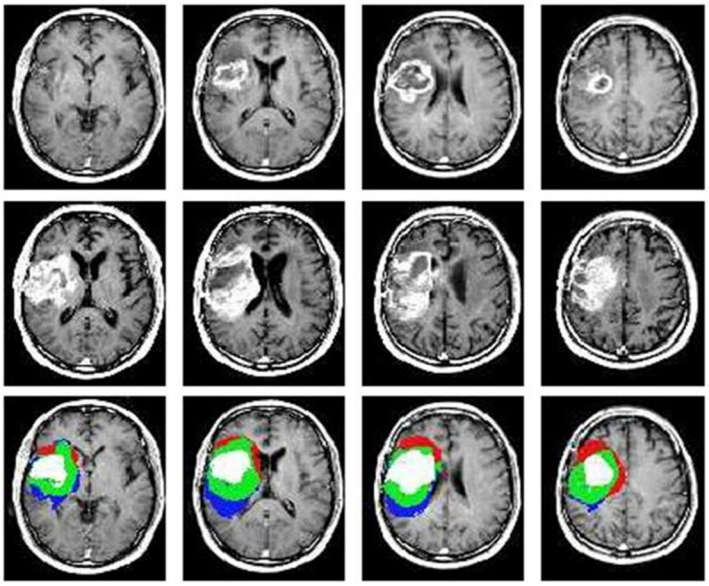

Figure 2: Image Segmentation Source- http://webdocs.cs.ualberta.ca/~btap/results.php

Mostly thresholding method is used for image segmentation because of its simplicity to use. But this segmentation method develops only two classes and unable to process the multichannel images. Apart from this, noise can develop as a result of image segmentation process. Therefore, there is need to develop effective and efficient image segmentation method which can easily divide the image into segments without introducing noise.
In thecase of medical research, the motive of image segmentation is as follows:

A. To anatomically study the structure of the brain tissues and abnormalities.
B. To locate the region of interest; it means to locate any abnormalities such as a tumor in the brain [3].
C. The tissue volume is measured to understand the growth of tissues and increase or decrease in the Tumor size during the time of treatment.
D. The data shown by image segmentation helps in calculating the dose of radiation therapy required during Tumor treatment planning.

V. IMAGE SEGMENTATION METHODS

The image segmentation process is the latest technique to locate any abnormal cells in the brain because it can help in locating unidentified objects by pixel viewing of every single part of brain cells [2]. Presently, the following image segmentation methods are commonly used

A. Active contour method

Active contour method helps in creating contours models of the images taken through MRI technique and helps in preventing global lines shapes. But this methodneeds strong points of gradients to draw the contour of the image. Also, the process lacks in image processing accuracy because of the presence of image noise and weak boundaries.

B. Watershed method

Watershed method for image segmentation is based on mathematical morphology system. It provides the user with a greater range of capturing options. But sometimes this type of segmentation leads to over segmentation of the pixels making it difficult to process any abnormal objects [13].

C. Threshold methods

It helps in finding edge pixels of the image and removes the noise in the image. The potential edge pixels are found by using the magnitude of the gradient in the image. But the detections are found to be consist of discrete pixels in thecase of threshold method of segmentation which can be discontinuous and incomplete. Also, this type of image processing technique is comparatively more expensive than other methods [12].

D. Seed region growing

Seed region growing is a good image segmentation technique as it effectively separates the similar areas in the image and determines the seed points in the image. But it needs manual interaction to get the seed points in the image [21].

E. Marker-based watershed method.

The marker-based watershed technique is very similar to the watershed method of segmenting the image. But, it is more accurate and advantageous as it overcomes the problem of over-segmentation.

