A STUDY OF VARIOUS BRAIN TUMOR DETECTION TECHNIQUES

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ABSTRACT
The brain tumor detection is a very important application of medical image processing. This paper has presented a review on various brain tumor detection techniques. The overall objective of this paper is to explore the various limitations of earlier techniques. The literature survey has shown that the most of existing methods has ignored the poor quality images like images with noise or poor brightness. Also the most of the existing work on tumor detection has neglected the use of object based segmentation. This paper ends up with the suitable future directions.

INDEX TERMS: BRAIN TUMOR, MRI, NEURAL NETWORK, FUZZY C-MEANS.

The overall goal of this research work is to propose an efficient brain tumor detection using the object detection and roundness metric. To enhance the tumor detection rate further we have integrated the proposed object based tumor detection with the Decision based alpha trimmed global mean. The proposed technique has the ability to produce effective results even in case of high density of the noise.

1. INTRODUCTION
Brain Tumor is several abnormal cells that grows uncontrollable of the standard forces inside the brain or just around the brain. Diagnosis of brain tumors is determined by the detection of abnormal brain structure, i.e. tumor with the precise location and orientation.

Brain tumor may be of two types like Beginning tumors or primary tumors and Malignant tumors. Beginning tumors are often not need to be treated. Malignant tumor is simply termed as brain cancer. Beginning tumors aren't cancerous. They can often be removed, and, in most cases, they don't come back. Cells in beginning tumors don't spread to the rest of the body. Malignant tumors are cancerous and are composed of cells that grow out of control. Cells in these tumors can invade nearby tissues and spread to the rest of the body. Sometimes cells move far from the first (primary)cancer site and spread to other organs and bones where they could continue to grow and form another tumor at that site. This is called metastasis or secondary cancer.

A. MAGENTIC RESOSANCE IMAGING (MRI)
It is really a technique that works on the magnetic field and radio waves to create detailed images of the organs and tissues within your body. MRI is widely used to visualize brain structures such as for instance white matter, grey matter, and ventricles and to detect abnormalities. The MRI may be the usually used modality for brain tumor growth imaging and location finding [1]. It is really a medical imaging technique used to imagine the internal structure of the human body and offer high quality images. MRI supplies a greater distinctive between different tissues of the body. MRI contains useful and good information that may be used in improving the grade of diagnosis and treatment of brain. MRI image texture holds rich sources of information such as for instance characterize brightness, color, slope, size, and other features. Most MRI machines are large, tube-shaped magnets. Whenever you lie inside an MRI machine, the magnetic field provisionally realigns hydrogen atoms in your body. Radio waves cause these aligned atoms to produce very faint signals, which are used to create cross-sectional MRI images.
B. SEGEMENTATION

Image segmentation is the method of partitioning a digital image into multiple segments (sets of pixels, also called super pixels). The goal of segmentation is always to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation may be the process of assigning a brand to every pixel in an image such that pixels with the exact same label share certain visual characteristics.[11]

In case there is medical image segmentation desire to is always to: 1. Study anatomical structure
2. Identify Region of interest i.e. locate tumor, lesion and other abnormalities.
3. Measure tissue volume to measure growth of tumor (also reduction in size of tumor with treatment)- Assist in treatment planning just before radiation therapy; in radiation dose calculation
Using segmentation in medical images is a very important task for detecting the abnormalities, study and tracking progress of diseases and surgery planning. All the pixels in region are similar regarding some characteristic or computed property, such as for instance color, intensity, or texture. Adjacent regions are significantly different regarding the exact same characteristics. The simplest method of image segmentation is known as the Thresholding method [12]. This approach is dependent on a threshold value to show a gray-scale image into a binary image. The important thing feature of this method is to choose the threshold value.

