# TUMOR DETECTION AND CLASSIFICATION OF MRI BRAIN IMAGE USING WAVELET TRANSFORM AND SVM

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*Abstract*— **Brain tumor is a life threatening disease and its early detection is very important to save life. The tumor region can be detected by segmentation of brain Magnetic Resonance Image (MRI). In the case of suspected brain tumor, the location and size of tumor can be determined with the help of radiologic evaluations. The report of this evaluation is very important for futher diagnosis and treatment planning. The detection of tumor must be fast and accurate for the diagnosis purpose. The segmentation or extraction of brain tumor from MRI is possible manually. But it is time consuming and tedious. Also the accuracy depends upon the experience of expert. Hence, the computer aided automatic segmentation has become important. MRI scanned images offer valuable information regarding brain tissues. MRI scans provide very detailed diagnostic pictures of most of the important organs and tissues in our body. It is generally painless and noninvasive. It does not produce ionizing radiation. So MRI is one of the best clinical imaging modalities. Several automated segmentation algorithms have been proposed. But still segmentation of MRI brain image remains as a challenging problem due to its complexity and there is no standard algorithm that can produce satisfactory results. The aim of this research work is to propose and implement an efficient system for tumor detection and classification. The different steps involved in this work are image preprocessing for noise removal, feature extraction, segmentation and classification. Proposed work preprocessed the MRI brain image using anisotropic diffusion filters. In the feature extraction step, discrete wavelet transforms(DWT) based features are extracted. The extracted features was given as input to the segmentation stage. Here Support Vector Machine (SVM) was used for tumor segmentation and classification.**

***Keywords—Segmentation, MRI image, tumor detection, SVM, wavelet transform***

## I. INTRODUCTION

The fundamental structural unit of all living organisms is the cell. Human body contains about 100 trillion cells and each of them has its own functions. These cells have to divide and should form new cells in a controllable way. Then only the body can function correctly.But there are cases in whch the cells divide and grow without any control so that a huge amount of unwanted tissue will be formed. It is known as tumor.Tumors can occur in any parts of the body. Brain tumor can be considered as one of the serious and life-threatening tumors. It is actually created either by the abnormal and uncontrolled cell division within the brain or from cancers primarily present in other parts of the body. Tumor can affect healthy cells directly and indirectly. It may cause brain swelling and also increases the pressure inside the skull. Generally, tumors are classified based on the location of their origin and its malignancy[2].

There exists several imaging techniques. Magnetic Resonance Imaging (MRI), Computed Tomography (CT) are two imaging techniques for the diagnosis of brain tumor. MRI has the following advantages. It does not uses ionizing radiation while CT scans do. This radiation is harmful if there is repeated exposure.

As per the report of National cancer Institute statistics(NCIS), death rate due to brain cancer for USA is 12764 per year, 1063 per month, 245 per week and 34 per day[3]. It indicates that the diagnosis of brain tumor in the advanced stages is very important in order to save life. Also tumor detection should have high speed and accuracy. It is possible using MRI images. MRI image segmentation extracts suspicious region from complex medical images. The manual detection of brain tumor is possible by experts. But it has some problems. First problem is over-time consumption that is a series of 1500-2000 images of 512*512 pixels takes 2 to 4 hours. Second problem is that it is subjective that is the segmentation by different experts can vary significantly. The third problem is the variability of result by the same expert under different circumstances. Fourth difficulty is that the brightness and contrast of display screen will affect segmentation results. At this point automatic detection of brain tumor, becomes important. This technique must be easy to operate and self explanatory.

Diagnosis of tumor with the help of tools can improve the chance of survival from tumor in brain. In medical field doctors don't have a standard method that can be used for brain tumor detection which leads to varying conclusions between one doctor to another. There are several research works going on in order to segment medical images. It will lead to development of more computational tools. It can helps to improve the accuracy, exactness, and speed of computation of segmentation approaches, as well as minimizing the manual effort. Automated interpretation of segmentation is still very difficult eventhough the studies are done during last two decades. So several researchers are doing in this field to help doctors in diagnosing and treatment planning.