1) Image Denoising: Image denoising technique is used to remove noise from images. It is considered as the main technique in the field of image processing in which noise free digital images are developed. In imagedenoising, the noisein the imageis removed by using the image smoothing operation. There are two approaches used in the image denoising [18].
a) *Spatial filtering:* In spatial filters, pixels are set to the accurate size by using the sliding window. The window used in this process is usually square, but any type of shapes can be used.
b) *Transform domain:* The transform domain filter is used to change the signal space so that some processing techniques can be addedto the image data. The main examples of transform domain filtering include wavelet transform and Fourier transform [15].

VI. LITERATURE REVIEW

A. *M. M. Ahmed and D. B. Mohamad*

Described efficient methods for the automatic brain Tumor segmentation for the extraction of the tissues with the help of the MR images. For the k-means clustering and image enhancement techniques, Malik anisotropic and Perona diffusion model were combined for grouping the tissues that belong to some specific group. The method proposed in the study used PD, T1, and T2 weighted gray level intensity images. It was also concluded from the results that unsupervised segmentation methods are better as compared to the supervised segmentation methods because in the supervised segmentation method there was a need of doing a lot of pre-processing. Along with this, supervised segmentation methodsalso require aconsiderable amount of testing and training the data which makes the process complicated **[1].**

B. *S. Renukalatha and K.V. Suresh* **(***2016***)**

Investigated the performance evaluation of three different image matting techniques to extract and refine the poor tumor boundaries from Rician noise which affected the complex MRI brain tumor images. With the help of the ADF filter in combination with Gauss filter, the image quality was improvedthat resulted indenoising. The results of the investigation showed that traditional segmentation method could not fetch the significant results alone. With the matting techniques, tumor boundarywas marginally improved. As compared to the alpha matting, combined Poisson matting and Bayesian matting technique provided significant results in less time. Also, region growing and Poisson matting technique in the combined form provides better sensitivity than the Bayesian matting. From the results, it is clear that the Poisson matting with the region growing is better in refining the tumor boundaries for the highly complex images as compared to the other matting techniques [2].

C. *Kandwa and A. Kumar* **(***2014***)**

Presented the completely automated way to detect and segment the brain tumor consisted of three different stages with the help of the MR images. Firstly, noise and sharpen image are removedthrough image processing. In the second stage, the location of the tumor was detected from any part of the brain with the help of the bounding box method using symmetry. And in the last stage, the tumor was segmented from the whole image by post-processing operations. The result indicated that the proposed method gives the better results in detecting, segmenting and enhancing the brain tumor from an MR images. **[**3**]**

D. *Y. Lia, F. Jia and J. Qin* **(***2016***)**

Formulated the multimodal MR brain tumor segmentation as the voxel-wise labeling problem by estimating the probability of maximization model. This model used the sparse representation-based framework to obtain the likelihood estimation. After that, the MAP was estimated using MRF. Then, the model was converted into minimum energy optimization problem by considering MAP asan NP-hard problem. An optimal partition was obtained from the graph cuts algorithm. In the image processing, brain tumor segmentation is a difficult problem due to the nonhomogeneous, blurring and low-resolution characteristics of the MR images but they still achieve good performance. Over the low-grade and high-grade cases of the BRATS, the quantitative and qualitative results indicated that the proposed algorithm outperforms as compared to the other state-of-the-art tumor segmentation algorithms in MICCAI 2013 BRATS challenge [4].

E. *Phophalia and S. K. Mitra* **(***2015***)**

Demonstrated the rough set based bilateral filter design forDenoising brain MR images which derived the pixel level edge map and class the labels that were used to improve the performance of the bilateral filters. RST was used to handle the uncertainty which was present in the data. The bilateral filter basic structure was not changed but boosted up by the prior information that was derivedfrom the rough class labels and rough edge map. This filterwas then applied to the denoise brain MR images and results were compared with the state-of-the-art approaches. The experiments were performedon pathological and normal disordered human MR databases. The results indicated that the performance of the bilateral filter is better regardingbenchmark metrics [5]

