BRAIN TUMOR MRI IMAGE CLASSIFICATION USING K-MEANS CLUSTERING

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ABSTRACT— A brain tumor is an abnormal growth of tissue in the brain. Unlike other tumors develops when abnormal cells multiply for unknown reasons, which can disrupt proper brain function. Tumor cells grow, even though the body does not need them, and unlike normal old cells, they don't die. Magnetic resonance images (MRI) plays a vital role to provide information about potential abnormal tissues necessary for medical follow up. Brain MRI gets additional importance in medical science as it is the only preliminary method of diagnosing a brain tumor. Brain tumor analysis is done by medical practitioners but its grading gives different conclusions which may vary from one doctor to another. In the recent years, medical imaging has great impact on the field of brain tumor detection and its classification. For accurate diagnosis of brain tumor, its size and location of brain tumor plays an important role. In this paper an efficient algorithm is proposed for tumor detection based on segmentation of brain MRI images using K-Means clustering.

Key words: - Tumor detection, MRI, clustering, image segmentation.

I. INTRODUCTION

1.1 Brain tumor

A brain tumor is an abnormal growth of tissue in the brain or central spine that can disrupt proper brain function. A tumor can cause damage by increasing pressure in the brain, by shifting the brain or pushing against the skull, and by invading and damaging nerves and healthy brain tissue. The location of a brain tumour influences the type of symptoms that occur. This is because different functions are controlled by different parts of the brain. Doctors refer to a tumour based on where the tumour cells originated, and whether they are cancerous (malignant) or not (benign).

1.2 Types of Tumor

Researchers There are three common types of tumor:
1) Benign; 2) Pre-Malignant; 3) Malignant (cancer can only be malignant).

a) **Benign Tumor:** A benign tumor is a tumor is the one that does not expand in an abrupt way; it doesn't affect its neighboring healthy tissues and also does not expand to non-adjacent tissues. Moles are the common example of benign tumors.
b) **Pre-Malignant Tumor:** Premalignant Tumor is a precancerous stage, considered as a disease, if not properly treated it may lead to cancer.

c) **Malignant** Tumor: Malignancy (mal- = "bad" and -ignis= "fire") is the type of tumor, that grows worse with the passage of time and ultimately results in the death of a person. Malignant is basically a medical term that describes a severe progressing disease. Malignant tumor is a term which is typically used for the description of cancer.

1.3 Diagnose

Identifying a brain tumor usually involves a neurological examination, brain scans, and/or an analysis of the brain tissue. A neurological examination is a series of tests to measure the function of the patient is nervous system and physical and mental alertness. A brain scan is a picture of the internal structures in the brain. A specialized machine takes a scan in much the same way a digital camera takes a photograph. The most common scans used for diagnosis are as follows:

MRI (Magnetic Resonance Imaging) [1] is a scanning device that uses magnetic fields and computers to capture images of the brain on film. It does not use x-rays. It provides pictures from various planes, which permit doctors to create a three-dimensional image of the tumor. The MRI detects signals emitted from normal and abnormal tissue, providing clear images of most tumors.

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. There are mainly two types of Clustering algorithms: 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 literature survey of probable solutions for brain tumor detection and segmentation. Section III involves the description of the proposed method. Section IV discussed the result and at last Section V provides conclusion of work.

II. RELATED WORK

A. S. Bhide et al., [1] discussed about Brain Division utilizing Fuzzy C means bunching to detect tumor Area. They utilized distance across and chart based technique to catch the volume of the mind.

Neha Tirpude et al., [2] proposed Robotized Location and Extraction of Mind Tumor from MRI images to concentrate the tumor parcel precisely.

Avijit Dasgupta [3] investigated boundary of brain tumor utilizing fluffy C-implies procedure. This procedure was great and proficient division system.

Anam Mustaqeem et al., [4] uses analysis watershed and thresholding based division for cerebrum tumor detection. This strategy was exceptionally helpful to discover careful size and area of the tumor. At the same time this procedure was not that much impact in dark and white picture of the mind.