## II. METODOLOGY

For the segmentation of a medical image there are numerous algorithms which are utilized by many researchers. Among the segmentation algorithms, fuzzy c-means algorithm is a commonly used method for segmentation of MRI images by many researchers. The segmented output is then subjected to feature extraction. Wavelets find their way in recent research works. The features for the classification were extracted using wavelet transform decomposition technique[9]. Then the extracted features are used for classification.

In the recent years, the brain tumor is the one of the leading cause of death irrespective of the age. With the advancement of imaging and image processing techniques it is expected to provide more information to the physicians to take the accurate decision for better healthcare. The brain tumors can be detected using any one of the imaging modality and further processed by using image processing tools for accurate classification of tumors. Many researchers have reported various preprocessing algorithms, feature extraction techniques and classification algorithms. The preprocessing should be carried out with an appropriate filter so that the image edges could not be missed[5].

The general block diagram for MRI brain image segmentation and classification is shown in Figure1. The test MRI images undergo the processes like preprocessing, segmentation, feature extraction, and classification of brain MR images.

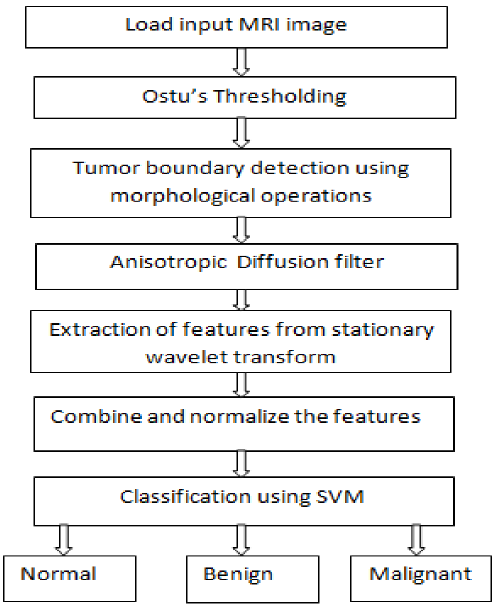


Figure 1.Block Diagram

### *A. Preprocessing*

The preprocessing involves various steps. Initially the input image is registered to a reference image. Now the skull and other unwanted details are removed from the input registered image. Ostu's thresholding and morphological operators are used for tumor boundary detection.Next step is the noise removal which can be accomplished by various filters. The filter used in this work is anisotropic diffusion filter[1]. This powerful filter is defined as a diffusion process. Inner parts of the regions are smoothed and edges are preserved by estimating local image structure and using edge strengths and the noise degradation statistics[4].

### *B. Extraction of features from DWT*

Discrete wavelet trasform decomposition is applied to the preprocessed image. Now the important features are extracted from the decomposed image. Then the extracted features are combined and normalized. The Discrete Fourier Transform (DFT) is a mathematical transform operation[15]. DFT converts digital signal form the spatial or temporal domain to the frequency domain. The frequency domain signal is expressed as a set of coefficients which is a factor of known sinusoidal components. The Discrete Wavelet Transformation (DWT) is similar to the DFT. DFT and DWT express the original signal as a combination of simpler signal called basic function . DCT and DFT uses sinusoidal waves as basic functions. But wavelet transform use small waves of varying frequency and of limited extent as basis function. It is known as wavelets. DWT can analyze the signal at different resolution. It deals with on approximation coefficient and detail coefficient[19][20]. This is similar to passing the signal through several band-pass filters. Successive low-pass and high-pass filtering of the signal and down sampling the signal after each filters is being done. DWT can be executed in multilevel. The data matrix used in each level is the approximation matrix generated in the previous level. In 2D wavelet decomposition, the wavelet transforms can be applied again on the lowpass-lowpass (LL) version of the image, yielding seven sub images. Hence N level decomposition in 2D cases resulting in 3N+1 different frequency bands namely, LL, LH, HL and HH.

