A New Threshold Approach for Brain Tumor Segmentation using Neuro Fuzzy

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Abstract
The lump inside the brain is considered a brain tumor, due to cells divide and grow in an uncontrolled way the lump formed inside the brain. At present-day, processing of medical images is a developing and important field. It includes many different types of imaging methods, they are Computed Tomography scans (CT scans), X-rays and Magnetic Resonance Imaging (MRI) etc. The technologies like MRI and CT allow us to separate even the smallest imperfections in the human body. Brain tumors are classified as noncancerous (benign), and cancerous (malignant). Accurate detection is exactly possible by using computer-aided technology. To improve the performance and reduce the complexity involves in the brain tumor detection process, the proposed method includes effective pre-processing, segmentation and classification. The brain tumor Magnetic Resonance Image (MRI) is converted into a grayscale image from the RGB image. Then, Morphological, Segmentation and Otsu thresholding operations are done after the basic pre-processing techniques implementation. Then, the Neuro-Fuzzy technique is used to classify the stages of the brain tumor as normal or abnormal based on texture features. In this paper, the steps mentioned above are discussed in detail with their simulation results.

Keywords *- MagneticResonance Imaging, Medical Image Processing, Pre-processing and Enhancement,Segmentation,Threshold, Neuro-fuzzy.*

I.INTRODUCTION

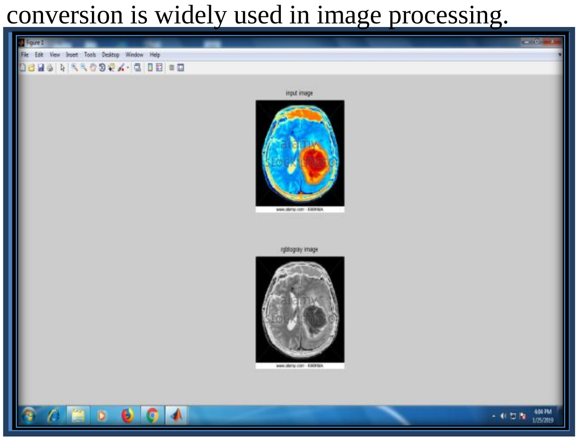
The abnormal growth of cells inside the skull which leads to a brain tumor and it also damages the other functioning cells in the brain. Estimation of the World Health Organization (WHO) pieces of evidence, the most common brain diseases is a tumor and there are more than 120 types of brain and Central Nervous System (CNS) tumors. Brain tumor detection is a thought-provoking task due to the complex structure of the human brain. Basically, tumor in the human brain is classified in to benign or malignant. The objective of this survey is to elaborate on different pre-processing and segmentation techniques available to determine benign or malignant cells inside the brain. MRI helps identify tumors by magnifying the differences in water content and blood flow between tissues. The growth of malignant tumors creates their own network of blood vessels via angiogenesis; because of this a huge supply of blood to the surrounding tissues. Contrast material points out the blood vessels with high concentration, helps locate the growth of malignant. Computer programs have defeated humans in Jeopardy.

Pre-processing is the first step, performed to extract the Region Of Interest (ROI) using manual skull stripping and noise effects are removed by filters. Segmentation is the second step, dividing the image to its essential parts sharing identical properties such as color, texture, contrast, and boundaries. Processing and analyzing of Magnetic Resonance brain tumor images are the most upcoming and challenging field. MRI is an advanced medical imaging technique used to characterize and discriminate among tissues using their physical and biochemical properties (water, iron, fat, and extravascular blood and its breakdown products) and it is a very important process for determining the correct treatment at the right stage for a tumor-infected individual.

II.PREPROCESSING

A. RGB to grayscale image

An RGB image referred to as a tricolor image that is red, green, and blue color components for each individual pixel. A Grayscale image contains only shades of gray and no color. In medical research proved that the human eye has different sensitivity to color and brightness. Thus there came about the transformation of RGB to Grayscale conversion. This process removes all color information, leaving only the luminance of each pixel. Thus RGB to Grayscale conversion is widely used in image processing.