Purnita Majumder et al., [5] discovered stage identification and divided in cerebrum tumor MR pictures with 3d evaluation. They utilized two calculations that are propelled k-implies and fluffy c-means are utilized within the division work. MRI picture edge identification technique is to be used for accurate detection of the tumor shape, position and its phase.

Sarbani Datta et al., [6] Clarified preprocess the two dimensional attractive reverberation pictures of the mind and accordingly identify the tumor utilizing edge identification strategy and shade based division calculation. This paper proposed a shade-based division of K-means bunching technique for identification of cerebrum tumor. The technique will help the specialists for finding in a finer manner by lessening the subjectivity and miss rate in cerebrum MR pictures and in this way will improve the tumor identification correctness in less time.

M. Rakesh et al., [7] explore Picture Division and Discovery of Tumor Protests in MR Mind Pictures Utilizing Fluffy C-Implies Calculation. The adjusted FCM calculation is focused around the idea of clamping where the dimensionality of the info is much diminished. The adjusted FCM calculation utilizes a decreased dataset, the merging rate is exceptionally enhanced when contrasted and the tried and true FCM. At the same time the principle disservice is that FCM system is lengthy.

Alyaa H. Ali et al., [8] located cerebrum tumor for MRI utilizing crossover technique wavelet and grouping calculation. K-mean clustering technique was used with different classes and provides best results. Despite the fact that the wavelet convert is not sufficient to prepare a great outcome for the mind tumor location.

R. Manikandan et al., [9] has used Bunch Based Division of Attractive Thunder A picture of Mind Tumor Recognition. The target range is divided and assessment of this apparatus is certain and helps the specialists in conclusion, medicine arrangement making and state of the tumor observing.

Somkantha, et al [10] 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 [11] 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 [12] 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 [13] 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 [14] 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 [15] 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 [16] deals with two dimensional MRI data for MRI brain tumor segmentation method. 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 tumor images were extracted from two dimensional data, reconstructed into three dimensional volumetric data and then calculated volume of the tumor.

M.C. Jobin Christ and R.M.S. Parvathi [17] proposed a methodology that integrates KMeans 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 [18] 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 [19] 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 [20] proposed an interactive segmentation method that enables users to quickly and efficiently segment tumors in MRI of brain. They introduced 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 [21] proposed a paper for brain tumor detection using converted histogram thresholding-quadrant approach.Brain tumor detection was one of the challenging task in the field of medical image processing, since brain images were complicated and tumors were analyzed only be expert and experienced medical practitioners.

M.K.Kowar and Yadav [22] 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 [23] 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 [24] 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.

III. PROPOSED WORK

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.

a) 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 gray scale image. The entries of a gray scale 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.

b) 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.

***Text Removal*:**

In this phase all unwanted text-noise will be removed. MRI scan images may contain some text such as first image in sample.

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 utliers.

Image Sharpening:

Sharpening of the image can be achieved by using different high pass filters. As now noise is been removed by using different low pass filters, we need to sharpens the image as we need the sharp edges because this will help us to detect the boundary of the tumor.

Gaussian high pass filter is used to enhance the boundaries of the objects in the image. Gaussian filter gives very high rated results and used very widely to enhance the finer details of the object.

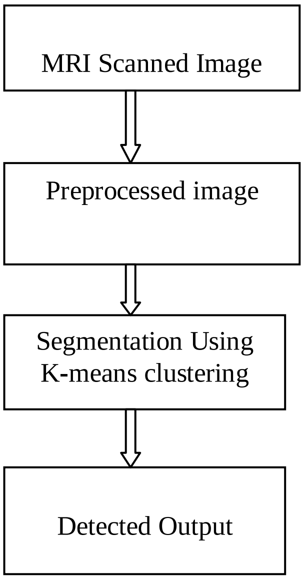

Figure 1: Steps of Tumor Detection

c) Processing Stage:

Image segmentation is based on the division of the image into regions. Division is done on the basis of similar attributes. Similarities are separated out into groups. Basic purpose of segmentation is the extraction of important features from the image, from which information can easily be perceived. Brain tumor segmentation from MRI images is an interesting but challenging task in the field of medical imaging.