### *C. Classification using Support Vector Machine (SVM)*

Classification is the process of classifying the given input by training with a suitable classifier. SVM classifier is one of the best classifiers suggested by many researchers which can be opted for the brain tumor classification from MR images[12][13]. It is independent of dimensionality and feature space. SVM transforms the input space to a higher dimension feature space through a non-linear mapping function and construct the separating hyper plane with maximum distance from the closest points of the training set[8] [6].

An efficient brain MR images classification technique using support vector machine was proposed. The features are extracted using wavelet transform decomposition and the obtained features are given as input to the SVM classifier[11]. The output of SVM classifier was obtained as normal or benign or malignant.

## III. RESULTS AND DISUSSION

### A. *Critical*

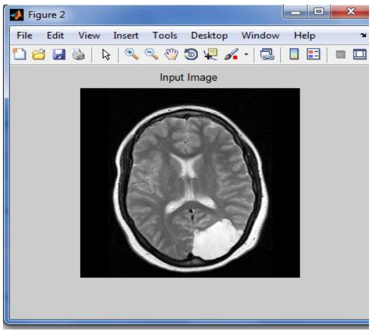


Figure 4.1.1 Input image

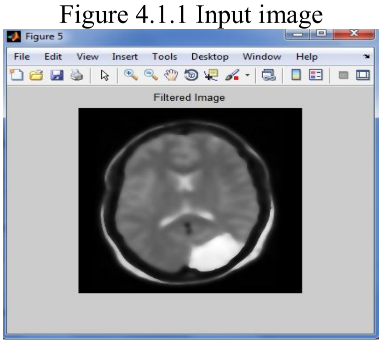


Figure 4.1.2 Filtered Image

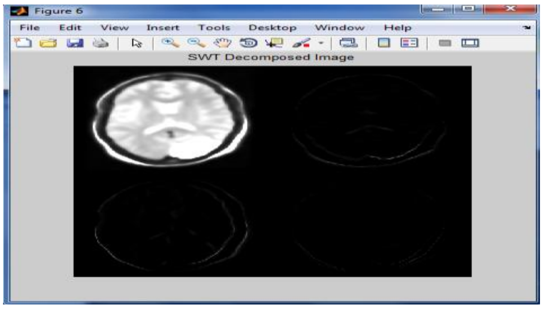


Figure 4.1.3 SWT decomposed Image

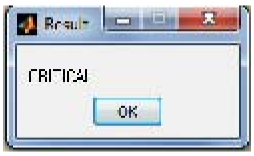


Figure 4.1.4 Classifier Output

The figure 4.1.1 shows the input MRI brain image which is critically affected by brain tumor[10]. Figure 4.1.2 shows the filtered image. The SWT decomposed output is shown in figure 4.1.3.Classifier output detected as critical case is shown in figure 4.1.4.

### B. *Medium*

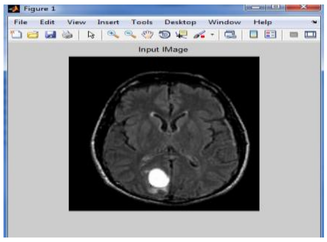


Figure 4.2.1 Input Image

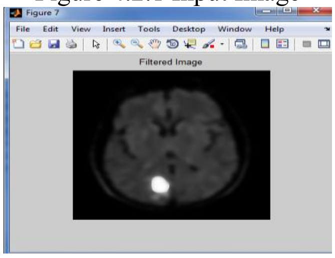


Figure 4.2.2 Filtered Image

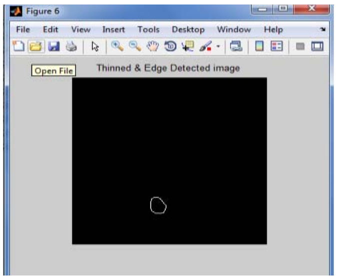


Figure 4.2.3 Edge deteted image


Figure 4.2.4 Classifier Output

The figure 4.2.1 shows the input MRI brain image which is medium affected case of brain tumor. Figure 4.2.2 shows the filtered image. The SWT decomposed output is shown in figure 4.2.3.Classifier output detected as medium affected case is shown in figure 4.2.4.

