Brain Tumor Detection and Segmentation using Graph Cut Method

A. Manjunatha[1], M. Shakunthala[2], N. Pallavi[2], Sangeetha[2]
[1] Assistant professor, Dept. of E&C Engineering, Govt. engineering college Kushalnagar-571234
[2] Students, Dept. of E&C Engineering, Govt. engineering college Kushalnagar-571234

Abstract: **Among the different types of tumor life-threatening diseases and it should be in human body, brain tumor is one of the most detected accurately in early stage for proper treatment. Recently magnetic resonance imaging (MRI) is found to be efficient in detecting tumor as it does not need any opening on the human body. Presence of tumor in brain may be detected by segmenting the captured MR images. Tumor segmentation is performing manually by radiologists which is a time consuming and also a subjective process. Presence of the radiologists in a distant location often its transmission over a radio mobile channel for which high bandwidth is required. Keeping these in mind, in this project an efficient low bandwidth transmission of the captured MRI brain images followed by its reconstruction and graph cut based automatic segmentation of the tumor is proposed.**

key words **:*MRI. graph cut, segmentation, median filter.***

I. INTRODUCTION

Information can be well interpreted through images. Basically machine learning focuses on bringing out information from an image and after extraction again those valuable information are applied to deal with other tasks. Few examples can clarify the point such as images used for robots to navigate through some patterns, extraction of spoiled tissues from body scan etc. The first step which counts in direction of understanding images is segmentation and finding out variety of different components in those images. With the recent rapid growth of the technological advancements, medical science has also improved. But medical science is dependable on the current improvement of technologies. With this technological improvement it has reached to certain esteem where it can diagnose any diseases in a very less time with full accuracy. Most tumor victims are children and adults in their prime of life. So, multi-disciplinary approach must be taken to resolve such diseases. There are many approaches to detect brain tumor.

Brain tumor segmentation in MR images has been recent area of research in the field of automated medical diagnosis as the death rate is higher among humans due to brain tumor. In automated

Medical diagnostic systems, MRI (Magnetic Resonance Imaging) gives better results than computed tomography as MRI provides greater contrast between different soft tissues of human body. Hence MRI is much more effective in brain and cancer imaging.

Detection of brain tumor requires brain image segmentation Manual brain MR images segmentation is a difficult task. It requires plenty of time, non-repeatable task, non-Uniform Segmentation and also segmentation results may vary from expert to expert. So computer aided system is useful in this context. An automated brain tumor detection system should take less time and should classify the brain MR image as normal or tumorous accurately it should be consistent and should provide a system to radiologist which is self-explanatory and easy to operate. Automatic brain tumor detection and segmentation faces many issues and challenges. It is a difficult task to segment brain tumor in an automatic computerized system as it involves pathology, physics related to MRI along with intensity and shape analysis of MRI image. The major issue with brain tumor segmentation is that the tumor varies in form of shape, size, location and image intensities.

Related Work

In [1] the methodologies considered in their work will cover the main classification strategy of segmentation for brain abnormality. Mean Shift (MS), Fuzzy C Means (FCM), Hough Transform (HT), Normalized Graph Cut (NGC), Thresholding by Histogram (ThH) and Support Vector Machine (SVM) are taken for performance analysis.

In [2], an efficient low bandwidth transmission of the captured MRI brain images followed by its reconstruction and graph cut based automatic segmentation of the tumor is proposed. Compressed sensing (CS) is used to offer the facility of low bandwidth transmission. Extensive simulation results are also shown for reconstructed images followed by segmentation results.

In [3], a super pixel-based framework for automated brain tumor segmentation is introduced. The kernel trick is adopted in dictionary learning to transform super pixel-level features to a high-dimensional feature space where their nonlinear similarities are considered to generate discriminative sparse codes. A graph is constructed from the approximation errors given by dictionaries modeling different brain tumor structures so that super pixels belonging to particular tumor regions can be effective.

In [4], authors present a novel technique for vessel classification on ultra-wide-field-of-view images of the retinal fundus acquired with a scanning laser ophthalmoscope. To the best of their knowledge, this is the first time that a fully automated artery/vein classification technique for this type of retinal imaging with no manual intervention has been presented. The proposed method exploits hand-crafted features based on local vessel intensity

and vascular morphology to formulate a graph representation from which a globally optimal separation between the arterial and venular networks is computed by graph cut approach.

In [5], authors proposed technique uses feature extraction and optimization of the extracted features based on their relevance to detect brain tumor from the magnetic resonance images. By optimizing extracted features, only relevant features are retained for further analysis and so reduce the mathematical complexity of classification of the brain tumor and so detect the abnormalities at a fast rate with higher accuracy as compared to manual detection.