2. BRAIN TUMOR TECHNIQUES

There are different techniques for brain tumor detection the following:

2.1 Classification Technology - Classifier methods are pattern recognition techniques that seek to partition an element space produced from the image using data with known labels. A function space is the number space of any function of the image, with common feature space being the image intensities themselves. Classifiers are referred to as supervised methods since they need training data that are manually segmented and then used as references for automatically segmenting new data. An easy classifier is the nearest-neighbor classifier, where each pixel or voxel is classified in the same class as the training datum with the close intensity. The k-nearest-neighbor (K-NN) classifier is just a simplification of this approach, where the pixel is classified in line with the majority vote of the k closest training data. The K-NN classifier is known as a nonparametric classifier since it creates no basic assumption in regards to the geometric structure of the data. K-NN estimation is founded on trying to find the k nearest samples within a couple of training samples to a test sample from the same type. K-NN classifier computes distances between a (feature vector) \( x \) and all training samples, and then \( K \) samples, out of \( n \) training samples, that are closest to \( x \) are afflicted by majority voting to find the class.[8]

Euclidean distance is the measure of distance between a test sample and types of an exercise set. For N-dimensional space, Euclidean distance between any two samples or vectors \( p \) and \( q \) is given by

\[
D = \sqrt{\sum_{i=1}^{N} (p_i - q_i)^2}
\]

Where \( p_i \) and \( q_i \) would be the coordinates of \( p \) and \( q \) in dimension \( i \).

![Fig. 2. K-NN Classifier at K=3](image)

Advantages of KNN algorithm :-
1. KNN algorithm is fairly simple to implement.
2. Real-time image segmentation is done using KNN algorithm since it runs more quickly.

Disadvantages of KNN algorithm :-
1. There's some probability of yielding an erroneous decision if the obtained single neighbor is definitely an outlier of some other class.[9]
2.2 Clustering Technology

Clustering algorithms primarily conduct the same function as classifier procedures without the usage of education files. Hence, they are named unsupervised procedures. As a way to make up intended for lacking education files, clustering procedures iterate in between segmenting your graphic and characterizing your components on the every single class. In a sense, clustering procedures coach themselves while using the available files. Clustering can be a couple of files together with identical qualities. With splitting the information in to sets of 2 materials within the files set. You will discover diverse clustering algorithms.

K-Means Clustering- Probably the most well-liked and widely learnt clustering algorithms to split up your feedback files within the Euclidian space may be the K-Means clustering. It's a nonhierarchical strategy that will employs a quick and easy method to classify settled dataset via a selected quantity of groups (we need to make an assumption intended for parameter k) which might be acknowledged a priori. The actual K-Means protocol is created using an iterative construction the spot that the portions of the information tend to be sold back in between groups to be able to match the standards associated with reducing your variance in every single group and increasing your variance in between groups. [7] While absolutely no factors tend to be sold back in between groups, the method can be quit. The four steps of the algorithm are briefly described below:

K-means Clustering performs pixel-based segmentation of multi-band images. A picture stack is interpreted as a couple of bands corresponding to exactly the same image. For instance, an RGB color images has three bands: red, green, and blue. Each pixels is represented by an n-valued vector, where n is several bands, for example, a 3-value vector [r,g,b] in case of a color image. Each cluster is defined by its centroid in n dimensional space. Pixels are grouped by their proximity to cluster's centroids. Clustercentroids are determined utilizing a heuristics: initially centroids are randomly initialized and then their location is interactively optimized.[6]

![Fig.3. Flowchart of K-means clustering algorithm](image)

2.3 Atlas-based-Segmentation

Atlas–based segmentation is a trusted technique for supervised methods. This will depend on a series of reference images in which the tissues have been segmented by hand. To segment the tumor of medical image, it needs to join up the atlas correspondence to the volume by point out point. A finite-element method, optical-flow, and elasticity of transform are found in these segmentation[3]. Atlas-guided approaches have been applied mainly in MR brain imaging.[10]

Advantages-1. An atlas-guided approaches is that labels are transferred as well as the segmentation. Additionally they provide a regular system for studying morphometric properties.

Disadvantages- 1. An atlas-based may be in enough time necessary for atlas construction wherever iterative procedure is incorporated inside, or a complicated non rigid registration.

2.4 Brain Tumor Detection and Segmentation Using Histogram Thresholding [4]-The concept is based mainly on three points: (i) the symmetrical structure of the mind, (ii) pixel intensity of image and (ii) binary image conversion. It is really a well-known detail that human brain is regular about its central axis and all through it's been supposed that the tumor is moreover on the left or on the right side of
the brain. MR image of the human brain can be split into sub region such that white matter, gray matter, blood cells and cerebrospinal fluid can be easily detected. The image of a brain in MRI is represented through pixel intensity. In gray color images, the intensity lies between 0-255 with 0 indicating for black and 255 is assigned for the white color. The blood cells (RED color in RGB) are represented by white color, and 255 pixel intensity. All of the gray matter is having pixel intensity significantly less than 255.