K-means Clustering Technique

A cluster is a collection of objects which are similar between them and are dissimilar to the objects belonging to other clusters. Clustering is an unsupervised learning method which deals with finding a structure in a collection of unlabeled data. The process of organizing objects into groups whose members are similar in some way is known as clustering.

K-means clustering is an algorithm to group objects based on attributes/features into k number of groups where k is a positive integer. The grouping (clustering) is done by minimizing the Euclidean distance between data and the corresponding cluster centroid. Thus the purpose of k-means clustering is to cluster the data.

The purpose of k-means algorithm is to cluster the data. K-means algorithm is one of the simplest partitions clustering method. K-Means is the one of the unsupervised learning algorithm for clusters. Clustering the image is grouping the pixels according to the some characteristics. In the k-means algorithm initially we have to define the number of clusters k. Then k-cluster center are chosen randomly. The distance between the each pixel to each cluster centers are calculated which may be of simple Euclidean function. Single pixel is compared to all cluster centers using the distance formula. The pixel is moved to particular cluster which has shortest distance among all. Then the centroid is re-estimated. Again each pixel is compared to all centroids. The process continuous until the center converges.

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.
   - (iii) 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.

IV. RESULTS

Some of the brain MR images containing tumor taken for testing our proposed algorithm is shown in Fig 2.

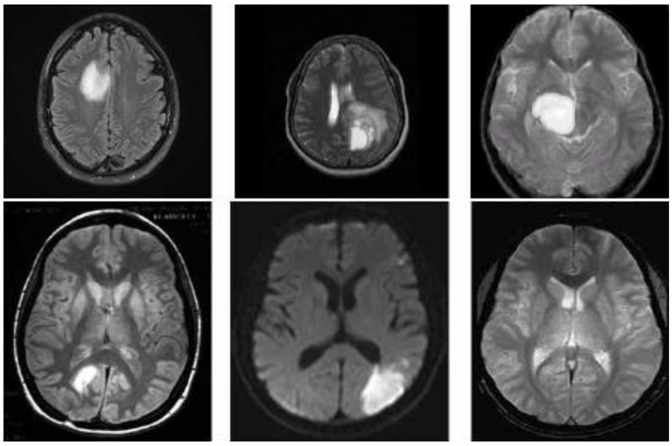

Figure 2:- Brain Tumor MR Images

The brain tumor location is found out by applying our proposed algorithm. Figure No. 3 Shows the final clustering of brain MR image after being processed by our algorithm. Figure No. 4 Shows the final tumor detected portion from the brain MR image.

