Minor Project Synopsis

On

BRAIN TUMOR DETECTION USING COLOR SEGMENATATION WITH K MEANS CLUSTERING

IN PARTIAL FULFILLMENT OF
REQUIREMENTS FOR THE DEGREE
OF
BACHELOR OF TECHNOLOGY
IN
COMPUTER SCIENCE & ENGINEERING

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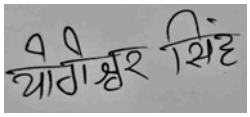
July-Dec 2021

CERTIFICATE

This is to certify that Anushree Agrawal and Shivani Gupta minor project, " Brain Tumor Detection" is a genuine record of a project completed under our supervision and guidance in partial fulfilment of the requirements for the award of a Bachelor of Technology in Information Technology in the Department of Information Technology, Madhav Institute of Technology and Science, Gwalior.

(Prof.Vikas Sejwar)

Mentor



(Prof. YOGESHWAR SINGH)

Mentor

ACKNOWLEDGEMENT

I would like to express my deepest appreciation to all those who provided me the possibility and played crucial role in completing this project. And provides best guidance and keep me motivated and invest their full effort in helping us. A special gratitude I give to our minor project supervisor Prof. Vikas Sejwar, Dr. Yogeshwar Singh, whose contribution in stimulating suggestions and encouragement, helped us to coordinate in our project .

Anushree Agrawal & Shivani Gupta

ABSTRACT

BRAIN TUMOR DETECTION USING COLOR SEGMENATATION WITH K MEANS CLUSTERING: *A brain tumor is cancerous or non-cancerous mass or growth of abnormal cells in the brain. A brain tumor is a benign or fatal growth in the brain. Primary brain tumor initially forms in brain tissue. Secondary brain tumors are cancers that have expanded (metastasized) to the brain tissue from elsewhere in the body. Brain tumor can occur in people of any age. Biomedical image processing is a growing and demanding field it incorporates many different types of imaging methods like CT-scan, X- ray and MRI. These techniques allow us to identify even the smallest abnormalities in the human body. Out of all the above techniques MRI is the most dependable and secures technique, since it doesn't involve exposing the body to any sort of harmful radiation. This MRI then can be processed, and the tumor can be segmented. Tumor segmentation includes use of several different techniques like preprocessing, segmentation, optimization and feature extraction. Furthermore, predicting the disease early leads to treating the patients before it becomes critical.*

In medical image processing the Brain tumor segmentation is an important task; for improving treatment possibilities and to increases the survival rate of the patients the early diagnosis of brain tumors plays an important role. Segmentation of the brain tumors for cancer diagnosis can be done manually from large amount of data of Magnetic resonance imaging (MRI), but it is a difficult and time consuming task. Therefore there is a need for automatic and reliable brain tumor image segmentation method. However the detection of tumor still is a challenging task for researchers because tumor possesses complex characteristics in appearance and boundaries. The purpose of this paper is to understand brain tumor, its types and different methods for detection and segmentation of brain tumor. The objective of this survey paper is to presents a various automatic Brain tumor segmentation method from MRI of brain.

TABLE OF CONTENT

LIST OF FIGURES

INTRODUCTION

Brain is the center of human central nervous system. The brain is a complex organ as it contains 50-100 billion neurons forming a gigantic network. Brain tumor is an abnormal growth of group of cells that grows inside of the brain or around the brain. The types of Brain tumors are benign tumor and malignant tumor. Benign tumors are nonmalignant/non-cancerous tumor. A benign tumor is usually localized and does not spread to other parts of the body. Most benign tumors respond well to treatment. Benign tumor is less harmful than malignant tumor. Malignant tumors are cancerous growths. They are often resistant to treatment, may spread to other parts of the body. Malignant tumors are classified into primary and secondary tumors. The malignant tumor spreads rapidly invading other tissues of brain, progressively worsening the condition causing death. Brain tumor detection is very challenging problem due to complex structure of brain.

