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Brain Tumor Detection using Image Segmentation

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***Abstract*- Image segmentation is a process of partitioning a digital image into N regions. In today's world, Brain tumor detection using image segmentation is fundamental but challenging problem in field of computer vision and image processing due to the diverse image content, image noise, non-uniform object texture and other factors. Accurate detection of size and location of brain tumor plays a vital role in the diagnosis of brain tumor. There are many image segmentation methods available for medical image analysis but the Region based and Clustering techniques are efficient, fast and accurate. This paper presents the two efficient image segmentation algorithms i.e. K-means and region growing techniques for brain MRI images and compare the two algorithms and determine the best one.**

***Keywords*—MRI,Image Segmentation,K-Means,Region growing**

I. INTRODUCTION

Segmentation is used to subdivide an image to its regions for components or objects and it is an important tool used for medical image processing. It is an initial step used for segmentation which can be used for visualization, compression and identification. The images are segmented on the basis of set of pixels in a region that are similar on the basis of some homogeneity criteria such as color, intensity, or texture which helps to locate and identify objects or boundaries in an image. By identifying all pixels (2D image) or voxels (3D image) which belongs to an object, segmentation for that particular object will be achieved.

Radiologists examine the patient physically by using Computed Tomography (CT scan) and Magnetic Resonance Imaging (MRI). MRI images showed the brain structures, tumor's size and location. From the MRI images the information such as tumors location provided radiologists, an easy way to diagnose the tumor and plan the surgical approach for its removal[1]

This project shows a color-based segmentation technique that uses the K-means clustering method to find the effective objects in magnetic resonance (MR) brain images. It also shows another effective segmentation technique i.e. region growing which is also a color-based segmentation technique. Before

A. Brain Tumor

A brain tumor is defined as an abnormal growth of cells within the brain or the central spinal canal. It is also referred as an intracranial solid neoplasm. Some tumors are brain cancers. Brain tumors include all tumors inside the human skull (cranium) or in the central spinal canal. They are produced by an irregular and unrestrained cell division, typically in the brain itself, but also in lymphatic tissue, in blood vessels, in the cranial nerves, in the brain envelopes (meninges), skull, pituitary gland, or pineal gland. Within the brain itself, the involved cells may be neurons or glial cells (which include astrocytes, oligodendrocytes, and ependymal cells).[11]. Though, brain tumors are not consistently incurable, particularly lipomas which are intrinsically kind. Brain tumors or intracranial neoplasms can be cancerous (wicked) or non-cancerous (incurable); though, the definitions of malignant or benign neoplasms differs from those generally used in other types of cancerous or noncancerous neoplasms in the body. Its danger level depends on the grouping of factors like the form of tumor, its place, its dimension and its condition of growth. Since the brain is fine confined by the head, the early on discovery of a brain tumor occurs just while diagnostic equipment is focused at the intracranial cavityMain brain tumors are usually situated in the posterior cranial fossa in children and in the frontal two thirds of the cerebral hemispheres in adults, though they can influence any fraction of the brain[11]. Visibility of cipher and symptoms of brain tumors mostly depends on two factors: the tumor dimension (quantity) and tumor place.[11]

United States in 2005, there were approximately 43,800 new cases of brain tumors (Central Brain Tumor Registry of the United States, primary brain tumors in the United States, Statistical Report, 2005-2006), which represented 14 percent of all cancers, 2.4 percent of all cancer deaths, and 20-25 percent of pediatric cancers. Ultimately, there are about 13,000 deaths per year in the U.S. alone due to brain tumors[3].

