Brain Tumor Detection and Identification Using K-Means Clustering Technique

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---***ABSTRACT***---

Brain tumor is an abnormal growth caused by cells reproducing themselves in an uncontrolled manner. Magnetic Resonance Imager(MRI) is the commonly used device for diagnosis. In MR images, the amount of data is too much for manual interpretation and analysis. During the past few years, brain tumor segmentation in Magnetic Resonance Imaging(MRI) has become an emergent research area in the field of medical imaging system. Accurate detection of size and location of brain tumor plays a vital role in the diagnosis of tumor. Image processing is an active research area in which medical image processing is a highly challenging field. Image segmentation plays a significant role in image processing as it helps in the extraction of suspicious regions from the medical images. In this paper an efficient algorithm is proposed for tumor detection based on segmentation of brain MRI images using K-Means clustering.

Keywords - ***Image Segmentation, K-Means clustering, MRI, Tumor Detection.***

1.INTRODUCTION

Image processing is a process where input image is processed to get output also as an image or attributes of the image. Main aim of all image processing techniques is to recognize the image or object under consideration easier visually. Segmentation of images holds a crucial position in the field of image processing. In medical imaging, segmentation is important for feature extraction, image measurements and image display. A tumor can be defined as a mass which grows without any control of normal forces. Real time diagnosis of tumors by using more reliable algorithms has been an active of the latest developments in medical imaging and detection of brain tumor in MR and CT scan images. Hence image segmentation is the fundamental problem used in tumor detection. Image segmentation can be defined as the partition or segmentation of a digital image into similar regions with a main aim to simplify the image under consideration into something that is more meaningful and easier to analyze visually. Image segmentation methods can be classified as thresholding, region based, supervised and unsupervised techniques.

MRI is commonly used in the medical field for detection and visualization of details in the internal structure of the body. It is used to detect the differences in the body tissues which is considerably better technique as compared to computed tomography(CT). Thus this technique become a special technique especially for the brain tumor detection and cancer imaging. Protons and neutrons of an atom has an angular momentum which is known as a spin. These spins will cancel when the number of subatomic particles in a nucleus is even. Nuclei with odd number will have a resultant spin. This forms the basis of magnetic resonance imaging. A magnetic resonance imaging (MRI) scanner uses powerful magnets to polarize and excite hydrogen nuclei (single proton) in human tissue, which produces a signal that can be detected and it is encoded spatially, resulting in images of the body.

Clustering is an important tool for a variety of applications. Clustering is division of data into groups of similar objects. Each group consists of objects that are similar between themselves and dissimilar to objects of other groups. From the machine learning perspective, Clustering can be viewed as unsupervised learning concepts. Unsupervised machine learning means that clustering does not depend different types of clusters depending on the predefined classes and training examples while classifying the data objects. Clustering algorithms are mainly divided into two techniques: Hierarchical algorithms and partition algorithms. A hierarchical clustering algorithm divides the given data set into smaller subsets in fashion. A partition clustering algorithm partitions the data set into desired number of sets in a single step. Numerous methods have been proposed to solve clustering problem. The most popular clustering method is K-Means clustering algorithm. This algorithm is more prominent to cluster massive data rapidly and efficiently. So it can be used in image processing techniques especially in segmentation.

During the acquisition of medical images, there are possibilities that the medical image might be degraded because of problems that can occur during the acquisition stage. So the original image may not be suitable for analysis. Noise presented in the image can diminish the capacity of segmentation algorithm. So it is important to filter out any noise in the primitive image before segmentation. There is a wide range of filters available to remove the noise from the images. Average filters for example, can remove these noise but with the sacrifice of sharpness of image. Median filter is an example of average filter used to remove the noise like salt and pepper. Sharpening is generally achieved by using high pass filters. Gaussian filter (a high pass filter) is used to enhance the boundaries of the object. This is important as edges will detect and highlight the tumor for us.

The remaining part of the paper is organized as follows: Section II involves the works related to probable solutions for brain tumor detection and segmentation. Section III involves the description of the proposed method. Section IV involves the simulation results of the proposed work. The paper is concluded in Section V.