Several new complex medical imaging modalities, such as X-ray, magnetic resonance imaging (MRI), and ultrasound, strongly depend on computer technology to generate or display digital images. With computer techniques, multidimensional digital images of physiological structures can be processed and manipulated to help visualize hidden diagnostic features that are otherwise difficult or impossible to identify using planar imaging methods. Magnetic resonance imaging of brain image computing has very increased field of medicine by providing some different methods to extract and visualize information from medical data, acquired using various acquisition modalities. The brain is one of the important organs of the human body as it coordinates each and every action of the human body. The human brain can be affected by many diseases like infections, strokes and tumors. All types of brain tumor may produce symptoms that vary depending on the part of the brain involved. These symptoms may include headaches, seizures, problems with vision, vomiting and mental changes. Detection of a brain tumor from medical images has been a challenging task. We are going to develop a software that is going to detect the tumor in the brain before it become critical by applying various image processing techniques on MRI image of brain. This paper reviewed and analyzed the current studies on detection of brain tumors. Furthermore, the study has developed the software for detecting brain tumor by using the algorithms like K-mean clustering. The results of K-means can be used by medical specialist to classify and diagnose tumor patients. These results help the medical doctor in the classification process of brain tumor.

In the diagnosis of brain tumor, determination of the exact location is an important task, using which helps to find out the shape & size of tumor. In brain tumor detection techniques, image segmentation plays a vital role there are many image segmentation methods are used to extract tumor from magnetic resonance imaging images of brain. Whereas segmentation provides the detailed information about the soft brain tissues such as gray matter (GM), white matter(WM),

cerebral spinal fluid (CSF)etc. There are two types of segmentation involves a manual segmentation and automatic segmentation. Manual segmentation technique depends on experience or expert knowledge of human and time-consuming technique but reduces the computational efficiency. Whereas automatic segmentation deals with histogram. Which is only based on the intensity of pixels. In this survey, various existing image segmentation techniques are introduced for detection and segmentation of brain tumor from MRI images i.e., thresholding-based, edge-based, region-based and clustering-based segmentation have been explained.

The survey on automated brain tumor detection and segmentation from MRI has following objectives

- To use fully automated tumor segmentation approach for patches extraction.
- To provide software (computer code) to detect the size and location of tumor in brain with quality approach.
- It suggests good classification of brain tumor.
- It provides early and precise detection of brain tumor.

Segmentation is an important process in most medical image analysis and classification for radiological evaluation or computer-aided diagnosis. Basically, image segmentation methods can be classified into three categories: edge-based methods, region-based methods, and pixel-based methods. K-means clustering is a key technique in pixel-based methods. Because pixel-based methods based on K-means clustering are simple and the computational complexity is relatively low compared with other region-based or edge-based methods, the application is more practicable. Furthermore, K-means clustering is suitable for biomedical image segmentation as the number of clusters is usually known for images of particular regions of the human anatomy. Many researchers have proposed related research into K-means clustering segmentation [1, 5]. The improvements achieved by [1, 5] have been remarkable, but more computational complexity and extra software functionality are required. In this paper, we carefully select the appropriate features from brain images as the clustering features to achieve good segmentation results while maintaining the low computation aspect of the segmentation algorithm. Because the color space transformation function in our proposed method is a fundamental operation for most image processing systems, the color space translation does not cause extra overhead in the proposed scheme. Therefore, by using color-based segmentation with K-means clustering to magnetic resonance (MR) brain tumors, the proposed image tracking method maintains efficiency. The experimental results also confirm that the proposed method helps pathologists distinguish exact lesion sizes and regions.

LITERATURE SURVEY

- This project proposes a medical image denoising algorithm using discrete wavelet transform. The presence of noise in biomedical image is a major challenge in image processing and analysis. Denoising techniques are aimed at removing noise or distortion from images while retaining the original quality of the image.- **Shashikant Agrawal, Rajkumar Sahu**

- MRI brain imaging technique is widely used to visualize the anatomy and structure of the brain. The detection of tumour requires several processes on MRI images which includes image preprocessing, feature extraction, image enhancement and classification. The final classification process concludes that a person is diseased or not. segmentation algorithms are reviewed and their advantages- **D.SELVARAJ, R.DHANASEKARAN**

- MRI based brain tumor segmentation studies are attracting more and more attention in recent years due to non-invasive imaging and good soft tissue contrast of Magnetic Resonance Imaging (MRI) images. With the development of almost two decades, the innovative approaches applying computer-aided techniques for segmenting brain tumor are becoming more and more mature and coming closer to routine clinical applications. - **Jin Liu, Min Li, Jianxin Wang , Fangxiang Wu, Tianming Liu, and Yi Pan**