### C. *Normal*

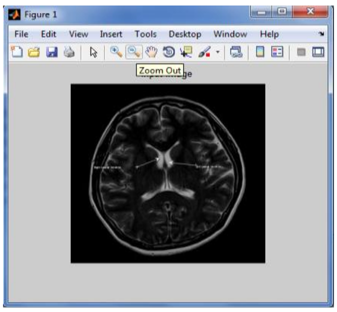


Figure 4.3.1 Input Image

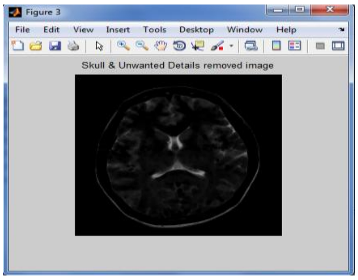


Figure 4.3.2 Filtered Image

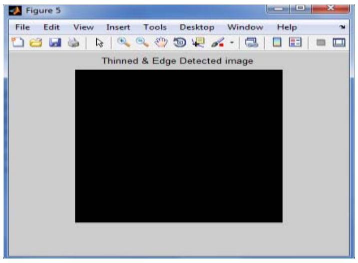


Figure 4.3.3 Edge deteted output

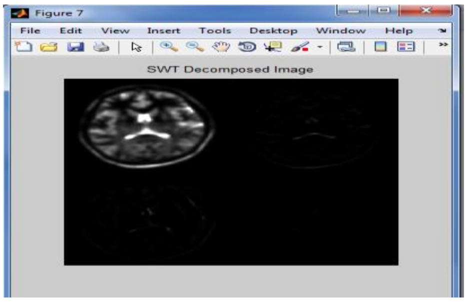


Figure 4.3.4 SWT decomposed Image

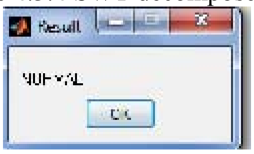


Figure 4.3.5 Classifier output

The figure 4.3.1 shows the input MRI brain image which is normal case without brain tumor. Figure 4.3.2 shows the filtered image. Edge detected output is shown in 4.3.3. The SWT decomposed output is shown in figure 4.3.4.Classifier output detected as medium affected case is shown in figure 4.3.4.

## IV. CONCLUSION

This work proposed a method for automatic segmentation and classification of MRI brain image with tumor. The tumor region is extracted using Ostu's thresholding and morphological operations. Then the segmented image has undergone wavelet decomposition. The features are extracted from the decomposed image. The extracted features are given as input to the support vector machine. Now the SVM classified the input image as normal, medium or critial. This work was implemented using MATLAB 2014a. The T1, T2 and FLAIR MRI images can also be segmented and classified[14]. The accuracy of the proposed method is 86%. The validation of the proposed method with existing clinical results is planned to implement as future work.

## V. REFERENCES

[1] Ayse Demirhan, Mustafa Toru, and Inan Guler, " Segmentation of Tumor and Edema Along with Healthy Tissues of Brain Using Wavelet and Neural Networks", IEEE journal of biomedical and health informatics, vol. 19, no. 4, july 2015,pp.1451-1458.

[2]Charutha s and M.J Jayashree, "An Efficient Brain Tumor Detection By Integrating Modified Texture Based Region Growing And Cellular Automata Edge Detection", 2014 International Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICCT),pp.1193-1199.

[3] Demirhan A and Guler.I, "Image segmentation using self-organizing maps and gray level co-occurrence matrices," J. Fac. Eng. Arch. Gazi Univ., vol. 25, no. 2, pp. 285–291, 2010.

