# Brain Tumor Detection Techniques: Brief Survey

[1]Deepthi Sehrawat, [2]Abhishek Sehrawat,
[1] Amity School of Engineering & Technology, Amity University Gurgaon, India
[2] University of Calcutta & The West Bengal University of Health Sciences, India

***Abstract:***

Brain tumor is nothing but an uncontrollable and abnormal growth of cells within the brain. Most research in developed countries shows that main cause of death of people having brain tumor is incorrect detection of brain tumor. It is one of the most dangerous diseases and therefore it should be detected quickly and accurately. This can be done by using automatic tumor detection techniques on medical images. Generally, MRI or CT scan that is directed into intracranial cavity produces the complete image of the brain tumor. Magnetic Resonance Imaging (MRI), a highly developed technique of medical imaging, is used to visualize internal structure of human body without any surgery. For the accurate detection of brain tumor, segmentation of MRI image is important. Classification of tumor, through segmented MR image, into normal and abnormal MRI brain images, is a difficult task due to complexity and alteration in tumor tissue characteristics like its location, size, gray level intensities and shape. In this paper, review of various techniques of automatic detection of brain tumor using Magnetic Resonance Image (MRI) is proposed**.**

*Keywords - Brain tumor, MRI, detection, Kmeans, SVM, CNN, Deep Learning*

## I. INTRODUCTION

Brain tumor is an uncontrollable and abnormal growth of cells in the brain. Brain Tumors are of two types- primary or benign brain tumors and metastatic or malignant brain tumors. Primary brain tumors starts and spread only in the brain. Metastatic brain tumors can initiate somewhere in the body as cancer and extend to the brain. Various methods, which are available in diagnosis, are expert opinion, human inspection, biopsy, and etc. These methods have some drawbacks like time consumption, incorrect inspection etc. So image processing techniques can be helpful to detect brain tumor. There are various medical imaging techniques like x-ray, computed tomography (CT), positron emission tomography (PET), magnetic resonance imaging (MRI), are available for tumor detection. The MRI is the most commonly used modality for brain tumor growth imaging and location detection due to its higher resolution. Magnetic Resonance Imaging (MRI) is an imaging technique which non-invasively provides high contrast images of different anatomical structures. It provides better differentiation of tissues than other medical imaging techniques. Evaluation and analysis of MRI images by radiologists is error-prone and time consuming. Hence radiologists can use an algorithmic image processing in brain tumor diagnosis in MR images, especially due to large alterations in shape and size of structures needs to be considered for brain tumor detection and segmentation. Therefore, automatic analysis and classification of such medical images is essential.

Image processing is basic step in identifying the tumor that helps in proceeding with further treatments. Digital Image processing is one of the field where we use computer algorithms that helps to perform image processing on digital images. Choosing Digital Image processing over Analog Image processing (in which image processing is the task conducted on two dimensional analog signals by analog means) has many advantages. Firstly, digital image processing provides a wide range algorithms compared to analog so we have more choices in selecting the best suitable algorithm. Secondly, digital processing can avoid buildup of noise and signal distortion. Digital Image processing consist of numerous types involved some of them are image Acquisition, Image Enhancement, Image Restoration, Compression, Image segmentation, object recognition and so on. The most important step is the Image Segmentation as identifying the exact tumor area would ease process of deciding on the further treatment. Image segmentation is the process of partitioning a digital image into multiple segments. The main objective is to change the representation of the image into something which is meaningful.

## II. LITERATURE REVIEW

In recent years, various methods have been proposed for image segmentation and classification techniques of brain tumors. Parveen and Amritpalsingh **[1]**, proposed data mining methods for classification of MRI images. Classification is performed in four stages: pre-processing, segmentation, feature extraction, and classification. In the first stage, enhancement and skull stripping is performed to improve the speed and accuracy. Segmentation was done by Fuzzy C-Mean (FCM) clustering. Grey level run length matrix (GLRLM) is used for extraction of feature from the brain image, after which SVM technique is applied to classify the brain MRI images, which provide accurate and more effective result for classification of brain MRI images. Kailash Sinha and G.R.Sinha **[2]**, presented a comparative study of three segmentation methods implemented for extraction of tumor in the MRI images. Proposed methods are k-means clustering with watershed segmentation algorithm, optimized k-means clustering with genetic algorithm and optimized c- means clustering with genetic algorithm. For comparison, the searching time and area of tumor region