- Despite intensive research, segmentation remains a challenging problem due to the diverse image content, cluttered objects, occlusion, image noise, non-uniform object texture, and other factors. This paper presents an efficient image segmentation approach using K-means clustering technique integrated with Fuzzy C-means algorithm. - **Eman Abdel-Maksoud , Mohammed Elmogy , Rashid Al-Awadi**

- Recent advancement in biomedical image processing using Magnetic Resonance Imaging (MRI) makes it possible to detect and localize brain tumors with ease. We aim to classify brain scans into eight (8) different categories with seven (7) indicating different tumor types and one for normal brain. The proposed classification approach is validated using Leave 2-Out cross-validation technique. - **Muhammad Nasir, Asim Baig and Aasia Khanum**

- An algorithm is presented for fully automated brain tumor segmentation from only two magnetic resonance image modalities. The technique is based on three steps: (1) alternating different levels of automatic histogram-based multi-thresholding step, (2) performing an effective and fully automated procedure for skull-stripping by evolving deformable contours, and (3) segmenting both Gross Tumor Volume and edema. The method is tested using 19 hand-segmented real tumors which shows very accurate results in comparison to

a very recent method (STS) in terms of the Dice coefficient. Improvements of 5% and 20% respectively for segmentation of edema and Gross Tumor Volume have been recorded. - **Mohamed Ben Salah, Idanis Diaz, Russell Greiner, Pierre Boulanger,Bret Hoehn, and Albert Murtha.**

- A novel hybrid method using Gaussian Mixture Model based Hidden Markov Random Field (HMRF) with Expectation Maximization (EM) has been proposed which segments tissues from MR brain images efficiently and helps to separate out tumour area easily. - **Saurabh Shah and N C Chauhan**

- In the past, many researchers in the field of medical imaging and soft computing have made significant survey in the field of brain tumor segmentation. Both semiautomatic and fully automatic methods have been proposed. **- Nelly Gordillo , Eduard Montseny, Pilar Sobrevilla**

- There is a growing interest in using multiresolution noise filters in a variety of medical imaging applications. We review recent wavelet denoising techniques for medical ultrasound and for magnetic resonance images and discuss some of their potential applications in the clinical investigations of the brain. - **Aleksandra Pi_zurica, Alle Meije Wink, Ewout Vansteenkiste,Wilfried Philips and Jos B.T.M. Roerdink**

- With the development of computer image processing technology, three-dimensional (3D) visualization has become an important method of the medical diagnose, it offers abundant and accurate information for medical experts. Three-dimensional (3-D) reconstruction of medical images is widely applied to tumor localization; surgical planning and brain electromagnetic field computation etc.- **Megha Borse, S.B. Patil, B.S.Patil**

- We propose an effective and efficient approach to 3D reconstruction of brain tumor and estimation of its volume from a set of two dimensional (2D) cross sectional magnetic resonance (MR) images of the brain. In the first step, MR images are preprocessed to improve the quality of the image. Next, abnormal slices are identified based on histogram analysis and tumor on those slices is segmented using modified fuzzy c- means (MFCM) clustering algorithm. Next, the proposed enhanced shape based interpolation technique is applied to estimate the missing slices accurately and efficiently. Then, the surface mesh of the tumor is reconstructed by applying the marching cubes (MC) algorithm on a set of abnormal slices. The large number of triangles generated by the MC algorithm was reduced by our proposed mesh simplification algorithm to accelerate the rendering phase. Finally, rendering was performed by applying Phong lighting and shading model on the

reconstructed mesh to add realism to the 3D model of the tumor. - **Megha P. Arakeri and G. Ram Mohana Reddy**

PROBLEM FORMULATION

Doctors rely on common knowledge for treatment. When common knowledge is lacking, studies are summarized after some number of cases have studied. But this process takes times, whereas if k-means algorithms is used, the detection can be more prominent.