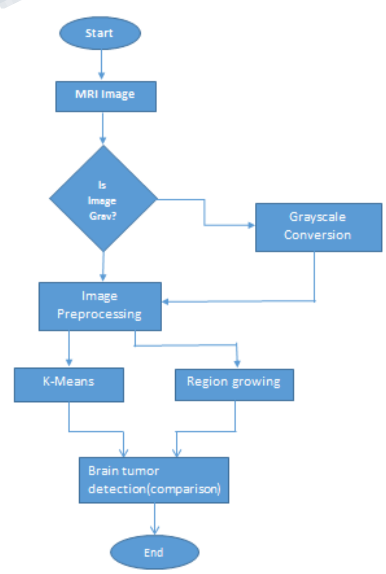
II . RELATED WORK

This section deals with the works related to the brain tumor detection and segmentation in medical images.There have been many researches and study done in the area of image segmentation by using different methods. And many are done based on different application of image segmentation. K-means algorithm is the one of the simplestand fast clustering algorithm. And there are many methods implemented so far with different method to initialize the centre. And many researchers are also trying to produce new methods which are more efficient than the existing methods, and shows better segmentedresult. Some of the existing recent works are discussed here[2]. PallaviPurohit and RiteshJoshi[7] introduceda new efficient approachtowards K-means clustering algorithm.They proposeda new methodfor generatingthe cluster center byreducingthe meansquare errorofthe final cluster without large increment in the execution time. It reduced the means square error without sacrificing the execution time..MadhuYedla, Srinivasa Rao Pathakota, T. M. Srinivasa[6] proposed Enhancing K-means clustering algorithm with improved initial center. A new method for finding the initial centroid is introduced and it provides an effective way of assigning the data points to suitable clusters with reduced time complexity. They proved their proposed algorithm has more accuracy with less computational time comparativelyoriginal k-means clustering algorithm. This algorithm does not require any additional input like threshold value. But this algorithm still initializes the number of cluster k and suggested determinationof value of k as one of the future work. Douglas and Michael suggested a method to select a good initial solution by partitioning dataset into blocks and applying k-means to each block. But the time complexity is slightly more[15]. Other than k-means several segmentation methods had been proposed by the digital image processing community, many of which are ad - hoc [10]. An effective modified region growing technique for detection of brain tumor. Modified region growing includes an orientation constraint in addition to the normal intensity constrain (Weaver et al., 2012)[1].The performance of the technique is systematically evaluated using the MRI brain images received from the public sources.

III PROPOSED METHODOLOGY

There is a never ending research on medical image segmentation study. Many researches came up with many methods for efficient segmentation. This research presents the two most efficient algorithms i.e. K-means and region growing, which will not only give efficient segmentation but detect the tumor from MRI scan.

Below is the block diagram of the proposedIdea:



Steps of algorithm are as following:-

1. Take MRI scan of brain as input.
2. Convert it to grey scale image if it is not.
3. Pass the resulting image through median filter to enhance the quality of image
4. Compute K-means segmentation.
5. Compute region growing segmentation.
6. Finally output will be a tumor region.
7. Compare the output of both the segmentations.

All above steps are explained here in detail.

A. Greyscale Conversion

Generally when we see MRI images on computer they looks like black and white images. Grayscale is a range of shades of gray without apparent color. The darkest possible shade is black, which is the total absence of transmitted or reflected light. The lightest possible shade is white, the total transmission or reflection of light at all visible wavelengths. So because of the above reasons first we convert our MRI image to be pre-processed in grayscale image.For every pixel in a red-green-blue (RGB) grayscale image, R = G = B. The lightness of the gray is directly proportional to the number representing the brightness levels of the primary colors. Black is represented by R = G = B = 0 or R = G = B = 00000000, and white is represented by R = G = B = 255 or R = G = B = 11111111.

B. Image Preprocessing

Image noise is defined as the random variation of brightness or somecolor information in images. It can usually be produced by the sensor and circuitry of a scanner or digital camera. It may also arrive due to the thermal effect[15].Image noise is an undesirable as it does not maintains the image quality and adds spurious and extraneous information.All medical images contain some visual noise, speckle noise, salt and pepper noise, Gaussian noise etc. Significant tumor detection usually depends on the regions of interest which are usually of low contrast and of noisy nature. Hence, there is a need to denoise an image to preserve its quality, highlight its features, there by suppressing the noise. Denoising here means removing the noise in the images.There are many filters available for preprocessing.