were considered as comparison parameters. Results depict that, clustering algorithm in case of optimized method perform much better segmentation than that of ordinary clustering algorithm. The problem of over segmentation has also been reduced. Also it is found that the optimized c-means perform better that optimized k-means method. H. B. Nandpuru, Dr. S. S. Salankar and Prof. V. R. Bora **[3]**, in their paper introduced classification techniques based on Support Vector Machines (SVM) and applied to brain image classification to recognize normal and abnormal MRI brain image. Proposed technique includes following stages: preprocessing, feature extraction, feature reduction, training, storing the database and testing. In this paper gray scale, symmetrical and texture features used for feature extraction from MRI Images. Extracted features reduced by using PCA method and then submitted to a support vector machine for training and testing. More accurate result than the other methods obtained. R.S.RajKumar and G.Niranjana **[4]**, introduces cellular automata based segmentation of MRI brain tumor and classification of tumors using Gray level Co-occurrence matrix features and artificial neural network. Grey Level Co-occurrence Matrix (GLCM) used for extracting Texture feature of the image. After the selection of seed pixel from co-occurrence features, it is checked that whether the selected seed pixel belongs to abnormal region or not and is checked by calculating the Run length features. For segmentation, cellular automata (CA) based seeded tumor segmentation method is proposed. Segmented images are fed to classification using Radial basis function which is the type of ANN. The approach is limited by the fact that it necessitates fresh training each time whenever there is a change in image database. B. Gupta and S. Tiwari **[5]**, proposed brain tumor detection using Curvelet Transform and Support Vector Machine. Proposed methodology consists of following main stages: image acquisition, feature extraction and classification. In the first stage, MRI brain images are obtained from the database. Feature extraction is done using curvelet transform which is more efficient than wavelet transform. Extracted features are then applied for classification of MRI brain images which is performed using support vector machine. Satisfactory performance achieved.
A. Padma and R. Sukanesh **[6]**, presented new wavelet based dominant run length feature extraction method for classification of soft tissues in brain CT Images. The proposed methodology consists of mainly 3 phases: i) Discrete wavelet decomposition (ii) Feature extraction and selection (iii) Classification and Evaluation. In the first phase, two level wavelet decomposition of region of interest is performed to get better results. Feature extraction is performed using wavelet based dominant gray level run length feature extraction method. Extracted features are applied to SVM classifier to detect abnormal tumor region. Classification accuracy achieved using SVM is 98%. G.V. Kumar and Dr G.V. Raju **[7]**, in their paper, presented brain tumor detection using a neuro fuzzy technique. For the detection of brain tumor from MRI images, various image processing techniques like image segmentation, image enhancement, morphological operation, feature extraction and classification are proposed. Image segmentation is performed using histogram equalization followed by thresholding technique. For adjusting contrast of images, image enhancement and sharpening filter are used. Gray Level Co-occurrence Matrix (GLCM) technique is used for feature extraction. Extracted features are then fed to neuro-fuzzy classifier for normal and abnormal MRI image classification. Experimental results demonstrates, about 50-60% improvement in iteration time and the accuracy level compared to the existing neuro classifier. Pranita Balaji Kanade and Prof. P.P. Gumaste **[8]**, proposed brain tumor detection using MRI images. In this paper, the brain tumor is detected & classified stages of the tumor by using testing & training the database. Proposed methodology consists of following main stages: image preprocessing, segmentation, feature extraction and classification. In the first stage, image normalization and de-noising is performed. Spatial FCM technique is used for segmentation. For feature extraction of MR images stationary wavelet transform (SWT) technique is used. Finally, using these extracted features, images are classified using Probabilistic neural networks (PNN). VijayaRekha.R, Sudha.S, Sangeetha.J and Shenbagarajan Anantharajan **[9]**, proposed method of detection and classification of brain tumor using Decision Tree. The proposed technique consists of four stages: preprocessing, segmentation, feature extraction and classification. First stage involves, noise removal, resizing and filtering of image. Segmentation is performed using adaptive thresholding technique and GLCM technique is used for feature extraction. Finally, classification is done using decision tree classifier. The system is found efficient in classification of these samples. Pratik P. Singhai and Siddharth A. Ladhake **[10]**, introduced a technique to detect brain tumor from Magnetic Resonance Image. The proposed methodology consists of following stages: preprocessing, Sobel Mask& Gradient Magnitude application, segmentation and tumor area calculation. In the first stage, RGB to gray conversion and Image resizing is performed. Using sobel mask, Gradient magnitude is computed before segmentation. Segmentation is performed using marker based watershed segmentation technique. In the last, using connected component analysis, tumor area is calculated. Rohini Paul Joseph, C. Senthil Singh and M.Manikandan **[11]**, proposed segmentation of brain MRI image using image processing techniques. The proposed method has three main steps: preprocessing, segmentation and morphological filtering. The preprocessing stage perform RGB to Grey conversion and noise removal. K-means clustering algorithm is used for image segmentation. In the last step, morphological filtering is performed to avoid the mis-clustered regions that can inevitably be formed after segmentation of the brain MRI image for detection of tumor location.