Nowadays we have seen most of the tumors are life threatening where brain tumor being one of them. As we know that brain tumor can be of any size, shape, location and intensity, therefore it is very difficult to detect tumor and diagnose it. The manual identification of tumor from MRI images is subjective in nature and may vary from expert to expert depending on their expertise and other factors which include lack of specific and accurate quantitative measures to classify the MRI images as it has brain tumor or not. So automated identification of brain tumor from MRI images help in alleviating the major issues and provide better results. Detection of brain tumor from the various symptoms of the patients has always been a major issue for the medical practitioner and pathologist for diagnosis and treatment planning. It is also a fact that some tests may be time consuming and it gives workloads and difficulty for the pathologists to obtain the accuracy of the presence of the tumor

Basically, feature space selection is a key issue in K-means clustering segmentation. The original MR brain image is rendered as a gray-level image that is insufficient to support fine features. To obtain more useful feature and enhance the visual density, the proposed method applies pseudo-color transformation, a mapping function that maps a gray-level pixel to a color-level pixel by a lookup table in a predefined color map. An RGB color map contains R, G, and B values for each item. Each gray value maps to an RGB item. The proposed method has adopted the standard RGB color map, which gradually maps gray-level values 0 to 255 into blue-to-green-to-red color.

RESEARCH OBEJECTIVE:

- The primary aim of this project is to analyze the tumor dataset and detect the tumor using k-means and allow the users to predict tumor using the algorithms. The objective is to achieve the précised, accurate and speedy results than the available method. The objective is also to understand how the algorithm will works.
- The motivation is to develop a software with better segmentation capability for use in medical imaging to detect diseases like brain tumor.
- Image segmentation has been identified as the key problem of medical image analysis and remains a popular and challenging area of research. Image segmentation is increasingly used in many clinical and research applications to analyze medical imaging datasets; which motivated us to present a snapshot of dynamically changing field of medical image segmentation.
- CT (Computed Tomography), MRI (Magnetic Resonance Imaging), PET (Positron Emission Tomography) etc. generates a large amount of image information. With the improved technology, not only does the size and resolution of the images grow but also the number of dimensions increases.
- In the future, we would like to have algorithms which can automatically detect diseases, lesions and tumors, and highlight their locations in the large pile of images. The motivation of this work is to increase patient safety by providing better and more precise data for medical decision.
- As the medical practitioner and pathologist face various such types of problems in detecting tumor manually from the MRI image, so there is a need of an automatic detection process. Thus, the main aim of our project is to design a framework for automatic detection of the tumor to obtain more accuracy from the imaging dataset which plays a vital role in the diagnosis of tumors by using various image processing algorithm in MATLAB. This framework will hopefully help the pathologist to reduce the work-load and minimize human error while maintaining and improving the accuracy to detect tumor.

RESEARCH METHODOLOGY

1. TUMOR SEGMENTATION ECHNIQUES:

MRI is mainly used for brain tumor diagnosis and treatment in the clinic. MRI offers various beneficial features like multiplanar capabilities, potential of tissue characterization and no bone and teeth artefacts. The different techniques of brain tumor segmentation using MRI images shown in fig. 2.

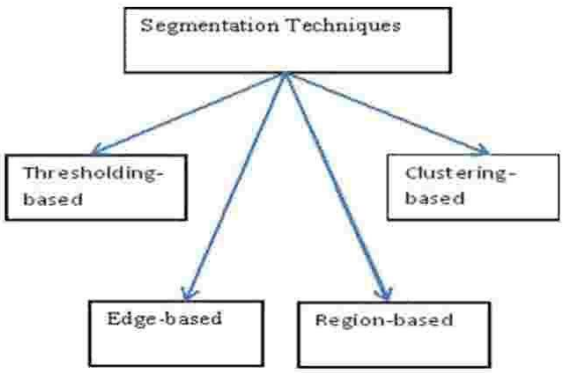


Fig. 1. Classification of segmentation techniques on the basis of pixel intensity.

Thresholding

Thresholding is one of the frequently used methods for image segmentation. This method is suitable for images with different intensities of pixels. Using this method, the image is partitioned directly into different regions based on these intensity values of the pixels. There are three types of thresholding algorithms. • Global thresholding • Local thresholding • Adaptive thresholding In adaptive thresholding, different threshold values for different local areas are used**.**

A. Global thresholding

Global thresholding method chooses only one threshold value T for the entire image. The following condition is imposed.

$$g(x,y) = \begin{cases} 1 \; if \; f(x,y) \geq T \\ 0 \; otherwise \end{cases}$$

Where T is the threshold parameter,

g(x,y) is the global threshold in 2D image,

f(x,y) is the original input image.

Global thresholding is used for bimodal images. It is simpler and faster in computational time only if the image has uniform intensity distribution and high contrast between foreground and background.

Traditional Thresholding method depends on a discriminant analysis which divides the image into two classes based on the intensity of gray levels in image. The main advantage of Traditional/Otsu's method is simple and effective to implement but it can segment only larger objects from background and fails, if the image has variable contrast distribution.