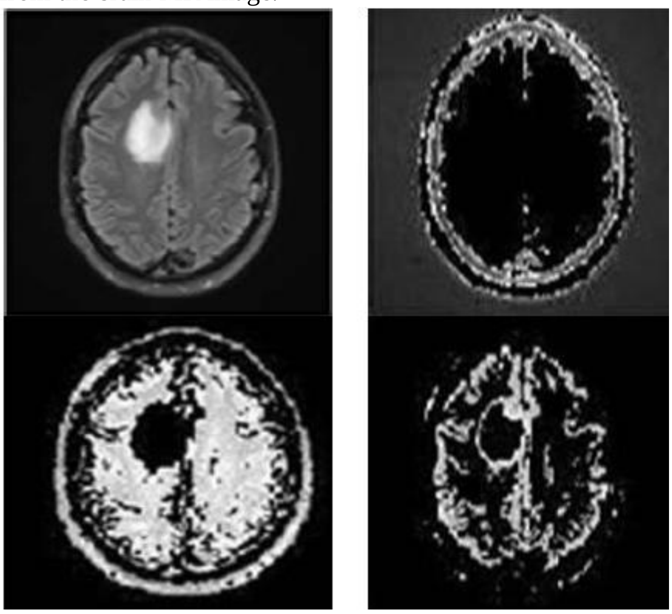

Figure 3:- Clustering of brain MR image

Figure 4:- Tumor detected

V. CONCLUSION

In medical reasons, the use of medical image processing plays an important role for analyzing different diseases. Magnetic Resonance Imaging (MRI) is mainly used to diagnose the critical diseases. In this work, preprocessing an image gives the result of an input image of tumor area. Segmentation, extraction and classification process removes the noise over an image and regain the smoothed clear an image of the tumor. Using the K-means clustering algorithm we detect the affected region over an tumor image. In near future we can implement several algorithm and techniques to detect the tumor more effectively.

REFERENCES

1. A.S.Bhide, priyankapatil, Shraddhadhande, "Brain Segmentation using Fuzzy C means clustering to detect tumour region", International Journal of Advanced Research in Computer Science and Electronics Engineering, Volume 1 , Issue 2 , April 2012, pp. 85-90.
2. Neha Tirpude, Rashmi Welekar, "Automated Detection and Extraction of Brain Tumor from MRI Images", International Journal of Computer Applications, Volume 77, No.4, September 2013, pp. 26-30.
3. Avijit Dasgupta,"Demarcation of Brain Tumor Using Modified Fuzzy C-Means", International Journal of Engineering Research and Applications, Volume 2, Issue 4, July-August 2012, pp.529-533.
4. Anam Mustaqeem, Ali Javed, Tehseen Fatima, "An Efficient Brain Tumor Detection Algorithm Using Watershed & Thresholding Based Segmentation", International Journal of Image, Graphics and Signal Processing, Volume 4, No. 10, September 2012, pp. 34-39.
5. Purnita Majumder, V. P. Kshirsagar, "Brain Tumor Segmentation and Stage Detection in Brain MRImages with 3D Assessment", International Journal of Computer Applications, Volume 84, No. 15, December 2013, pp. 16-19.
6. Sarbani Datta, Dr. Monisha Chakraborty,"Brain Tumor Detection from Pre-Processed MR Images using Segmentation Techniques", 2nd National Conference Computing, Communication and Sensor Network, No. 2, 2011, pp. 1-5.
7. M. Rakesh, T. Ravi,"Image Segmentation and Detection of Tumor Objects in MR Brain Images Using FUZZY C-MEANS (FCM) Algorithm", International Journal of Engineering Research and Applications, Volume 2, Issue 3, May-Jun 2012, pp.2088-2094.
8. Alyaa H. Ali, Kawther A. Khalaph, IhssanS.Nema, "Detection of Brain Tumor for MRI using Hybrid Method Wavelet and Clustering Algorithm", International Journal of Applied Information Systems, Volume 6, No. 7, January 2014, pp. 9-14.
9. R. Manikandan, G.S. Monolisa, K. Saranya, "A Cluster Based Segmentation of Magnetic Resonance Images for Brain Tumor Detection", Middle-East Journal of Scientific Research, Volume 14, Issue 5, May 2013, pp. 669-672.
10. 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.
11. A.Gooya, *et al*., "GLISTR:Glioma image segmentation and registration", *Medical Imaging, IEEE Transaction on,* vol.31, pp.1941-1954, 2012.
12. 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.

13. 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. 16.
14. S.Bauer, *et al*., "Multiscale modeling for image analysis of brain tumor studies", *Biomedical Engineering, IEEE Transactions On*, vol. 59, pp.25-29, 2012.
15. S.Roy, *et al*., "A Review on Automated Brain Tumor Detection and Segmentation from MRI of Brain", *arXiv preprint arXiv:1312.6150*, 2013.
16. 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.
17. 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.
18. 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.
19. 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.
20. 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.
21. 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.
22. 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.
23. 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.
24. 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.