## III. RESEARCH METHODOLOGY

### a) Unsupervised Artificial Bee Colony algorithm and FCM clustering

By knowing importance of tumor segmentation of MRI brain images, in this paper, “Brain Tumor Segmentation in MRI images using Unsupervised Artificial Bee Colony algorithm and FCM clustering” [12] the author has proposed a fast MRI brain image segmentation

method which uses Artificial Bee Colony algorithm and Fuzzy C-means algorithm. ABC algorithm is used to find optimized threshold. The original image is decomposed by discrete wavelet transforms to get well ordered fitness function for ABC algorithm. Then a filtered image is reconstructed with low frequency by performing noise reduction to approximation image. The segmented image is clustered using FCM algorithm which is used in identifying the brain tumor.

**b) Pixel Classification**

This paper, "Pixel Classification based Brain MR Image segmentation" [13] presents the segmentation of brain MR images into four classes namely background, Cerebra spinal fluid, grey and white matter. This method also accomplishes an accurate segmentation of tumor in brain. The inter class distances are compared for classifying the pixelin various different classes. The author have ensured average Jaccord Index and dice co-efficient of 0.8173 and 0.8952 respectively. The result of this proposed method has proven that the segmentation accuracy is good for images which have no noise or in-homogeneity.

**c) K-means Clustering and SVM**

In this paper, "A New Brain MRI image segmentation strategy based on K-means Clustering and SVM"[14] the authors have proposed a new strategy that uses K-means Clustering and SVM to segment brain MR images for the problem of noise and no reference image during MRI image segmentation. In this work MRI images are segmented using K-means clustering algorithm which gives us the initial classification result as class label then the feature vectors of each pixel of brain tissue are selected as training sample and test sample, and also SVM is used to segment brain MRI image. Experimental results of this proposed method produces better segmentation and good suppression of noise with low signal-noise-ratio (SNR) for brain images. The outcome of this proposed method has given better segmentation effect for low SNR brain MRI.

**d) Improved Fuzzy C-Means clustering and Watershed Algorithm**

The most commonly used algorithm for extracting Brain tumor is Fuzzy C-Means clustering and Watershed algorithm. This work, "Brain Tumor Segmentation from MR Brain Images using Improved Fuzzy C-Means clustering and Watershed Algorithm"[15] combines these two algorithms and it also presents an improved version of Fuzzy C-Means for clustering which includes an effective method to select the initial centroid based on histogram calculation. To avoid over segmentation problem often found in Watershed algorithm Atlas based Marker detection method is used. Before segmentation process, this work includes a preprocessing stage that contains 3 operations: Noise removal, Skull stripping and Contrast enhancement. They have achieved an improved accuracy for Fuzzy C-Means of 88.91 and 81.56 for Dice and Tanimoto coefficients and for Watershed 93.13 and 88.64 of Dice and Tanimoto coefficients. They have compared accuracy of normal Fuzzy C-Means and Watershed algorithm accuracy with the proposed method.

**e) Convolution Neural Network**

This paper, "Brain Tumor Image Segmentation based on Convolution Neural Network"[16] provides a new method for automatic brain tumor segmentation combining Multimodality Images and Convolution Neural Network. Early diagnosis and automatic brain tumor segmentation reduces the problem of low accurateness and time consumption compared to that in manual segmentation. This model extracts the natural and important features from Multimodality brain tumor images and then combines it with Multimodality information. Later to obtain comprehensive and quantitative evaluation, Convolution Neural Network results is compared with Menze 2010 and Bauer 2011, and is found that it evaluates better than the two.

**f) Bacteria Foraging Optimization algorithm**

The proposed system, "MR Brain Image Segmentation using Bacteria Foraging Optimizationalgorithm"[17] presents a unique population based image segmentation method that combines MRF with Bacteria Foraging Optimization algorithm which is a biologically inspired technique. It works on pixel data of image and to form a content in which they can merge, it uses neighborhood/region map. The result of this is compared with traditional Genetic algorithm and proves that it performs better. Better characterization of natural brain structure has resulted in better accuracy.

**g) Deep Learning Based Segmentation**

The framework of hierarchical image segmentation consists of image preprocessing, deep learning network based classification and post-processing. In preprocessing the image patches are extracted and gray level sequence of image patches are obtained which is considered as input to deep learning network. Deep learning based classification is implemented using a stacked auto encoder network that extracts the high level abstract feature from the input. Post-processing is implemented after the classification result is mapped to binary image, by a morphological filter to get the final segmentation outcome. The experiment is applied on to segment real patient's brain tumor dataset. The proposed method, "A Deep Learning Based Segmentation method for Brain Tumor in MRImages" **[18]** automatically segments brain

tumor, learns a deep non-linear network, realizes approximation of complex function and describes input data distribution. Segmentation results have increased by integrating stacked denoising auto encoder into segmentation procedure. It gives higher classification accuracy, good matching rate and more stabled result.