B. Local thresholding

Threshold values are chosen locally by dividing an image into sub-images and threshold value for each part is calculated. A local thresholding technique takes more computational time than the global thresholding. Its result is satisfactory in an image with background variations. It can extract only smaller regions.

The limitations of thresholding as follows.

- The main limitation of thresholding techniques is that in its simplest form, only two classes are generated and it cannot be applied to multi- channel images.
- A Thresholding technique does not take into account the spatial characteristics of an image. Therefore a Thresholding technique is sensitive to noise and intensity inhomogeneities.

C. Adaptive Thresholding

In many cases background gray level is not constant, and object contrast varies within an image. In such cases a threshold that works well in one area might not work well in other areas of the image in these cases, it is convenient to use a threshold gray level that is a slowly varying function of position in the image. In adaptive thresholding, different threshold values for different local areas are used.

Edge Based Segmentation

Edge based segmentation methods divide an image based on abrupt changes in the intensity of pixels near the edges [12]. The result is a binary image with edges of the objects being detected. Based on the theory, there are two basic edge based segmentation methods viz. gray histogram and gradient based methods.

A. Gray Histogram Technique

The result of the technique of gray histogram mainly depends upon selection of threshold (T). The image is converted into gray scale image and after that gray-level thresholding is applied on the histogram of that image.

B. Gradient Based Method

In the gradient based method, the difference between intensity values of neighbouring pixels is taken into account [13]. So, when there is an abrupt change in the intensity in a region of an image and there is very less image noise then gradient based methods works well. These methods involve applying gradient operators on the image. The basic edge detection operators used in this method are Roberts operator, Prewitt operator, Sobel operator, Canny operator, Laplace operator, Laplacian of Gaussian (LOG) operator, Frei-chen edge detector Difference of Gaussians filter etc. out of which Sobel and Canny operators produce better results Edge detection methods exhibit a balance between accuracy and noise immunity. If the level of detecting accurate edges is too high, then noise may produce fake edges and if the degree of noise immunity is too high, then some parts of the image containing important information might go undetected. These operators work well for images with sharps edges and low amounts of noise. The detected boundaries using these operators may not necessarily form asset of closed connected curves, so some edge linking may be required.

Region Based Segmentation

Region based methods divide an image into regions that are similar on the basis of a set of a particular criterion [14]. The existing region segmentation techniques mainly consist of the following methods:

A. Region growing

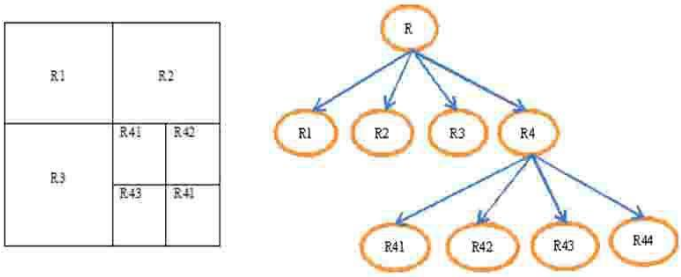
Region growing method is one of the most frequently used segmentation methods. This method requires initiates with a seed pixel and grows the region by incorporating the neighbouring pixels based on some threshold if no edges are detected. Region growing process is iterated for each boundary pixel in the region. If adjacent regions are found, a region-merging algorithm is used in which weak edges are dissolved and strong edges are left intact. Region growing algorithms vary depending on the criteria used to decide whether a pixel should be included in the region or not, connectivity type used to determined neighbours, and the strategy used to visit neighbouring pixels.

B. Region splitting and merging

The region splitting is a top-down approach. The image is split into a number of different regions depending on some criterion and after the splitting, it is merged. The whole image is initially considered as a single region and then the internal similarity of the image is calculated using standard deviation. If the variation is very large, then the image is split into regions using some threshold value. This process is repeated until no more further splitting of the region is possible. A

merging phase after the splitting phase is always desirable ,which is done by split-and-merge algorithm. Quad tree is a common data structure used for splitting.as shown in Fig.2.

Where R represent the entire image.



(a) **(b)**

Fig.2. (a) Splitting of an image (b) Representation by a quad tree

C. Watershed segmentation

Watershed segmentation algorithm can be used if the image has uniform contrast distribution and the intensity of the foreground and background is distinguishable. Watershed algorithm is also used to find the weak edges in the images.