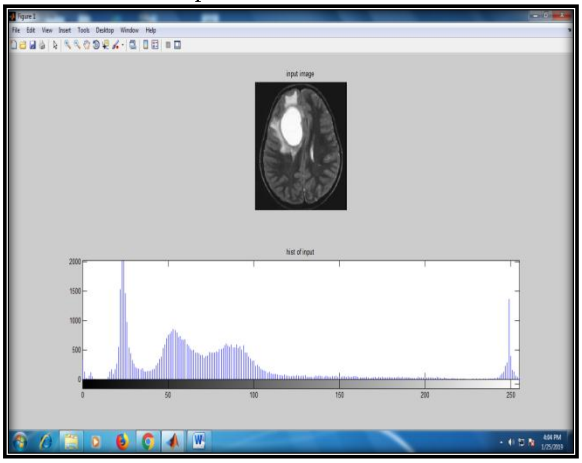


B. Histogram equalization

The Histogram of the image represents the relative frequency occurrence of various graylevel in the image. Histogram equalization is used to improve the contrast of the image. To transform an image in such a way that the transformed image has a nearly uniform distribution of pixel values. It makes more visible in an image. Histogram of the digital image with gray levels in the range [0, L-1] is a discrete function

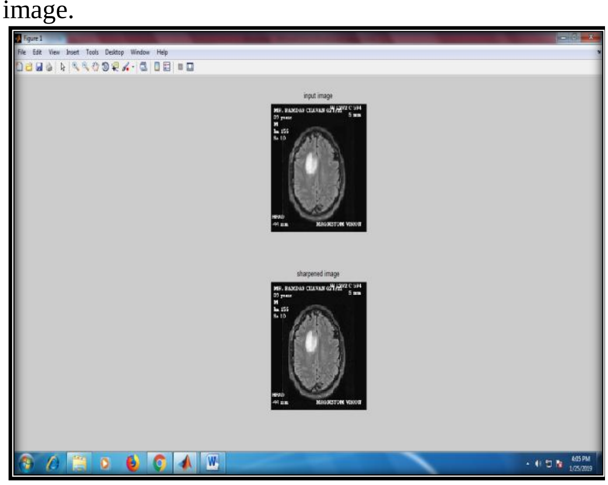
$$H(r_k) = n_k$$

The components of the histogram in the high contrast image cover a broad range of grayscale and the distribution of pixel is also uniform.



C. Image sharpening

Human perception is highly sensitive to edges and fine details of an image, since they are composed primarily by high-frequency components, the visual quality of an image can be enormously degraded if the high frequency are attenuated or completed removed in contrast, enhancing the high-frequency components of an image leads to improvements in the visual quality image sharpening is widely used in medical and industries for increasing the local contrast and sharpening the image.



D. Filtering

Filtering is a technique for enhancing an image. Filtering technique is used to emphasize certain features or remove other features. Image processing operation implemented with filtering includes smoothing sharpening and edge enhancement.

TYPES OF FILTERS:

(a) Nonlinear filtering:

Non-linear filters also exist which are not space invariant; these attempt to locate edges in the nosey image before applying to smooth, a difficult task at best, in order to reduce the blurring of edges due to smoothing.

(b) Linear filtering:

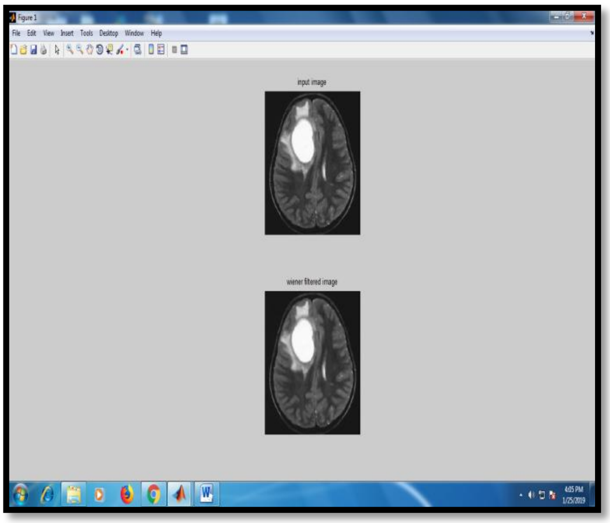
Linear filtering is filtering in which the value of an output pixel is a linear combination of the value of the pixels in the input pixel's neighborhood.