F. *E. Hajimania, M.G. Ruano, and A. E. Ruano***(***2017***)**

Presented a Radial Basis Functions Neural Network (RBFNN) which was a detection system used for the automatic identification of Cerebral Vascular Accidents (CVA) by analyzing the images of the Computer Tomographic (CT). A Multi-Objective Genetic Algorithm (MOGA) framework was used for designing the neural network classifier and to determine the architecture of the classifier. The input features and parameters correspond to this algorithm ensured the generalization by maximizing the classification precision. This approach comprised the first and second order pixel intensity, symmetry/asymmetry information by

considering any input features in comparison to the ideal midsagittal line. At the pixel level, both the sensitivity and specificity obtainedwas 98% enabling the non-dominated models which were generated by MOGA and marked by Neuro Radiologist. [6]

G. V. Vijay, A. R. Kavith and S.R. Rebecca **(***2016***)**
Demonstrated an automated BrainTumor segmentation and detection in MRI which was used for enhanced Darwinian particle swarm optimization (EDPSO) and then compared with the PSO algorithm. The steps involved in the proposed algorithm included image enhancement, pre-processing, final classification, and segmentation. In this research, MRI image datasetwas utilized which contained 101 brain MRI images, from which 87 brain images were with thetumor and 14 brain images were without Tumor. Proposed EDPSO and PSO algorithm were comparedregarding accuracy and execution time. The results indicatedthat the EDPSO algorithm has better-quality rate for all the input images [7].

H. S. Koley, et al. **(***2016***)**
Presented new approach of delineation and characterization of four types of the brain Tumorincludingmetastasis (MET), Glioblastoma multiforme (GBM), granuloma (GN), and meningioma (MG) from the magnetic resonance imaging (MRI). The MRI slices of post contract T1-weighted (T1C) sequence were used to improve the computer assistive diagnostic accuracy. The proposed approach consisted of an integrated framework of quantification of histogram, shape and textural features, and identification and extraction of Tumor region followed by pattern classification with the machine learning algorithm. In the granular computing paradigm, rough entropy was based on the thresholding for delineation of the Tumor. The experimental results indicated the applicability and efficiency of the proposed segmentation method after comparison with the existing model and accomplishing the quantitative validation. To develop the training dataset, extracted lesions were quantifed with the 86 features. An ensemble learning scheme i.e. Random forest was implemented that learns the training data for the accurate prediction for a given input. The results indicated the superiority of RF [8].

I. A. Rajendran and R. Dhanasekaran **(***2012***)**
Proposed a method which combined the fuzzy clustering with a deformable model for segmenting the tumor regions on the MRI images. For the initial segmentation of the tumor, region based fuzzy clustering was used which provided initial contour for the deformable model. It further determined the final contour using the gradient vector as an external force field for the exact tumor boundary for the final segmentation. The results showed that with the MRI images, the proposed method is robust and more accurate for brain tumor segmentation. [9]

J. A. S. Capelle, O. Colot and C. F. Maloigne **(***2004***)**
Proposed an evidential segmentation scheme of multi-echo MR images for the detection of the brain Tumor. This research shows that the evidence theory is suitable for the processing of complementary and redundant data of the MR images. The relationship between the voxels was considered by the Dempster's combination rule which helps in improving the classification results which are obtained previously and leads to the real region based segmentation. The conflicts are computed by the combination of the spatial information which reflects the spatial organization of the data [10].

K. G. R.Chandra and K. R. Rao (2016)
proposed a study related to the detection of the tumor by using image segmentation technology that uses agenetic algorithm. Image segmentation is used to extract the anomalous Tumor portion in the brain. A brain Tumor is an abnormal tissue in which cells produce and multiply hysterically. The concentration of the study is the use of image segmentation for Tumor detection. Tumor classification and division from brain tomography-computed image information is a significant process. But it takes a large time to be executed by medical experts. For this purpose, a discrete wavelet transform was used. The genetic algorithm works by stimulating the growing trends of the population to the conditions when evolution gives out best-fitted individuals. The study was focused on the concern of soft thresh-holding Discrete Wavelet Transform and Genetic algorithms for enhancement in image segmentation. The developed method from the study can integrate the previous information related to Tumor study. The proposed technique attained SNR value from 20 to 44. Segmentation accuracy for the method was from 82 to 97 percent of spotted Tumor pixels based on the idea of ground truth [11].