2. CLUSTERING

Cluster analysis or clustering is the task of grouping a set of objects in such a way that objects in the same group (called a cluster) are more similar (in some sense or another) to each other than to those in other groups (clusters). It is a main task of exploratory data mining, and a common technique for statistical data analysis, used in many fields, including machine learning, pattern recognition, image analysis, information retrieval, bioinformatics, data compression, and computer graphics.

Clustering is the technique which is most frequently used in the MRI Segmentation, where it divides pixels into classes, without having prior information or training [15]. It classifies the pixels having largest probability into the same class. In the clustering technique, the training is done by utilizing the pixel characteristics with properties of each class of

classified pixels. Clustering methods can be divided in to two categories are Hierarchical and Partitional.

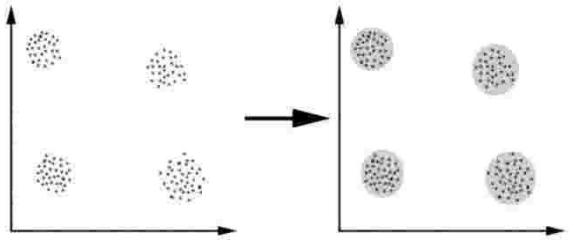


Fig.3: -Clustering

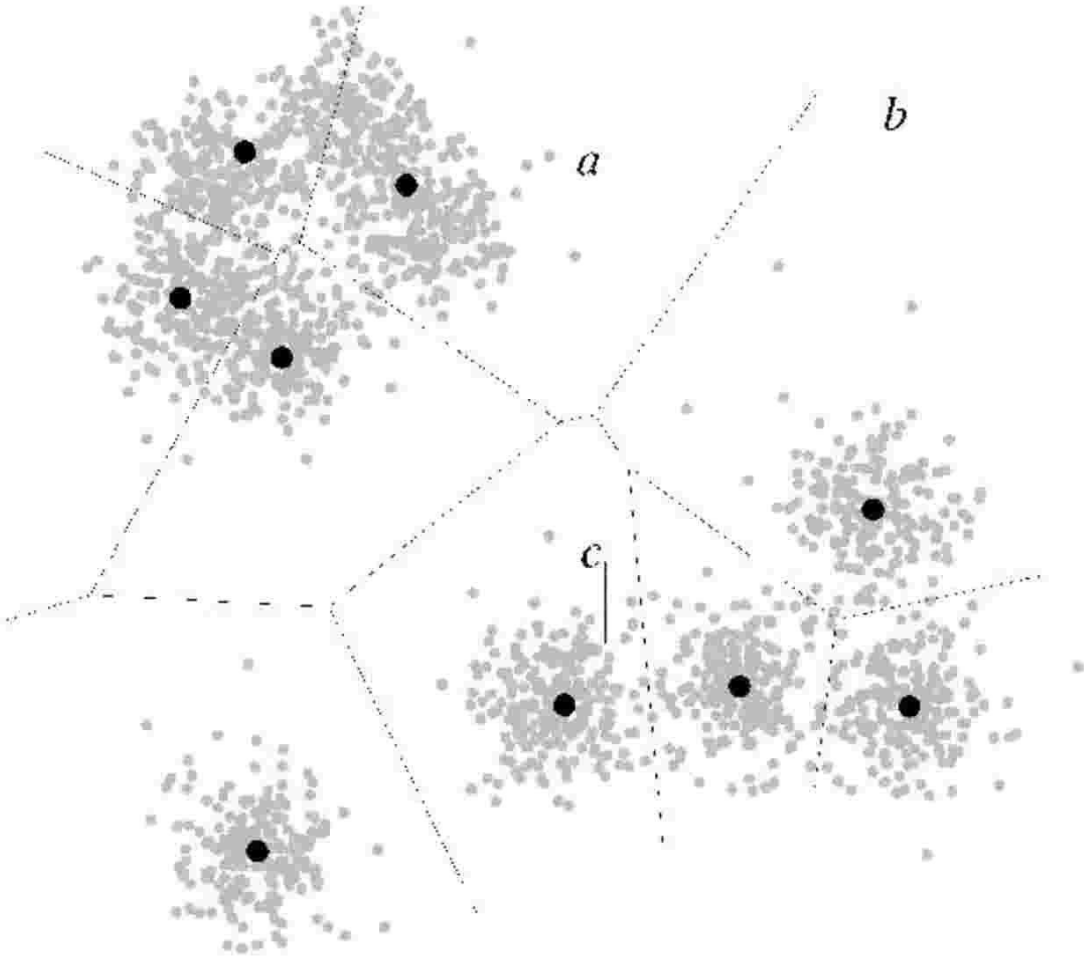


Fig.4

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K-means

Clustering is a method to divide a set of data into a specific number of groups. It's one of the popular method is k-means clustering. In k-means clustering, it partitions a collection of data into a k number group of data [16]. It classifies a given set of data into k number of disjoint cluster. K-means algorithm consists of two separate phases. In the first phase it calculates the k centroid and in the second phase it takes each point to the cluster which has nearest centroid from the respective data point. There are different methods to define the distance of the nearest centroid and one of the most used methods is Euclidean distance. Once the grouping is done it recalculate the new centroid of each cluster and based on that centroid, a new Euclidean distance is calculated between each center and each data point and assigns the points in the cluster which have minimum Euclidean distance. Each cluster in the partition is defined by its member objects and by its centroid. The centroid for each cluster is the point to which the sum of distances from all the

objects in that cluster is minimized. K-means is an iterative algorithm in which it minimizes the sum of distances from each object to its cluster centroid, overall clusters.

Let us consider an image with resolution of x × y and the image has to be cluster into k number of cluster. Let p(x, y) be an input pixels to be cluster and ck be the cluster centers. The algorithm for k-means [17] clustering is as follow:

1. Initialize number of cluster k and Centre.
2. For each pixel of an image.

   calculate the Euclidean distance d, between the center and each pixel of an image using the relation given below