In [6], authors present a scheme for the automatic classification of MRI brain images as normal, where tumor is not present or abnormal, where tumor is present using K-Means clustering, non-sub sampled contour let transform (NSCT) and support vector machine (SVM). In the preprocessing stage of this proposed scheme, median filter is used for removing noise and enhancing resolution of MRI brain images. Then K-means clustering is used for segmenting MRI brain images because it segments an image faster. Because of salient properties of NSCT like multiscale, multidirection and shift invariance, NSCT is applied to the segmented image. Then seven features are extracted from subband coefficients of NSCTand these features are applied to support vector machine for the classification of MRI brain images

In [7], authors present Fuzzy C-Means (FCM), Otsu's method, Region Growing and Self-Organizing Maps methods is used for the automatic segmentation of brain tumors on the MR images and results are compared with each other. Application software is designed with a user interface for this purpose. Thus, the ease of decision-making by physicians will be provided. Consequently, the application software will prevent errors may be used as a secondary means for brain tumor segmentation.

In [8], the authors present a novel approach for the detection of normal and abnormal tissues. Anisotropic diffusion filtering is used as the preprocessing step. The part of the algorithm used to detect the healthy tissues White Matter (WM), Gray Matter (GM) and Cerebral Spinal Fluidis based on multilevel thresholding that selects the best threshold values using Electro-magnetism-Like algorithm. A Region-based Active Contour is used to detect the tumor. A trained Support Vector Machine with different kernels which can be treated as KSVM is used for the classification of the tumor. In the classification process, features are extracted from the tumor images using the single level decomposition of 2-D Daubechies DWT. The high dimensioned feature vector is reduced by using Independent Component Analysis (ICA). The suggested method can identify the benign and malignant type of tumors.

In [9], the authors present Brain tumour detection in MRI images using PNN and GRNN. they use fuzzy c means K Mean Clustering and radial basis function. Proposed classifier provides a the highest accuracy as compared to the used classifiers in this paper. Future work can be extended by carrying out better segmentation technique that will yield a better result compared to the three techniques used here.

In [10], presents an objective comparison of various algorithms and techniques employed in pre-processing, Feature Extraction and segmentation process. Our study focuses on supervised and unsupervised deterministic techniques. Compared to other pre-processing technique Optimized KernalPossibilistic C-Means (OKPCM) algorithm removes the noise effectively from the Magnetic Resonance Image (MRI). Then Adaptive DW-MTM filter improves the quality of MR Image. Then Regression Neural Network helps to segment the ROI from the background. So by utilizing this advanced techniques and algorithms Brain tumor can be easily detected and diagnosed.

In [11], This paper describes brain tumor detection by using thresholding algorithm and describes the comparative study about the tumor detection. Achieved results are shown in upper section which shows the efficient tumor detection and also finding the boundary extraction of tumor by using sobel edge detection operator. Size and stage of tumor is described. MRI images are best suitable for brain tumor detection. In this study Digital Image Processing Techniques are important for brain tumor detection by MRI images

In [12], In this paper, we have presented an efficient detection algorithm to detect tumor in MRIs using FCM based Support Vector Machine. This proposed algorithm is established to give encouraging results than the other existing brain tumor detection algorithm based on segmentation or classification algorithms.

In [13], presented a scheme for detecting the normal and abnormal brain MRI's. Initially, brain MRI is read by the system, then preprocessing, processing, post processing and classification is done. it use gray code convertion and K-means and segmentation method.

In[14], Algorithm shows the promising results for detection and segmentation of tumor. In future we incorporate the preprocessing step to improve the contrast of tumor regions with background which helps to improve the performance of algorithm

In[15], In this paper, we studied various feature extraction techniques used for brain tumor detection and segmentation. It’s a fact that the accuracy of the machine learning algorithm mainly depends upon the features to be used. So proper selection of features is mandatory. Here we found that widely used features are a texture-based feature and transform based features. These features are then given to any supervised and unsupervised machine learning technique for the tumor detection and segmentation purpose. Accurate analysis of brain tumor is a major issue in this world. If we can give a small contribution to this research area, then it might help the experts or doctors for diagnosis of the tumor.

In[16], In this paper, we have proposed a system that can be used for segmentation of brain MR Images for Detection and identification of brain tumor. We find area of tumor and its type of tumor. Future scope for detection and segmentation of brain tumor is that if we obtained the three dimensional image of brain with tumor then we can also find out its tumor size and also can evaluate its tumor type and also its stage of tumor.