L. P. Shanthakumar and P. Ganeshkumar (2014)
Suggested the study of work consists of various steps in their analysis process such as preprocessing of data, anisotropic diffusion, image feature extraction and image classification. The confined binary patterns and co-occurrence of gray level features, wavelet

features with gray level were mined. These features were classified using SVM classifier. The achieved results are quantitatively compared and evaluated with numerous ground truth data. The proposed technique gives fast and improved segmentation with high classification rate by producing 99.4 percent of sensitivity, 97.03 percent of positive predictive value, 99.6 percent of specificity, and 99.5 percent of total accuracy [12].

M. E. A. El-Dahshan, H. M. Mohsen, K. Revett and A. M. Salem.(2014)
Suggested a method whichis grounded on the various computational methods such as image segmentation of the feedback pulse-coupled neural network. The DWT was used for features extraction. The main constituent analysis was used for decreasing the dimensionality of the wavelet coefficients, and feed forward-back transmission neural network to categorize inputs. The experiments were performed on 101 images which consist real human brain MRI data of 14 normal and 87 images of benign and malignant tumors). The sorting accuracy on both exercise and final test pictures was 99% which is considerably good. The proposed method shows its efficacy related to other machine techniques. The results discovered that the proposed cross method is accurate, fast and robust [13].

N. J. Mohan, V. Krishnaveni,and Y. Guo(2013)
suggested a technique of using the ω-wiener filtering method which was used on image domains of T (true) and F (false) to decrease the set of indeterminacy and remove noise from an image. The tests have been shown on simulated MRI (Magnetic Resonance images) from Brain web databank and medical MR images degraded by Rician noise. The results of the research show that NS Wiener filter yields improved de-noising effects regarding visual view, quality and quantity measures when compared with former de-noising techniques such as classical Wiener filter, nonlocal means filter, the total variation minimization scheme and the anisotropic diffusion filter based on PSNR and SSIM. Future works of the study would be about spatially adaptive Wiener filtering implementation in the neutrosophic domain for understanding the spatially changing noise level in MRI mainly parallel imagery [14].

O. N. Sasirekha and K. R. Kashwan(2015)
proposed a study to reduce the rician noise from the images by using a robust Rician noise estimation algorithm to recognize pixels with high Rician noise. The study used a bilateral filter centered de-noising algorithm which is employed to filter picture in the wavelet area. Uninterruptedly the bilateral filter bound optimization technique is implemented which routines the contrast, frequency components and noise in MRI to select appropriate filter limits for Bilateral Filter. It was properly working for adaptive denoising and edge preserving to fragment image correctly. After de-noising the image it was found that the contrast of the image is enhanced as a pre-processing phase before the image segmentation. Then to segment, the 2D MRI and SVM-based image segmentation algorithm were employed. The observed values for Dice Coefficient, RMSE, and MCR depicted the enhancement in segmentation quality. The use of de-noising algorithm before segmentation showed positive results [15].

VII. RESULT AND DISCUSSION

The following table illustrates the research findings.

Table 2: Research Findings

Year	Researchers	Algorithm/Method/Technique	Results/ Solution/Conclusion
2017	M. M. Ahmed and D. B. Mohamma [1]	The proposed technique used T1, T2 and PD images with weighted gray level intensity.	Unsupervised segmentation techniques are superior to the supervised segmentation methods
2016	S. Renukalatha and K.V. Suresh [2]	Analyzed Rician Noise Affected MRI Images by using Gaussian Filter and Anisotropic Diffusion Filter with main use of Otsu's thresholding	Denoising results show that image quality increases with a grouping of Gauss filter and ADF filter. And the accuracy of Tumor boundary is found to be slightly improved using matting techniques.