WIENER FILTERING:

The most important technique for removal of blur in images due to linear motion or unfocussed optics is the Wiener filter. From a signal processing standpoint, blurring due to linear motion in a photograph is the result of poor sampling. Each pixel in a digital representation of the photograph should represent the intensity of a single stationary point in front of the camera. Unfortunately, if the shutter speed is too slow and the camera is in motion, a given pixel will be an amalgam of intensities from points along the line of the camera's motion. This is a two-dimensional analogy to

$$G(u,v)=F(u,v) \cdot H(u,v)$$

Where F is the Fourier transform of an "ideal" version of a given image, and H is the blurring function. In this case, H is a sinc function



E. Artefact Removal

In natural science and signal processing, an artifact is an error in the perception or representation of any information, introduced by the involved equipment or technique.An artifact in medical imaging: In medical imaging, artifacts are misrepresentations of tissue structures produced by imaging techniques such as ultrasound, X-ray, CT scan and magnetic resonance imaging (MRI). These artifacts may be caused by a variety of phenomena such as

a. The underlying physics of the energy-tissue interaction as between ultrasound and air susceptibility artifacts.

b. Data acquisition errors such as patient motion or reconstruction algorithms inability to represent the anatomy.

F. Skull stripping

The skull stripping method is important in brain image processing applications. Brain Extraction or removing the Skull from a brain tumor image. The brain extraction tool is used to remove the skull from an image, leaving only the region occupied by actual brain tissue. It segments these by using the dark space between the skull and brain.

Magnetic Resonance Imaging is a recently emerged method for brain imaging. Two major limitations of brain MR images are low contrast image and presence of skull region in the image. So before a detailed analysis of an image, as a pre-processing stage, these two problems must be resolved. In this study, we propose a method for MR image contrast enhancement and skull stripping based on the Morphological image processing technique and Atlas based method.

1. Morphological based skull stripping

Though the skull is an important part of the human body, for diagnosing using MR Images of the brain, it is not needed. Many methods are reported for removing the skull part from an MR brain image. Algorithm for skull stripping based on mathematical morphology.

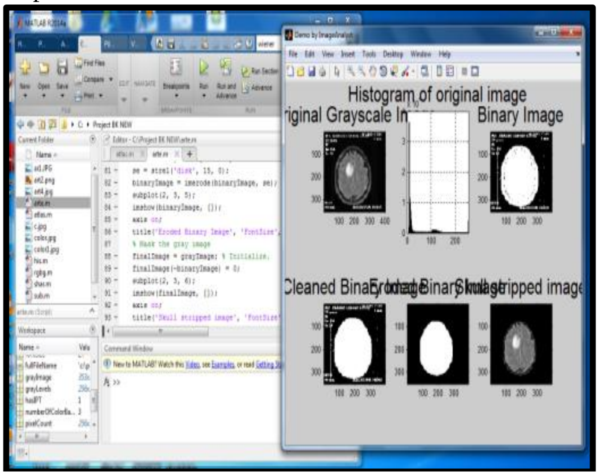
Dilation: The value of the output pixel is the maximum value of all the pixels in the input pixel's neighborhood.

Erosion: The value of the output pixel is the minimum value of all the pixels in the input pixel's neighbourhood.

2. Atlas Based Method

The atlas-based method relies on fitting an atlas on the MRI brain image to separate the brain from the skull. It has an ability to separate brain and non-brain when no well-defined relationship between regions and pixel intensities in the brain image. These methods vary in how many templates they use in distinguishing brain regions and also how they apply this atlas.