In[17], From the above results it can be concluded that rough based K-means provides a better segmentation result than fuzzy Cmeans. Hence, even for SVM, in the test dataset images are recognized correctly for less number of images in the training dataset.

In[18], 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.

In[19], The proposed method incorporates a mean field term within the standard fuzzy c means objective function. The proposed technique is designed and implemented in MATLAB 2013a by using image processing tool. Different evaluation of parameters has been considered for experimental purpose i.e. peak signal to noise, bit error rate and accuracy.

II. METHODS

1. Preprocessing

Preprocessing of brain MR/CT image is the first step in our proposed technique. Preprocessing of an image is done to reduce the noise and to enhance the brain MR image for further processing. The purpose of these steps is basically to improve the image and the image quality to get more surety and ease in detecting the tumor. Steps for preprocessing are as follows:

- Image is converted to gray scale.
- A 3x3 median filter is applied on brain MR image in order to remove the noise.
- The obtained image is then passed through a high pass filter to detect edges.
- The edge detected image is added to the original image in order to obtain the enhanced image.

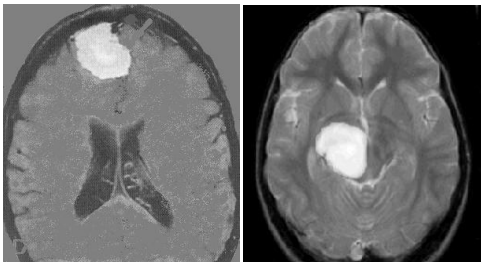
2.Segmentation

After enhancing the brain MR image, the next step of our proposed technique is to segment the brain tumor MR image. Segmentation is done to separate the image foreground from its background. Segmenting an image also saves the processing time for further operations which has to be applied to the image. Graph is an abstract representation of objects, where objects are connected by links. Graph G = (V, E)consists of a set of nodes V and a set of directed edges that connect them. Usually the nodes corresponds to pixels etc. The gra ph have two special nodes called terminal nodes one is sink(T) and the other is source(S). The weights are given in the way that the minimal cut goes along the borders of object. An s-t cut in the graph is a subset of edges, such that the terminal nodes S and T get completely separated in the graph. The cost function that we use as a soft constraint for segmentation is general enough to include both region and boundary properties of segments. But the hard constraints for segmentation include certain pixels from object and certain pixels background.

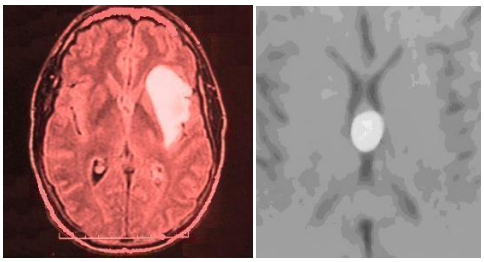
3. Post Processing

Post process in gafter segmenting the brain MR image, several post processing operations are applied on the image to clearly locate the tumor part in the brain. The basic purpose of the operations is to show only that part of the image which has the tumor that is the part of the image having more intensity and more area. These post processing operations include morphological operations and windowing technique.

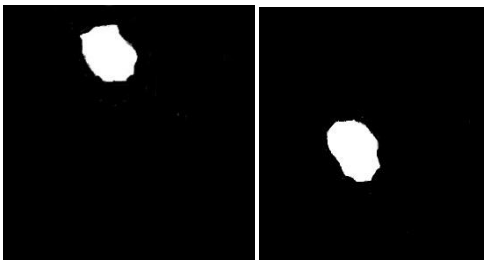
III. EXPERIMENTAL RESULTS AND DISCUSSION



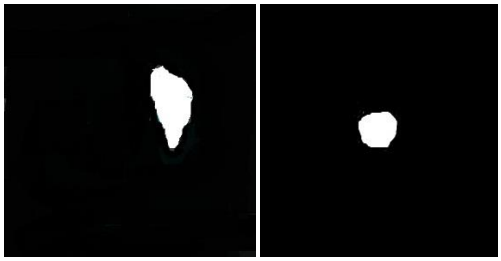
Input_image1 **Input_image2**



Input_image3 **Input_image4**



Ground truth_image1 **Ground truth-image2**



Ground truth_image3 **Ground truth_image4**

Output_image1(a) **Output_image2(a)**

Output_image3(a) **Output_image4(a)**

Table for comparing Accuracy and time elapsed (sec) for different input images.