2. RELATED WORK

This section deals with the works related to the brain tumor detection and segmentation in medical images. *Somkantha, et al* [1] designed a new edge following technique for boundary detection in noisy images and applied it to object segmentation problem in medical images. The proposed technique was applied to detect the object boundaries in several types of noisy images where the ill-defined edges were encountered. *Gooya, et al* [2] presented a method GLISTR for segmentation of gliomas in multi-modal MR images by joint registering the images to a probabilistic atlas of healthy individuals. The major contribution of the paper was the incorporation of tumor growth model to adopt the normal atlas into the anatomy of the patient brain. *Parisot, et al* [3] contemplated a different approach for detection, segmentation and characterization of brain tumors. This technique exploits prior knowledge in the form of a sparse graph delineating the expected spatial positions of tumor classes. In this paper, implied a novel way to encode prior knowledge in tumor segmentation, making use of the fact that the tumors tend to appear in the brain in preferential locations. They combined an image based detection scheme with identification of the tumor's corresponding preferential location, which was associated with a specific spatial behavior. *Manikis, et al* [4] suggested a novel framework for assessing tumor changes based on histogram analysis of temporal Magnetic Resonance Image(MRI) data. The proposed method detects the distribution of tumor and quantitative models its growth or shrinkage offering the potential to assist clinicians in objectively assessing subtle changes during therapy. *Bauer, et al* [5] determined a novel approach to adapt a healthy brain atlas to MR images of tumor patients. They presented a new method which makes use of sophisticated models of bio-physio mechanical tumor growth to adapt a general brain atlas to an individual tumor patient image.

Roy, et al [6] suggested an analysis on automated brain tumor detection and segmentation from MRI of brain. Brain tumor segmentation was a significant process to extract information from complex MRI of brain images. *Sindhushree. K.S, et al* [7] have developed a brain tumor segmentation method and validated segmentation on two dimensional MRI data. Also, detected tumors are represented in three dimensional view. High pass filtering, histogram equalization, thresholding, morphological operations and segmentation using connected component labeling was carried out to detect tumor. The two dimensional extracted tumor images were reconstructed into three dimensional volumetric data and the volume of the tumor was also calculated. *M.C. Jobin Christ and R.M.S. Parvathi* [8] proposed a methodology that integrates K-Means clustering with marker controlled watershed segmentation algorithm and integrates Fuzzy C Means clustering with marker controlled watershed segmentation algorithm separately medical image segmentation. *P.Vasuda and S.Satheesh* [9] proposed a technique to detect tumors from MR images using fuzzy clustering technique. This algorithm uses fuzzy C-means but the major drawback of this algorithm is the computational time required. *Logeswari and Karan* [10] studied the performance of the MRI image in terms of weight vector, execution time and tumor pixels detection. A tumor was a mass of tissue that grows out of control of the normal forces that regulates growth. The convoluted brain tumors were scattered into two broad classes depending on the tumor's origin, their growth pattern and malignancy.

Roy and Bandyopadhyay [11] proposed an interactive segmentation method that enables users to quickly and efficiently segment tumors in MRI of brain. They implied a new method that in addition to area of the region and edge information uses a type of prior information also its symmetry analysis, which was more consistent with pathological cases. *Xavierarockiaraj, et al* [12] proposed a paper for brain tumor detection using converted histogram thresholding-quadrant approach. In medical image processing, brain tumor detection was one of the challenging task, since brain images were complicated and tumors were analyzed only be expert physicians. *M.K.Kowar and Yadav* [13] presented a novel technique for the detection of tumor in brain using segmentation and histogram thresholding. In this paper, a technique to detect presence of the brain base don thresholding technique has been developed. *A.Mustaqeem, et al* [14] implemented an efficient brain tumor detection algorithm using watershed and threshold based segmentation. This research was conducted to detect brain tumors using medical imaging techniques. *Taheri, et al* [15] introduced a threshold based scheme that uses level sets for 3D tumor segmentation(TLS). In this scheme the level set speed function was designed using a global threshold. This threshold was defined based on the idea of confidence intervals and iteratively updates throughout the evolution process.

3. PROPOSED METHOD

We have proposed segmentation of the brain MRI images for detection of tumors using K-Means clustering technique. A cluster can be defined as a group of pixels where all the pixels in certain group defined by similar relationship. Clustering is also unsupervised classification because the algorithm automatically classifies objects based on user given criteria. Here K-Means clustering algorithm for segmentation of the image is used for tumor detection from the brain MRI images. The proposed block diagram is as shown.

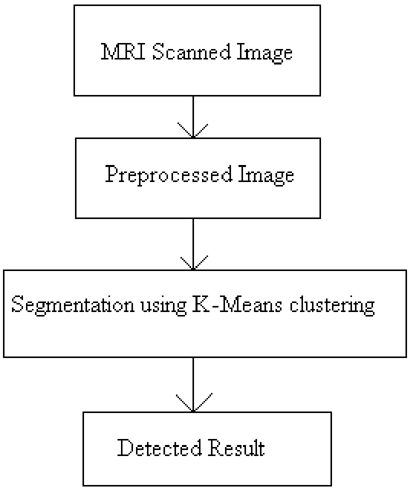

Fig 1. Proposed Block Diagram

MRI scans of the human brain forms the input images for our system where the grayscale MRI input images are given as the input. The preprocessing stage will convert the RGB input image to grayscale. Noise present if any, will be removed using a median filter. The image is sharpened using Gaussian filtering mask. The preprocessed image is given for image segmentation using K-Means clustering algorithm.