A skull stripping method as a pre-processing step for the cortical surface reconstruction process. This procedure takes an intensity-normalized image and deforms a tessellated ellipsoidal template into the shape of the inner surface of the skull.



III. IMAGE DECOMPOSITION

The dual-tree complex wavelet transform (CWT) is a relatively recent enhancement to the discrete wavelet transform (DWT), with important additional properties: It nearly shifts invariant and directionally selective in two and higher dimensions. It achieves this with a redundancy factor of the only 2d for d-dimensional signals, which is substantially lower than the undecimated DWT.

The multidimensional (M-D) dual-tree CWT is non-separable but is based on a computationally efficient, separable filter bank (FB). This tutorial discusses the theory behind the dual-tree transform, shows how complex wavelets with good properties can be designed and illustrates a range of applications in signal and image processing.

We use the complex number symbol C in CWT to avoid confusion with the often-used acronym CWT for the (different) continuous wavelet transform. This article aims to reach two different audiences.

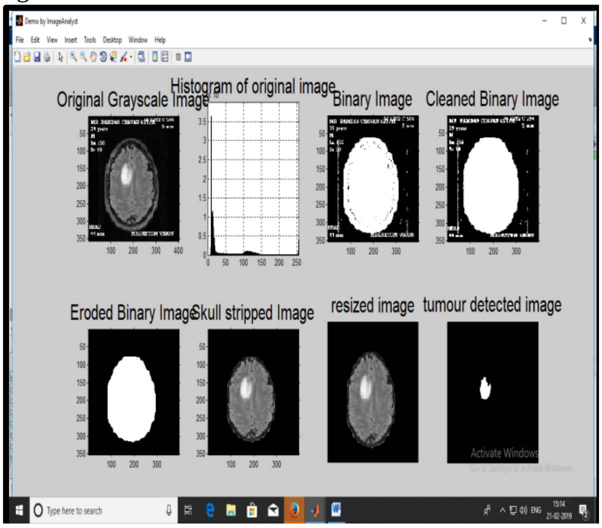
The first is the wavelet community, many members of which are unfamiliar with the utility, convenience, and unique properties of complex wavelets. The second is the broader class of signal processing folk who work with applications where the DWT has proven somewhat disappointing, such as those involving complex or modulated signals (radar, speech, and music, for example) or higher dimensional, geometric data (geophysics and imaging, for example).

In these problems, the complex wavelets can potentially offer significant performance improvements over the DWT.

IV.THRESHOLDING

Otsu method is a very famous and excellent scheme. Otsu's algorithm has utilized the scheme for robust and automatic gray level image segmentation at a certain commercial system, such as Matlab. In image segmentation process, determining an optimal threshold t* is usually based on the estimates of dispersion and location of intensities in c1 and c2. As with various other algorithms,

Otsu's algorithm uses the average value and the deviation to calculate the dispersion and the location. Unfortunately, for those images with the presence of very long-tailed distributions, the Otsu method usually provides poor thresholding results. The average difference is commonly chosen as the estimate of the separation when the point with median level is selected for the location. For addressing this problem, a median-based Otsu method is proposed in this work and obtains very satisfactory results compared with the original Otsu algorithm.



V. NEURO-FUZZY

Image classification is an issue that utilizes image processing, pattern recognition, and classification methods. Automatic medical image classification is a progressive area in image classification, and it is expected to be more developed in the future. Because of this fact, automatic diagnosis can assist pathologists by providing second opinions and reducing their workload. This paper reviews the application of the adaptive neuro-fuzzy inference system (ANFIS) as a classifier in medical image classification during the past 16 years.

ANFIS is a fuzzy inference system (FIS) implemented in the framework of an adaptive fuzzy neural network. It combines the explicit knowledge representation of a FIS with the learning power of artificial neural networks. The objective of ANFIS is to integrate the best features of fuzzy systems and neural networks. In this proposal, it classifies the stage of the tumor as benign or malignant.