Input images	Time elapsed in seconds	Accuracy
Input_image1	0.022800	0.9211
Input_image2	0.025164	0.8697
Input_image3	0.020365	0.8508
Input_image4	0.020387	0.8508

IV. CONCLUSION

In this paper, the three stages are implemented namely preprocessing and segmentation and post processing. Segmentation involves graph cut method. The preprocessing steps include median filtering, edge detection and image enhancement techniques. An input image is filtered using 3x3 median filter to remove the noise, it is then passed through a high pass filter to detect the edges. Edge detection refers to the process of identifying and locating sharp discontinuities in an image. The discontinuities are abrupt changes in pixel intensity which characterize boundaries of objects in a scene. The edge detected image is added to the original image in order to obtain the enhanced image. Image enhancement is the process of manipulating an image so that the result is more suitable than the original image for a specific application. The experiment is conducted for different MRI images. The result shows that the brain tumors are segmented effectively from the MRI images.

REFERENCES

[1] M.G. Sumithra, and B. Deepa, "Performance analysis of various segmentation techniques for detection of brain abnormality", IEEE 2017.
[2] Apurba Roy; Santi P. Maity, "Graph cut method for automatic tumor detection in prediction based reconstructed MR image", IEEE Wireless Communications, Signal Processing and Networking (WiSPNET) 2016.
[3] Xuan Chen; Binh P. Nguyen; Chee-Kong Chui; Sim-Heng Ong, "Automated brain tumor segmentation using kernel dictionary learning and superpixel-level features",Man, and Cybernetics (SMC), 2016
[4] Enrico Pellegrini; Gavin Robertson; Tom MacGillivray, "A Graph Cut Approach to Artery/Vein Classification in Ultra-Widefield Scanning Laser Ophthalmoscopy",IEEE Transactions on Medical Imaging 2018
[5] Nilesh B. Bahadure; Arun Kumar Ray and Har Pal Thethi, "Feature extraction and selection with optimization technique for brain tumor detection from MR images" International Conference on Computational Intelligence in Data Science(ICCIDS), 2017
[6] ChandanSaha; Md. Foisal Hossain, "MRI brain tumor images classification using K-means clustering, NSCT and SVM" 4th IEEE Uttar Pradesh Section International Conference on Electrical, Computer and Electronics (UPCON), 2017
[7] EmreDandıl, "Implementation and comparison of image segmentation methods for detection of brain tumors on MR images", International Conference on Computer Science and Engineering (UBMK), 2017
[8] G. Sandhya; GiriBabuKande; T SatyaSavithri. "Detection of normal and abnormal tissues in MR images of the brain using an advanced multilevel thresholding technique and kernel SVM classifier", International Conference on Computer Communication and Informatics (ICCCI), 2017
[9] K.S. Thara,K.Jasmine,"Brain Tumor Detection in MRI images using PNN and GRNN",IEEE
[10] B.Suneetha, Dr. A.Jhansirani. "A survey on image processing techniques for brain tumor detection using Magnetic Resonance Imaging". IEEE 2017.
[11] Mss Shrutika santosh, Prof. swati kulkarni, Prof. Akshata Raut,"Implementation of image processing for detection of brain tumors",IEEE 2017.
[12] Amiya halder,Oyendria dobe,"Raigh K-means and Support Vector Machine based Brain Tumor Detection",IEEE 2017.
[13] S.K.Shil ,F.P.Polly, M.A.Hossain,"An Improved Brain Tumor Detection and Classification Mechanism",IEEE 2017.
[14] C.Hemasundara Rao,Dr. P.V.Naganjaneyulu ,Dr.K.Safya Prasad,"Brain Tumor Detection and Segmentation using Conditional random field",IEEE 2017.
[15] Brijesha D. Rao, Mukesh M. Goswami,"A Comprehensive study of features used for Brain Tumor detection and Sgmentation",IEEE 2017.
[16] Swapnil R.Telrandhe, Amit Pimpalkar, Ankita Kendhe,"Detection of Brain Tumor from MRI images by using segmentation and SVM",IEEE 2016.
[17] Amiya Halder, Oyendrila Dobe," Detection of Tumor in Brain MRI Using Fuzzy Feature selection and Support Vector Machine",IEEE 2016.
[18] Reema Mathew A Dr. Babu Anto P," TUMOR DETECTION AND CLASSIFICATION OF MRI BRAIN IMAGE USING WAVELET TRANSFORM AND SVM",IEEE 2017.
[19] Baljinder Singh, Pankaj Aggarwal, "Detection of brain tumor using modified mean-shift based fuzzy c-mean segmentation from MRI Images",IEEE 2017.
[20] Zaineb B.Messaoud, siwar Chnitti, Ines Njeh " An Automated MRI brain tissue segmentation approach"IEEE 2016