2.5 Watershed and Edge Detection in HSV Colour Model

The idea of watersheds is founded on visualizing an image in 3 dimensions: two spatial coordinates versus grey levels. In this topographic interpretation, we consider three forms of points: a) points owned by regional minimum, b) point at which water drops and c) point at which water will be equally likely to fall. For a particular regional minimum, the group of points satisfying condition (b) is named catchment basin or watershed of this minimum. A watershed region or catchment basin is defined since the region over which all points flow “downhill” to a standard point. The points satisfying condition (c) are termed divide lines or watershed lines.

HSV Color Model

HSV color model is a method which defines color according to the three feature of the color hue, saturation, and intensity or value. HSV color space could be represented as a hexacone while represented in three dimensional representation. Hue describes the basic feature of color, i.e., only the color which offers the image. It's defined being an angle in the product range [0, 2π]. Saturation may be the way of measuring purity of color and could be measure in the product range [0, 1]. It measures the quantity of white color that's diluted with the color. It may be measured from the central axis to the outer surface. Intensity or value may be the brightness of the color that's generally impossible to measure, the vertical axis represents the intensity. RGB image can very quickly be converted to HSV image using them following:

\[
H = \begin{cases} 
\theta & \text{if } B \leq G \\
360^\circ - \theta & \text{if } B > G 
\end{cases}
\]

With \( \theta = \cos^{-1} \left( \frac{1}{2} \left( \frac{R-G}{(R-G)^2 + (R-B)(G-B)} \right) \right) \)

\[
S = 1 - \frac{3}{(R+G+B)} [\min(R, G, B)]
\]

\[
I = \frac{1}{3} (R+G+B)
\]

The total algorithm is based on HSV color model. The brain tumor image is changed into HSV color model which separates the full total image into three regions hue, saturation, and intensity. It is executed using all the three regions. First histogram equalization is done for contrast improvement of hue region. Histogram equalization is a method for modifying the dynamic range and contrast. Then marker based watershed is applied to the contrasted improved image. Then edge of the image is obtained through the use of canny operator to the output of the watershed algorithm. The complete process is repeated for saturation and intensity region of the image. Finally, the three output images obtained from canny edge detection is combined. The combined image is then converted to RGB color model.
2.6 Neural Network: Artificial neural networks (ANNs) are non-linear data driven self-adaptive approach instead of the standard model based methods. They're influential equipment for modeling, particularly whilst the fundamental data relationship is unknown. An extremely important characteristic of the networks is their adaptive character, where “learning by example” replaces “programming” in solving problems. This feature makes such computational models very appealing in application domains where you have little or incomplete knowledge of the problem to be solved but where training data is readily available. The intensity, shape deformation, symmetry, and texture characters were taken off every image. The Ada Boost classifier was used to find the mainly discriminative character and to segment the tumor region.

2.7 Fuzzy C-Means: It is a method of clustering. In this approach, one pixel may fit in with several clusters which represents group. In this algorithm, the finite assortment of pixels are partitioned into a small grouping of “c” fuzzy clusters according with a given criterion. The objective function of the algorithm is defined because the sum of distances between cluster centers and patterns. Several types of similarity measures are accustomed to identify classes depending on the data and the applying in which it is usually to be used. Some examples which may be used as similarity measures are intensity distance and connectivity. [9]

The algorithm contain following steps:-
1. Initialize the matrix M.
2. Centers vectors are calculated.
3. Perform K steps before termination value is reached.

Advantages of fuzzy c-means :-
1. It is simple and fast algorithm.
2. This algorithm is more robust to noise and provides better segmentation quality.

Disadvantages of fuzzy c-means :-
1. It considers only image intensity values.