VI.RESULTS

The proposed technique is implemented in real human brain images. The training database consists of 15 images: five normal, five benign and five malignant images. The testing database consists of several unknown images. These are 1.5 T1 axial, T2-weighted images of varying sizes. There are three images classes; normal, benign and malignant.

The input image is pre-processed by gray-scale imaging and image re-sizing. Dual tree complex wavelet transform decomposed the pre-processed image into multiple sub-bands for analysis texture of an image. Features are extracted from high-frequency sub-bands using the Gray-level co-occurrence matrix. For each sub-band, we calculate the texture features such as contrast, correlation, energy, and homogeneity.

Then image classifier classifies the unknown MR images based on training for detecting the classes of tumor such as Normal, Benign and Malignant. Segment the classified benign and malignant MR images for locating tumor area using Otsu thresholding. The tumor is displayed as a white portion in the image which includes information such as the total number of pixels, black pixels, and white pixels.

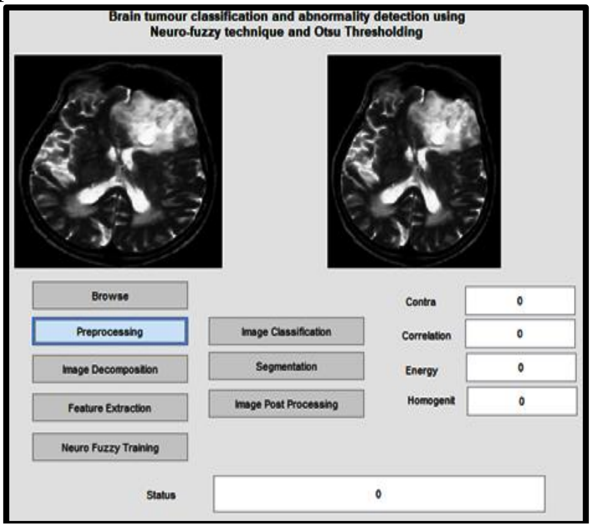


Fig.1 Pre-processing