## IV. Conclusion

This paper comprises of a brief introduction on Image processing, Brain tumor, Brain tumor segmentation and review on different brain tumor segmentation techniques. After performing a survey on different Segmentation techniques we have come to a conclusion that K-means clustering and SVM, Improved Fuzzy C-means clustering and Watershed algorithm, Deep Learning based Segmentation, Convolution Neural Network algorithm's performances are efficient.

## REFERENCES

**[1]** Parveen and Amritpalsingh, "Detection of Brain Tumor in MRI Images, using Combination of Fuzzy C-Means and SVM," 2nd International Conference on Signal Processing and Integrated Networks (SPIN), pp. 98-102, 2015.

**[2]** KailashSinha and G. R. Sinha, "Efficient Segmentation Methods for Tumor Detection in MRI Images," IEEE Student's Conference on Electrical, Electronics and Computer Science, pp.1-6, 2014.

**[3]** H. B. Nandpuru, Dr. S. S. Salankar and Prof. V. R. Bora, "MRI brain cancer classification using support vector machine," IEEE Students' Conference on Electrical, Electronics and Computer Science, 2014.

**[4]** R. S. RajKumar and G. Niranjana, "Image Segmentation and Classification of MRI Brain Tumor Based on Cellular Automata and Neural Networks," IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 1, Issue 1, March 2013.

**[5]** B. Gupta and S. Tiwari, "Brain Tumor Detection using Curvelet Transform and Support Vector Machine," International Journal of Computer Science and Mobile Computing, Vol.3 Issue.4,pp. 1259-1264, April-2014

**[6]** A. Padma and R. Sukanesh, "SVM based classification of soft tissues in brain CT images using wavelet based dominant gray level run length texture features," middle-east journal of scientific research, pp.883-888, 2013.

**[7]** G.V. Kumar and Dr. G.V. Raju, "Biological early brain cancer detection using artificial neural network," International Journal on Computer Science and Engineering, Vol. 02, pp.2721-2725, 2010

**[8]** Pranita Balaji Kanade, Prof. P.P. Gumaste, "Brain tumor detection using mri images," International journal of innovative research in electrical, electronics, instrumentation and control engineering, vol. 3, issue 2, pp.146-150, february 2015.

**[9]** Vijaya Rekha. R, Sudha.S, Sangeetha.J and Shenbagarajan Anantharajan, "C.A.D.S., for Classification of MRI Brain Tumour Using Decision Tree," International Journal of Innovative Research in Science, Engineering and Technology, Vol. 3, Issue 3, pp.10509-10516, March 2014.

**[10]** Pratik P. Singhai and Siddharth A. Ladhake, "Brain Tumor Detection Using Marker Based Watershed Segmentation from Digital MR Images," International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol.2, Issue-5, pp. 201-204, April 2013

**[11]** Rohini Paul Joseph, C. Senthil Singh and M. Manikandan, "Brain tumor mri image segmentation and detection in image processing," International Journal of Research in Engineering and Technology (IJRET), Vol.03, Special Issue-1, pp. 1-5, March 2014.

**[12]** Neeraja Menon, Rohit Ramakrishnan. "Brain Tumor Segmentation in MRI images using Unsupervised Artificial Bee Colony algorithm and FCM clustering",I EEE ICCSP 2015 Conference.

**[13]** Archana Chaudhari, Dr. Abhijit Pawar, Prof. Dr. jayant Kulkarni. "Pixel Classification based Brain MR Image segmentation", International Conference on Industrial Instrumentation and Control (ICIC).

**[14]** Jianwei Liu, Lei Guo. "A New Brain MRI image segmentation strategy based on K-means Clustering andSVM", 7th International Conference on Intelligent Human-Machine Systems and Cybernetics.

**[15]** Benson. C. C, Deepa V, Lajish V, Kumar Rajamani. "Brain Tumor Segmentation from MR Brain Images usingImproved Fuzzy C-Means clustering and Watershed Algorithm", International Conference on Advances in Computing, Communications and Informatics (ICACCI).

**[16]** Ruixuan Lang, Liya Zhao, Kebin Jia. "Brain Tumor Image Segmentation based on Convolution Neural Network", International Congress on Image and Signal Processing, BioMedical Engineering and Informatics (CISP-BMEI 2016)

**[17]** E. Ben George, M.Karnan. "MR Brain Image Segmentation using Bacteria Foraging Optimizationalgorithm",International Journal of Engineering and Technology ( IJET).

**[18]** Zhe Xiao, Ruohan Hang, Yi Ding, Tian Lan, Xinjie Zhang, Wei Wang. "A Deep Learning Based Segmentation method for Brain Tumor in MR Images".