3.1 Image Acquisition

Images are obtained using MRI scan and these scanned images are displayed in a two dimensional matrices having pixels as its elements. These matrices are dependent on matrix size and its field of view. Images are stored in Image file and displayed as a grayscale image. The entries of a grayscale image are ranging from 0 to 255, where 0 shows total black color and 255 shows pure white color. Entries between these ranges vary in intensity from black to white.

3.2 Pre-processing stage

In this phase image is enhanced in the way that finer details are improved and noise is removed from the image. Most commonly used enhancement and noise reduction techniques are implemented that can give best possible results. Enhancement will result in more prominent edges and a sharpened image is obtained, noise will be reduced thus reducing the blurring effect from the image. In addition to enhancement, image segmentation will also be applied. This improved and enhanced image will help in detecting edges and improving the quality of the overall image. Edge detection will lead to finding the exact location of tumor.

3.2.1 Noise Removal: Many filters are used to remove the noise from the images. Linear filters can also serve the purpose like Gaussian, averaging filters. For example average filters are used to remove salt and pepper noise from the image. Because in this filter pixel's value is replaced with its neighborhood values. Median filter is also used to remove the noise like salt and pepper and weighted average filter is the variation of this filter and can be implemented easily and give good results. In the median filter value of pixel is determined by the median of the neighboring pixels. This filter is less sensitive than the outliers.

3.2.2 Image Sharpening: Sharpening of the image can be achieved by using different high pass filters. As now noise is being removed by using different low pass filters, we need to sharpen the image as we need the sharp edges because this will help us to detect the boundary of the tumor. Gaussian high pass filter gives very high rated results and used very widely to enhance the finer details of the project.

3.3 Segmentation using K-Means clustering

Segmentation is an essential process to extract information from complex medical images. The main objective of the image segmentation is to segregate an image into commonly exclusive and exhausted regions such that each region of interest is spatially contiguous and the pixels within the region are homogeneous with respect to a predefined criterion. Fig 2. Shows the steps for the proposed algorithm.

1. Let D be the data points in the given input image.
2. Partition the data points into k equal sets.
3. In each set, take the middle point as the initial centroid.
4. Compute the distance between each data point $di(1 \leq i \leq n)$ to all initial centroids $cj(1 \leq j \leq k)$.
5. For each data point di, find the closest centroid cj and assign di to cluster j.
6. Set $clusterId[i] = j$.
7. Set $NearestDist[i] = d(di, cj)$.
8. For each cluster $j(1 \leq j \leq k)$, recalculate the centroids.
9. For each data point di,
   (i) Compute its distance from the centroid of the present nearest cluster.
   (ii) If this distance is less than or equal to the present nearest distance, the data point stays in the same cluster. Otherwise compute the distance $d(di, cj)$ for every centroid $cj(1 \leq j \leq k)$.
10. Repeat from steps 5 to 9 until convergence is met.

Fig2. Proposed Algorithm

4. RESULTS

Some of the brain MR images containing tumor taken for testing our proposed algorithm are shown in Fig 3.

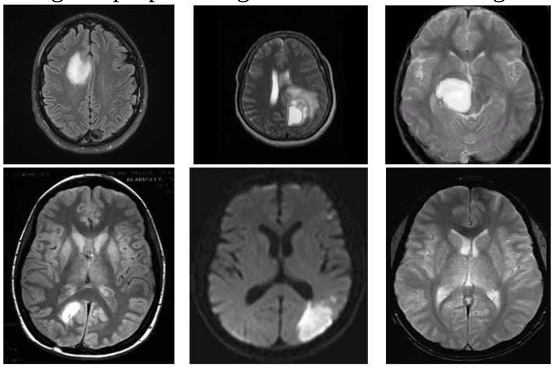

Fig 3. Brain MR images containing tumor

The brain tumor location is found out by applying our proposed algorithm. Fig 4. Shows the final clustering of brain MR image after being processed by our algorithm. Fig 5. Shows the final tumor detected portion from the brain MR image.