3. Related Work
S. Ghanavati et al. (2012) [2] have proposed a multi-modality framework for automatic tumor detection is presented, fusing different Magnetic Resonance Imaging modalities including T1-weighted, T2-weighted, and T1 with gadolinium contrast agent. The intensity, shape deformation, symmetry, and texture features were extracted from each image. The Ada Boost classifier was used to select the most discriminative features and to segment the tumor. I.Maiti et al. (2012) [5] have proposed a new method for brain tumor detection. For this purpose watershed method is used in combination with edge detection operation. It is a color based brain tumor detection algorithm using color brain MRI images in HSV color space. The RGB image is converted to HSV color image by which the image is separated in three regions hue, saturation, and intensity. After contrast enhancement watershed algorithm is applied to the image for each region. Canny edge detector is applied to the output image. After combining the three images final brain tumor segmented image is obtained. H. Yang et al. (2013). [3] experimented several segmentation techniques, no one method can segment all the brain tumor data sets. Clustering and classification technique are sensitive with the initial parameters. Some clustering methods are a point operation, and do not preserve the connectivity among regions. The training data and the appearance of the tumor strongly affect the results of the atlas-based segmentation. Edge-based deformable contour model is suffered from the initialization of the
V. Zeljkovic et al. (2014) have developed a computer aided method for automated brain tumor detection in MRI images. This method allows for the segmentation of tumor tissue with an accuracy and reproducibility comparable to manual segmentation. The results show 93.33% accuracy in abnormal images and full accuracy in healthy brain MR images. This method for tumor detection in MR images also provides information about its exact position and documents its shape. Therefore, this assistive method enhances diagnostic efficiency and reduces the possibility of a human error and misdiagnosis. H. Kaur et al. (2014) have proposed a new technique to overcome the limitations of earlier techniques. It has been found that the most of existing methods has ignored the poor quality images like images with noise or poor brightness. Also the most of the existing work on tumor detection has neglected the use of object based segmentation. H. Aejaz Aslam et al. (2013) have proposed a new approach to image segmentation using Pillar K-means algorithm. The system applies the k-means algorithm optimized after Pillar. Pillar algorithm considers the placement of pillars should be located as far from each other to resist the pressure distribution of a roof, as same as the number of centroids between the data distribution. This algorithm is able to optimize the K-means clustering for image segmentation in the aspects of accuracy and computation time. A. Al. Badarneh et al. (2012) proposed an automatic classification system for tumor classification of MRI images to avoid the Automatic classification of tumors of MRI images requires high accuracy, since the non-accurate diagnosis and postponing delivery of the precise diagnosis would lead to increase the prevalence of more serious diseases. This work shows the effect of neural network (NN) and K-Nearest Neighbor (K-NN) algorithms on tumor classification. The experimental results show that our approach achieves 100% classification accuracy using KNN and 98.92% using NN. M. S. R et al. (2014) proposed a method segmentation and k-means clustering is combined for the improvement analysis of MR images. The results that interpret the unsupervised segmentation methods better than supervised segmentation methods. A pre-processing is required to screen images in the supervised segmentation method. The image training and testing data which significantly complicates the process however the image analysis of noted K-means clustering method is fairly simple when compared with frequently used fuzzy clustering methods. Natarajan et al. (2012) proposed brain tumor detection method for MRI brain images. The MRI brain images are first pre-processed using median filter, then segmentation of image is done using threshold segmentation and morphological operations are applied and then finally, the tumor region is obtained using image subtraction technique. This approach gives the exact shape of tumor in MRI brain image. S. Roy et al. (2013) discussed the several existing brain tumor segmentation and detection methodology for MRI of brain image. MRI is an advanced medical imaging technique providing rich information about the human soft-tissue anatomy. There are different brain tumor detection and segmentation methods to detect and segment a brain tumor from MR Images. These detection and segmentation approaches are reviewed with an importance placed on Enlightening advantages and drawbacks of these methods for brain tumor detection and segmentation. The use of MRI image detection and segmentation in different procedures are also described.
## Comrispon of various techniques-

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4. GAPS IN LITERATURE

1. The most of existing methods has ignored the poor quality images like images with noise or poor brightness.
2. Most of the existing researchers have neglected the use of object based segmentation; to detect tumors in brain.
3. Neural network based brain tumor detection may provide better results; but due to training and testing phase it will comes up with some potential overheads i.e. poor in case of time complexity.

CONCLUSION AND FUTURE WORK

The literature survey has shown that the most of existing methods has ignored the poor quality images like images with noise or poor brightness. Also the most of the existing work on tumor detection has neglected the use of object based segmentation. To remove these limitations a new technique will be proposed in near future using the object detection and roundness metric. To enhance the tumor detection rate further we will also integrated the new object based tumor detection with the Decision based alpha trimmed global mean. The proposed technique will have the ability to produce effective results even in case of high density of the noise.

REFERENCES-