2014	R. Kandwal, and A. Kumar [3].	In a brain MRI image, they improved the image and applied bounding box algorithm to discover image.	Experimental results show that the projected technique yields very decent results in enhancing, detecting and segmenting brain Tumor.
2016	Y. Li, F. Jia, and J. Qin [4]	Estimated maximum Posterior probability by introducing the sparse representation into a likelihood probability and an MRF into the prior probability convert.	The experimental results show that the projected algorithm is valid and ranks 2nd paralleled with the state-of-the-art Tumor segmentation algorithms in the MICCAI BRATS 2013 challenge.
2015	Phophalia, A. and Mitra, S. K [5]	A Rough Set Theory (RST) based method was used to source pixel level edge derivation.	The research concluded to show an improved performance of bilateral filters.
2017	E. Hajimani, M. Ruano, and A. Ruano [6]	A Multi Objective Genetic Algorithm (MOGA) framework was used to determine the architecture of the classifier.	98% specificity and sensitivity wereobtained.
2016	V. Vijay, A. Kavitha, and S. R. Rebecca [7].	Proposed the use of tracking algorithm, Gaussian filter, Darwinian Particle Swarm Optimization and finally, Adaptive Neuro-Fuzzy Inference System	The results concluded EDPSO Algorithm shows a better quantity rate for all the input images.
2016	S. Koley, A. K. Sadhu, P. Mitra, B. Chakraborty, andC. Chakraborty [8]	MRI slices of post contrast T1-weighted sequence is used to improve the computer assistive diagnosisaccuracy for four different types of Tumor.	An integrated framework of identification and extraction of Tumor region, quantification of histogram, shape and textural features implementsare shownby using proposed technique.

VIII. CONCLUSION

The advancement in technology haschanged the process in every field of work. The computer system is easy to use, reliableand accurate, that's why it is used for various medical purposes. The detection of Tumor in the brain also does not rely on manual image segmentation method. Various techniques have been deployed to detect the Tumor with high accuracy.

This paper investigates the performance evaluation of different Brain Tumor detection techniques. The research findings provided in Table 2 demonstrate the accuracy of different Brain Tumor detection techniques. In conclusion, the traditional image segmentation techniques cannot provide satisfactory results. We need efficient and effective image segmentation and denoising techniques to predict the presence of Tumor in the brain.

IX. REFERENCES

[1] M. M. Ahmed and D. B. Mohamma "Segmentation of Brain MR Images for Tumor Extraction by Combining Kmeans Clustering and Perona-Malik Anisotropic Diffusion Model" International Journal of Image Processing, Vol. 2,Issue. 1, pp: 27-34.

[2] S. Renukalatha and K.V. Suresh. "Brain Tumor Analysis of Rician Noise Affected MRI Images." *International Journal of Computer Applications*, Vol. *141*, No. 14, pp: 26-33. 2016.

[3] R. Kandwal, and A. Kumar. "An Automated System for Brain Tumor Detection and Segmentation." *International Journal of Advanced Research in Computer Science and Software Engineering*, Vol. *4*, No. 3, pp: 97-100, 2014.

[4] Y. Li, F. Jia, and J. Qin. "Brain Tumor segmentation from multimodal magnetic resonance images via sparse representation." *Artificial Intelligence in Medicine*, vol. *73*,pp: 1-13. 2016.

[5] Phophalia, A. and Mitra, S. K. "Rough set based bilateral filter design for denoising brain MR images." *Applied Soft Computing*, Vol. *33*, pp: 1-14, 2015.