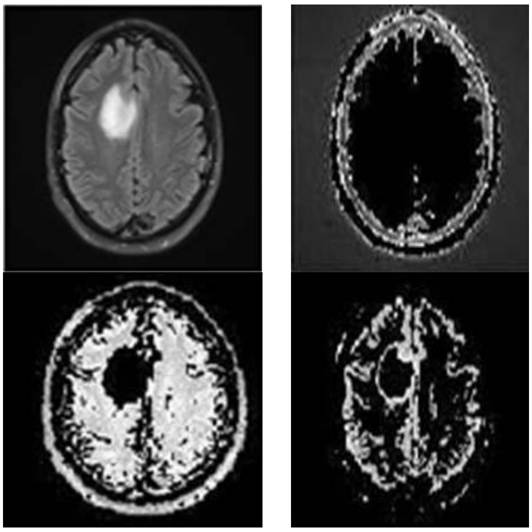

Fig 4. Clustering of brain MR image

Fig 5. Tumor detected

5. CONCLUSION

Segmentation of brain image is imperative in surgical planning and treatment in the field of medicine. In this work, we have proposed a computer aided system for brain MR image segmentation for detection of tumor location using K-Means clustering algorithm. The proposed brain tumor detection comprises three steps: image acquisition, pre-processing, and K-Means clustering. We were able to segment tumor from different brain MR images from our database.

REFERENCES

[1] K.Somkantha, *et al*., “Boundary detection in medical images using edge following algorithm based on intensity gradient and texure gradient features”, *Biomedical Engineering, IEEE Transactions On*, vol.58, pp. 567-573, 2011.

[2] A.Gooya, *et al*., “GLISTR:Glioma image segmentation and registration”, *Medical Imaging, IEEE Transaction on*, vol.31, pp.1941-1954, 2012.

[3] S.Parisot, *et al*., “Graph-based detection, segmentation & characterization of brain tumors”, in *Computer Vision and Pattern Recognition(CVPR), 2012 IEEE Conference on*, 2012, pp. 988-995.

[4] G.C.Manikis, *et al*., “A fully automated image analysis framework for quantitative assessment of temporal tumor changes”, in *E-Health and Bioengineering Conference(EHB), 2011*, 2011, pp. 1-6.

[5] S.Bauer, *et al*., “Multiscale modeling for image analysis of brain tumor studies”, *Biomedical Engineering, IEEE Transactions On*, vol. 59, pp.25-29, 2012.

[6] S.Roy, *et al*., “A Review on Automated Brain Tumor Detection and Segmentation from MRI of Brain”, *arXiv preprint arXiv:1312.6150*, 2013.

[7] Sindhushree. K.S, Mrs. Manjula, T.R.K.Rmesha, “Detection And 3D Reconstruction of Brain Tumor From Brain MR Images”, in *International Journal of Engineering Research & Technology(IJERT)*, vol. 2, no. 8, pp. 528-534, 2013.

[8] M.C.Jobin Christ, R.M.S.Parvathi, “Segmentation of Medical Image using Clustering and Watershed Algorithms”, in *American Journal of Applied Sciences*, vol. 8, pp. 1349-1352, 2011.

[9] P.Vasuda, S.Satheesh, “Improved Fuzzy C-Means Algorithm for MR Brain Image Segmentation”, in *International Journal on Computer Science and Engineering(IJCSE)*, vol. 02, no. 05, pp. 1713-1715, 2010.

[10] T.Logeswari and M.Karnan, “An improved implementation of brain tumor detection using soft computing”, in *Communication Software and Networks, 2010. ICCSN’10. Second International Conference on*, 2010, pp. 147-151.

[11] S.Roy and S.K.Bandyopadhyay, “Detection and Quantification of Brain Tumor from MRI of Brain and its Symmetric Analysis”, *International Journal of Information and Communication Technology Research*, vol. 2, 2012.

[12] S.Xavierarockiaraj, *et al*., “Brain Tumor Detection using Modified Histogram Thresholding-Quadrant Approach”, in *Journal of Computer Applications(JCA)*, vol. 5, pp. 21-25, 2012.

[13] M.K.Kowar and S.Yadav, “Brain Tumor Detection and Segmentation Using Histogram Thresholding”, in

International Journal of Engineering and Advanced Technology(IJEAT) ISSNI, pp. 2249-8958, 2012.

[14] A.Mustaqeem, *et al*., "An efficient Brain Tumor Detection Algorithm using Watershed & Thresholding Based Segmentation", in *International Journal of Image, Graphics and Signal Processing*, vol. 4, 2012.

[15] S.Taheri, *et al*., "Level set Segmentation of Brain Tumors using a Threshold-based speed function", in *Image and Vision Computing*, vol. 28, pp. 26-37, 2010.