We have used median filter in this paper.A non-linear, median filter is used as it preserves the edges and also removes impulse and, salt and pepper noise. Its main objective is to replace each pixel value in an image with the median value of its neighbors, including itself.When median filters are applied to an image, the pixel values which are very different from their neighboring pixels will be eliminated.A square kernel of 3 x 3 is often used, although larger kernels (e.g. 5×5 squares) can also be used, it causes more severe smoothing.

C. Segmentation using K-Means clustering

K-means is the simplest , unsupervised clustering technique.Clustering is an unsupervised learning method which deals with finding a structure in a collection of unlabeled dataA cluster is a collection of objects which are similar between them and are dissimilar to the objects belonging to other clusters[11]. K-mean clustering is a clustering technique that groups N pixels of an image into K number of clusters, where K < n and K is a positive integer. [12]

Initially the centroids of the predefined clusters are initialized randomly.[12] Clusters are formed on the basis of some similarity features like gray level intensity of pixels and distance of pixel intensities[12].

The main advantages of this algorithm are its simplicity and low computational cost, which allow it to run efficiently on large data sets. The main drawback is that: K the number of clusters must be determined [5], it does not yield the same result each time the algorithm is executed and the resulting clusters depend on the initial assignments of centroids.

The Algorithm is as follows:

(i) Randomly choose number of clusters K.
(ii) Randomly choose K pixels of different intensities a
Centroids.

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(iii) Centroids are finding out by calculating mean of pixel values in a region. Place Centroids as far away from each other as possible.

(iv) Now, compare a pixel to every Centroid and assign pixel to the closest Centroid to form a cluster. When all the pixels have been assigned, initial clustering has been completed .

(v) Recalculate the mean of each cluster and recalculate the position of Centroids in K clusters.

$$\mu_i := \frac{\sum_{i=1}^{m} 1\{c_{(i)} = j\} x^{(i)}}{\sum_{i=1}^{m} 1\{c_{(i)} = j\}} \quad \text{------------(1)}$$

(vi) Repeat steps (iv) & (v) until the Centroids no longer move.

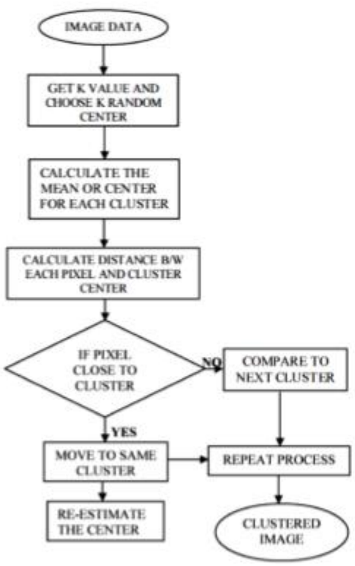

Fig: Block diagram of K-MEANS method

D. Segmentation using Region growing

Region Growing is the region based sgmentationmethod.This method group pixels in an entire image into sub regions or large regions based on predefined criterion. In other words, the basic idea is to group a collection of pixels with similar properties to form a region [12].

Region growing can be processed into four steps:

(i) Select a group of seed particles in original image

(ii) Select a set of criteria for determining similar seeds based on properties such as grey level intensity or color and then set up a stopping rule.

(iii) Grow the region by adding to each seed those neighboring pixels that have predefined properties similar to the seed pixel.

(iv) Stop the region growth when there are no more pixels that match the criterion for inclusion in that region.[12]

IV PROPOSED ALGORITHM:

1) Find a pixel which is not labeled. Label it and store its coordinates on a stack.

2) While there are pixels on the stack, do:

- ♦ Get a pixel from the stack (the pixel being considered).
- ♦ Check its neighbors to see if they are unlabeled and close
- ♦ to the considered pixel;
- ♦ if are, label them and store them on the stack.

3) Repeat from 1) until there are no more pixels on the image.