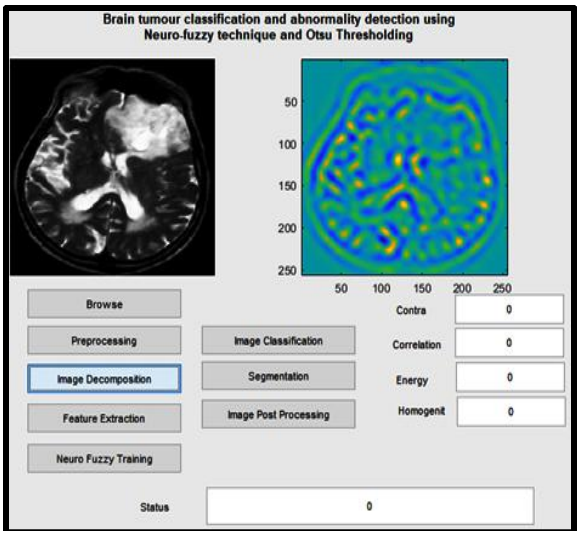


Fig.2 Image Decomposition

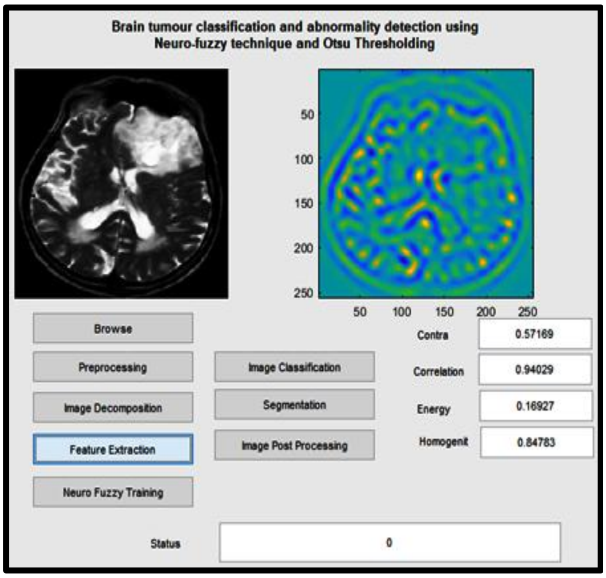


Fig.3 Feature extraction

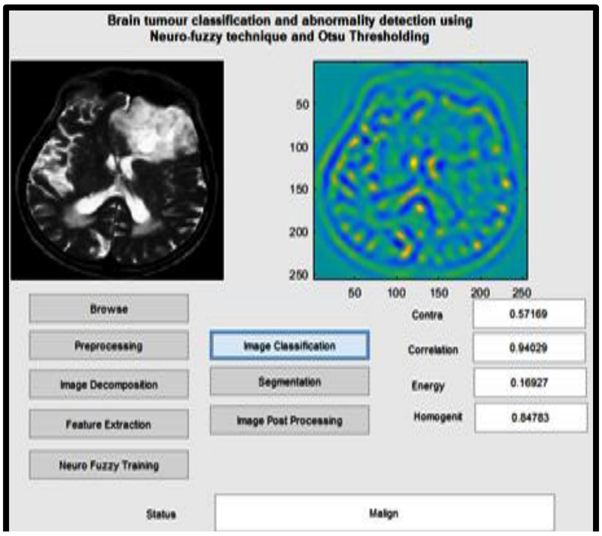


Fig 4 Image classification

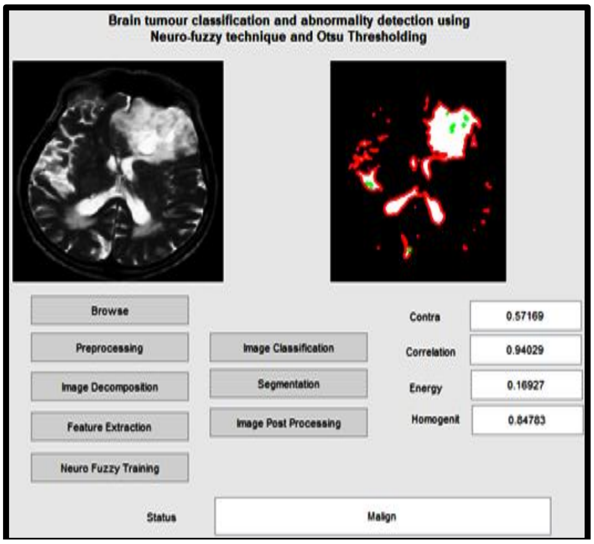


Fig.5 Image Segmentation

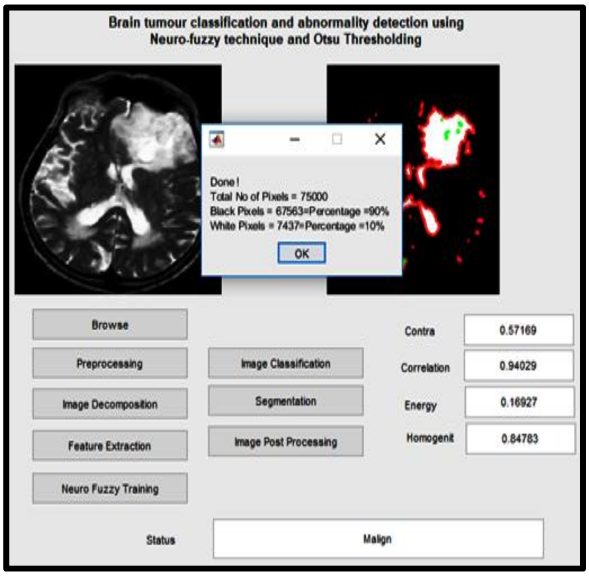


Fig.6 Image post-processing

VII.CONCLUSION

In this paper, we have proposed a new approach to classification and segmentation techniques for detecting and locating brain tumors. We have used DT-CWT to decompose MR images into multiple sub-bands for analyzing the texture of an image. We have performed GLCM to extract features from decomposed subbands that will be used as input to the neuro-fuzzy technique. Classification operation is performed by the neuro-fuzzy method for detecting the type of brain tumor such as benign, malignant and normal. We have presented a segmentation using Advanced Thresholding for locating the brain tumor. We have used sensitivity, specificity, and accuracy to estimate the performance of the developed algorithm. Performance comparison of the developed algorithm for classification and segmentation to the existing algorithm showed that our technique performed well.