[4] Gerig G, Kubler O, R. Kikinis, and F. A. Jolesz, "Nonlinear anisotropic filtering of MRI data," IEEE Trans. Med. Imag., vol. 11, no. 2, pp. 221–232, Jun. 1992.

[5]Howard Lee, Yi-Ping Phoebe Chen, 'Image based computer aided diagnosis system for cancer detection', Expert Systems with Applications 42 (2015) 5356–5365.

[6] Reddick W.E, Glass J.O, Cook E, Elkin T.D, and Deaton R.J, "Automated segmentation and classification of multispectral magnetic resonance images of brain using artificial neural networks," IEEE Trans. Med. Imag., vol. 16, no. 6, pp. 911–918, Dec. 1997.

[7]Vala, Hetal J., and Astha Baxi. "A review on Otsu image segmentation algorithm." International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) 2, no. 2 (2013): pp-387.

[8]Yu, Hwanjo, and Sungchul Kim. "Svm tutorial—classification, regression and ranking." Handbook of Natural computing. Springer Berlin Heidelberg, 2012. 479-506.

[9] Zhang Y, Dong Z, L. Wu, S. Wang, and Z. Zhou, "Feature extraction of brain MRI by stationary wavelet transform," in Proc. Int. Conf. Biomed. Eng. Comput. Sci., Wuhan, China, 2010, pp. 1–4.

[10]http://www.imm.dtu.dk/projects/BRATS2012.

[11]S. Ahmed, K. M. Iftekharuddin, and A.Vossough, "Efficacy of texture, shape, and intensity feature fusion for posterior-fossa tumor segmentation in MRI," *IEEE Trans. Inf. Technol. Biomed.*, vol. 15, no. 2, pp. 206–213, Mar. 2011.

[12]N. Zhang, S. Ruan, S. Lebonvallet, Q. Liao, and Y. Zhu, "Kernel feature selection to fusemulti-spectral MRIimages for brain tumor segmentation," *Computer Vision Image Understanding*, vol. 115, pp. 256–269, 2011.

[13]B. Menze, A. Jakab, S. Bauer, M. Reyes, M. Prastawa, and K. van Leemput. Challenge on multimodal brain tumor segmentation presented at MICCAI 2012 [Online]. Available: http://www.imm.dtu.dk/ projects/BRATS2012

[14]S. C. Kim and T. J. Kang, "Texture classification and segmentation using wavelet packet frame and Gaussian mixture model," *Pattern Recognit.*, vol. 40, pp. 1207–1221, 2007.

[15]A. Demirhan and ˙I. Guler, "Combining stationary wavelet transform and self-organizing maps for brain MR image segmentation," *Eng. Appl. Artif. Intell.*, vol. 24, pp. 358–367, 2011.

[16]Y. Zhang, Z. Dong, L. Wu, S. Wang, and Z. Zhou, "Feature extraction of brain MRI by stationary wavelet transform," in *Proc. Int. Conf. Biomed. Eng. Comput. Sci.*, Wuhan, China, 2010, pp. 1–4.

[17]A. Demirhan and ˙I. G¨uler, "Image segmentation using self-organizing maps and gray level co-occurrence matrices," *J. Fac. Eng. Arch. Gazi Univ.*, vol. 25, no. 2, pp. 285–291, 2010.

[18]X. Li, L. Wang, and E. Sung, "AdaBoost with SVM based component classifier," *Eng. Appl. Artif. Intell.*, vol. 21, no. 5, pp. 785–795, 2008.

[19]R. Vijayarajan and S. Muttan, ―Discrete wavelet transform based principal component averaging fusion for medical images, *AEU-International Journal of Electronics and Communications*, vol. 69, pp. 896-902, 2015.

[20]P. John, "Brain Tumor Classification Using Wavelet and Texture Based Neural Network", International Journal of Scientific & Engineering Research, vol.3, no.10, pp.1-7, October-2012.