E. Approximate reasoning

In the approximate reasoning banalization method is used to calculate tumor area. In banalization method image consist of two values either black or white. Black value assigned 0 and white value assigned to 1. [4]

$$\text{Image , I} = \sum_{w=0}^{255} \sum_{h=0}^{255} [f(0) + f(1)]$$

Pixels = Width (W) X Height (H) = 256 X 256 f (0) = white pixel (digit 0) f(l) = black pixel (digit 1)

$$\text{No. of white pixel P} = \sum_{w=0}^{255} \sum_{h=0}^{255} [f(0)]$$

Where,

P = number of white pixels (width*height) 1 Pixel = 0.264 mm The area calculation formula is

Size of tumor, S=[(√P)*0.264] mm²

P= no-of white pixels; W=width; H=height.[4].

IV. EXPERIMENTAL RESULTS

Usually, most of the segmentation algorithms have implemented using MATLAB but in this research, an attempt is made to implement the same in java language.Data set (MRI Images) is taken from the

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clinical centres.

Below are the snapshots of the result showing both, the K-means and the region growing segmentation:

Fig1:UI

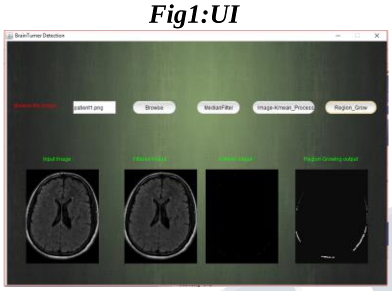

Fig2:Output-MRI brain image without tumor

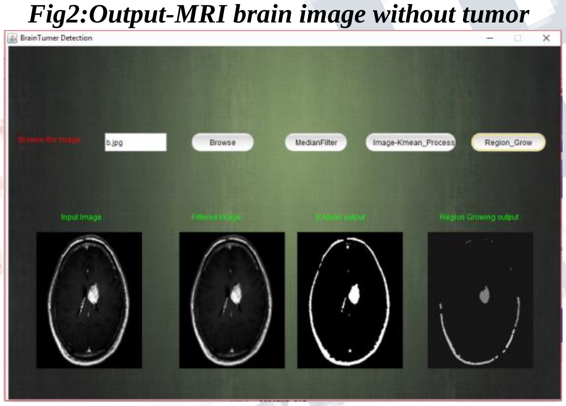

Fig3:Output-MRI brain image with tumor

Fig4:Output-MRI brain image with tumor

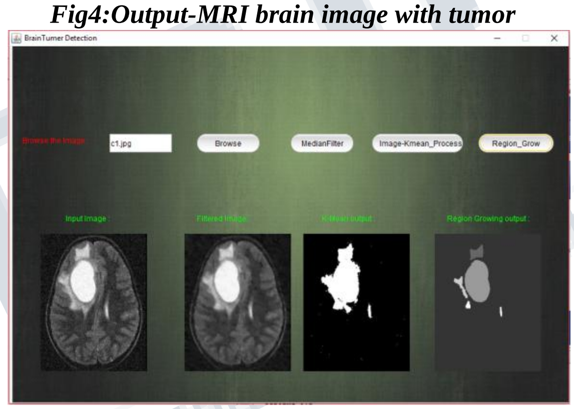

Fig5:Output-MRI brain image with tumor

V. CONCLUSION

A research has been made on Segmentation process, its application and different existing techniques for implementing it for brain tumor detection application. Our research suggested the two most efficient and best suitable algorithms for this application. Cancerous Tumor have been detected from the brain MRI scans using two different segmentation algorithms i.e. k-means and region growing. Then the output of both the algorithms is compared based on their accuracy. It was seen that though K-means method is easy and efficient, it is not as accurate as region growing method. Region growing method proved to be more accurate than k-means, giving a satisfiable segmentation and also proved to be one of the best region based segmentation methods.The entire project is coded in java using netbeans software and UI is done using java swings. We have made this application for brain MRI images but it can also be used for spinal cord MRI Images and other MRI images.

FUTURE WORK

Other than tumor extraction, this project can further be worked on recognition of objects (tumors). The GUI can be more enhanced and it can be used by hospitals on the regular basis which can be useful for naïve users..

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