   $$\boldsymbol{d = || \, p(x,y) - ck \, |}$$
3. Assign all the pixels to the nearest center based on distance
4. After all pixels have been assigned, recalculate new position of the Centre using the relation given below.

   $$ck = \frac{1}{k} \sum_{y \in ck} \sum_{y \in ck} p(x, y)$$
5. Repeat the process until it satisfies the tolerance or error value.
6. Reshape the cluster pixels into image.

Although k-means has the great advantage of being easy to implement, it has some drawbacks. The quality of the final clustering results is depends on the arbitrary selection of initial centroid. So if the initial centroid is randomly Chosen, it will get different result for different initial centers. So the initial center will be carefully chosen so that we get our desire segmentation. And also computational complexity is another term which we need to consider while designing the K-means clustering. It relies on the number of data elements, number of clusters and number of iteration.

K-means clustering algorithm is the simplest of the existing clustering algorithms that can do clustering of pixels into numerous regions based on pixel properties. This method is called hard clustering as the clusters must be distant enough from each other and every pixel is assigned the membership function in such a way that it belongs to one particular region only. This method

works well if the spreads of the distributions are approximately equal, but it does not handle well the case where the distributions have differing variances.

3. Proposed Method

The propose method for segmentation of brain tumors in MRI images based on convolutional neural networks. This method consists of mainly, pre- processing stage, classification stage by using CNN and post processing stage. Bias field correction, patch and intensity normalization are done in the pre-processing stage. In our proposed method the distortion caused by multi-site multi-scanner acquisition of MRI images is removed by intensity normalization method proposed by Nyul et al. intensity normalization is help to improve the effectiveness of the classification. For classification CNN found to be effective due to the use of deal with variability in brain tumor.

The advantages of this method are as follows

- It takes only less computational time.
- This method has higher potential in tumor detection and classification.
- It improves the achieved segmentation results.
- It not only shows the detailed and complete aspects of brain tumors, but also improves clinical doctors to study the mechanism of brain tumors at the aim of better treatment.

The Block diagram of propose automatic image segmentation method as shown in Fig.4.

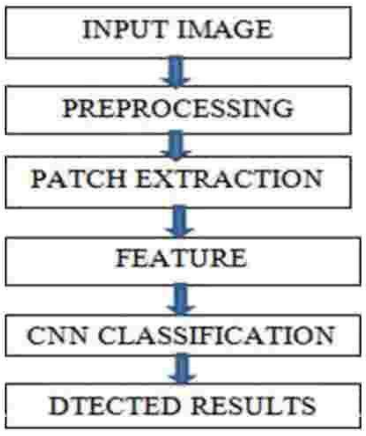

Fig 5. Block diagram of brain tumor detection and classification system