REFERENCES

[1] G. Vijay Kumar, Dr GV Raju, “Biological early brain cancer detection using artificial Neural Network”, IJCSE, Volume 2, No.8, 2010.

[2] AnantBhardwaj, Kapil Kumar Siddhu, “An approach to medical image classification using Neuro Fuzzy logic and ANFIS classifier”, IJCTT, 2014, Volume 4, Issue 3.

[3] Jinal A. Shah, S.R.Suralkar, “Brain Tumor detection from MRI Images using Fuzzyaja C-Means Segmentation”, IJAR, 2016.

[4] N. V. Chavan, B. D. Jadhav and P. M. Patil, “Detection and Classification of Brain Tumors”,International Journal of Computer Applications, vol. 112, no. 8, (2015).

[5] ArokiaRenjith, P.Manjula&P.Mohan Kumar “Brain tumour classification and abnormality detection using neuro fuzzy technique and otsuthresholding”Journal fo Medical engineering & Technology,2015.

[6] Al-Amin, Md, Mohammad BadrulAlam, and MdRonju Mia. “Detection of Cancerous and Non-cancerous Skin by using GLCM Matrix and Neural Network Classifier.” International Journal of Computer Applications, Vol. 132, No. 8, 2015, p. 44.

[7] Viharos, Zs J., and KrisztiánBalázsKis. “Survey on Neuro-Fuzzy systems and their applications in technical diagnostics and measurement.” Measurement, Vol. 67, 2015, pp. 126-36.
[8] SonuSuhag and L. M. Saini,“ Automatic Detection Of Brain Tumor By Image Processing In Matlab”, SARC-IRF international conference, may-2015.
[9] Riddhi.S.Kapse, Dr. S.S. Salankar and Madhuri.Babar,” Literature Survey on Detection of Brain Tumor from MRI Images”, IOSR Journal of Electronics and Communication Engineering, ISSN: 2278-8735, Volume 10, Issue 1, Ver. II, PP 80-86 (Jan - Feb. 2015)
[10] Nidhi; Kumari, P.; "Brain tumor and edema detection using Matlab,"International Journal of Computer Engineering and Technology (IJCET), vol.5(3), pp. 122-131, March (2014).
[11] Chalumuri Revathi1, Dr. B. Jagadeeshsegmentation of brain images for tumor detection using neuro-fuzzy inference system(ijcesr)volume-4, issue-12, 2017.
[12] Nikita V. Chavan , B.D. Jadhav , P.M. PatilDetection and Classification of Brain TumorsInternational Journal of Computer Applications Volume 112 – No. 8, February 2015.
[13] Anjali Gupta, GunjanPahuja, “Efficient Fuzzy based method for brain tumor segmentation on MR images”, IJARCSSE,Volume 6, Issue 8, 2016.
[14] Sudipta Roy, Shayak Sadhu, Samir Kumar Bandyopadhyay, Debnath Bhattacharyya and Tai-Hoon Kim, “Brain Tumor Classification using Adaptive.
[15] Neuro- Fuzzy Inference System from MRI”, IJBB,Volume 8, pp. 203-218, 2016
[16] Imran Ahmed, QaziNida-Ur-Rehman, GhulamMasood, Muhammad Nawaz, “Analysis of Brain MRI for Tumor Detection & Segmentation”, ISBN, Volume 1 , 2016.
[17] Jinal A. Shah, S.R.Suralkar, “Brain Tumor detection from MRI Images using Fuzzy CMeans Segmentation”, IJAR, 2016.

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