[6] E. Hajimani, M. Ruano, and A. Ruano. "An intelligent support system for automatic detection of cerebral vascular accidents from brain CT images." *Computer Methods and Programs in Biomedicine*, Vol. *146*,pp: 109-123, 2017.

[7] V. Vijay, A. Kavitha, and S. R. Rebecca. "Automated Brain Tumor Segmentation and Detection in MRI Using Enhanced Darwinian Particle Swarm Optimization (EDPSO)." *Procedia Computer Science*, Vol. *92*,pp: 475-480, 2016.

[8] S. Koley, A. K. Sadhu, P. Mitra, B. Chakraborty, andC. Chakraborty. "Delineation and diagnosis of brain tumors from post-contrast T1-weighted MR images using rough granular computing and random forest." *Applied Soft Computing*, vol. *41*, pp: 453-465, 2016.

[9] A. Rajendran and R. Dhanasekaran. "Fuzzy Clustering and Deformable Model for Tumor Segmentation on MRI Brain Image: A Combined Approach." *Procedia Engineering*, vol. *30*,pp: 327-333. 2012.

[10] A. Capelle, O. Colot, and C. Fernandez-Maloigne. "Evidential segmentation scheme of multi-echo MR images for the detection of brain tumors using Neighborhood information." *Information Fusion*, Vol. *5*, *No.* 3, pp: 203-216, 2004.

[11] G. R. Chandra, and K. R. Rao. "Tumor Detection in Brain Using Genetic Algorithm." Procedia Computer Science, Vol. 79, pp: 449-457, 2016.

[12] P. Shanthakumar, & P. Ganeshkumar. "Performance analysis of classifier for BrainTumor detection and diagnosis." Computers & Electrical Engineering, vol. 45,pp: 302-311, 2015.

[13] E. A. El-Dahshan, H. M. Mohsen, K. Revett and A. M. Salem. Computer-aided diagnosis of ahuman brain Tumor through MRI: A survey and a new algorithm. Expert Systems with Applications, Vol. 41, No. 11, 2014.

[14] J. Mohan, V. Krishnaveni,and Y. Guo. "MRI denoising using thenonlocal neutrosophic set approach of Wiener filtering." Biomedical Signal Processing and Control, Vol. *8*, No. 6, pp: 779-791,2013.

[15] N. Sasirekha, & K. R. Kashwan. "Improved Segmentation of MRI Brain Images by Denoising and Contrast Enhancement." Indian Journal of Science and Technology, Vol. *8*, No. 22, 2015.

[16] N. Nabizadeh and M. Kubat. "Brain tumors detection and segmentation in MR images: Gabor wavelet vs. Statistical features." Computers & Electrical Engineering, Vol. 45,pp: 286-301, 2015.

[17] T. Ramakrishnan and B. Sankaragomathi (2017). "A professional estimate on the computed tomography brain Tumor images using SVM-SMO for classification and MRG-GWO for segmentation." Pattern Recognition Letters, Vol. 94,pp: 163-171. 2017.

[18] I. Cabria, and I. Gondra (2017). "MRI segmentation fusion for brain Tumor detection." Information Fusion, Vol. 36, pp: 1-9,2017.

[19] Z. Iscan, Z. Dokur, and T. Ölmez. "Tumor detection by using Zernike moments on segmented magnetic resonance brain images." Expert Systems with Applications, Vol. 37, No. 3. pp: 2540-2549, 2013.

[20] K. Thapaliya, J. Pyun, C. Park, & G. Kwon. "The level set method with automatic selective local statistics for BrainTumor segmentation in MR images." Computerized Medical Imaging and Graphics, Vol. 37, No. 7-8., pp: 522-537. 2013.

[21] A. Faisal, S. Parveen, S. Badsha, & H. Sarwar. "An Improved Image Denoising and Segmentation Approach for Detecting Tumor from 2-D MRI Brain Images." 2012 International Conference on Advanced Computer Science Applications and Technologies *(*ACSAT*)*, 2012**.**