The Analysis of Disease from MRI Image Using Automatic Segmentation

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***Abstract*— Image Segmentation is an important and challenging factor in the field of medical sciences. It is widely used for the detection of tumors. This paper deals with detection of brain tumor from MR images of the brain. The brain is the anterior most part of the nervous system. Tumor is a rapid uncontrolled growth of cells. Magnetic Resonance Imaging (MRI) is the device required to diagnose brain tumor. The normal MR images are not that suitable for fine analysis, so segmentation is an important process required for efficiently analyzing the tumor images. Clustering is suitable for biomedical image segmentation as it uses unsupervised learning. This paper work uses K-Means clustering where the detected tumor shows some abnormality which is then rectified by the use of morphological operators along with basic image processing techniques to meet the goal of separating the tumor cells from the normal cells.**

***Index Terms*— Automatic Image Segmentation, Image Processing, Magnetic Resonance Imaging, K-Means clustering, Morphological Operators**

I. Introduction

It is important to find out tumor from MRI images but it is somewhat time-consuming and difficult task sometime performed manually by medical experts. Large amount of time was spent by radiologist and doctors for identification of tumor and segmenting it from other brain tissues. However, exact labeling brain tumors is a time-consuming task, and considerable variation is observed between doctors. Subsequently, over the last decade, from various research results it is being observed that it is very time consuming method but it will get faster if we use image processing techniques. Primary brain tumors do not spread to other body parts and can be malignant or benign and secondary brain tumors are always malignant. Malignant tumor is more dangerous and life threatening than benign tumor. The benign tumor is easier to identify than the malignant tumor. Also the first stage tumor may be malignant of benign but after first stage it will change to dangerous malignant tumor which is life threatening.

Information can be well interpreted through images. Basically machine learning focuses on bringing out information from an image and after extraction again that valuable information are applied to deal with other tasks. Few examples can clarify the point such as images used for robots to navigate through some patterns, extraction of spoiled tissues from body scan etc. The first step which counts in direction of understanding images is segmentation and finding out variety of different components in those images. With the recent rapid growth of the technological advancements, medical science has also improved. But medical science is dependable on the current improvement of technologies. With this technological improvement it has reached to certain esteem where it can diagnose any diseases in a very less time with full accuracy. Most tumor victims are children and adults in their prime of life. So multi-disciplinary approach must be taken to resolve such diseases. There are many approaches to detect brain tumor.

Different brain tumor detection algorithms have been developed in the past few years. Normally, the automatic segmentation problem is very challenging and it is yet to be fully and satisfactorily solved. The main aim of this system is to make an automated system for detecting and identifying the tumor from normal MRI. It takes into account the statistical features of the brain structure to represent it by significant feature points. Most of the early methods obtainable for tumor detection and segmentation may be largely divided into three groupings: region-based, edge-based and fusion of region and edge-based methods. Well known and broadly used segmentation techniques are K-Means clustering algorithm, unsupervised method based on neural network classifier. Also, the time spent to segment the tumor is getting condensed due to the detailed demonstration of the medical image by withdrawal of feature points. Region-based techniques look for the regions satisfying a given homogeneity standards and edge based segmentation methods look for edges between regions with different characteristics

Magnetic resonance imaging (MRI) has become a common way to study brain tumor. In this paper we preprocess the two-dimensional magnetic resonance images of brain and subsequently detect the tumor using Image Segmentation approach. many procedures has been invented for the detection of damaged cells of brain but my goal is to sort out particularly the abnormal cells of human brain which is not an abstract rather it is possible by using combination of thresholding and watershed segmentation along with applying the morphological operators we get the output of the MRI image with the legion part highlighted which is possible for doctors to detect accurately where the tumor is located.

Also a comparative analysis has been done with detecting tumor cells by k-means clustering and better results were obtained with the application of morphological operators.

LITERATURE REVIEW

In [1] the author Proposed brain tumor detection in which Segmentation separates an image into its component regions or objects. Image segmentation it needs to segment the object from the background to read the image properly and classify the content of the image carefully. In this framework, edge detection was an important tool for image segmentation. In this paper their effort was made to study the performance of most commonly used edge detection techniques for image segmentation and also the comparison of these techniques was carried out with an experiment. In [2] the author Proposed approach by integrating wavelet entropy based spider web plots and probabilistic neural network for the classification of Brain MRI. The proposed technique uses two steps for classification i.e. Wavelet entropy based spider web plot for feature withdrawal and probabilistic neural network for classification. The obtained brain MRI, the feature extraction was done by wavelet transform and its entropy value was calculated and spider web plot area calculation was done. With the help of entropy value classification using probabilistic neural network was calculated. Probabilistic neural network provides a general solution for pattern classification problem and its classification accuracy is about 100%. In [3] the author presented a combination of wavelet statistical features (WST) and co-occurrence wavelet texture feature (WCT) obtained from two level distinct wavelet transform was used for the organization of abnormal brain matters in to benign and malignant. The planned system was consisting of four stages: segmentation of region of interest, discrete wavelet disintegration, feature abstraction, feature selection, organization and evaluation. The support vector machine was employed for brain tumor segmentation. A grouping of WST and WCT was used for feature extraction of tumor region extracted from two level discrete wavelet transform. Genetic algorithm was used to select the optimal texture features from the set of mined features. The probabilistic neural network was used to classify abnormal brain tissue in to benign and malignant and the performance evaluation was done by comparing the classification result of PNN with other neural network classifier. The classification accuracy of the proposed system is 97.5%. In this paper the author proposed the work on information (region of interest) in the medical image and thereby vastly improves upon the computational speed for tumor segmentation results. Significant feature points based approach for primary brain tumor segmentation was proposed. Axial slices of T1- weighted Brain MR Images with contrast enhancement have been analyzed. In order to extract significant feature points in the image, applied a feature point extraction algorithm based on a fusion of edge maps using morphological and wavelet methods. Evaluation of feature points thus obtained has been done for geometric transformations and image scaling. A region growing algorithm was then employed to isolate the tumor region. Preliminary results show that our approach has achieved good segmentation results. Also this approach was reducing a large amount of calculation. Future work will involve an investigation of the method in automatic 3D tumor segmentation, segmentation of ROI's in other medical images, as well as the importance of implemented technique in medical image retrieval applications. In [5] the author proposed Fuzzy c-Means (FCM) clustering and watershed algorithm are the two commonly used methods for brain tumor extraction. In this paper we implemented the improved version of fuzzy c-Means clustering and watershed algorithm. In fuzzy c-Means clustering we proposed an effective method for the initial centroid selection based on histogram calculation and in watershed algorithm we proposed an atlas based marker detection method for avoiding the over-segmentation problem. Before applying the segmentation algorithms as a pre-processing stage we performed three operations-noise removal, skull stripping and contrast enhancement. The main problem associated with the fuzzy c-Means clustering is the selection of initial centroid. Watershed segmentation suffers from over segmentation problem. One solution to the over-segmentation problem is the use of internal and external markers. We proposed an atlas based marker detection method and achieved the accuracy of 93.13 and 88.64 of Dice and Tan moto coefficient values respectively. In [6] the author proposed adaptive brain tumor detection, Image processing is used in the medical tools for detection of tumor, only MRI images are not able to identify the tumorous region in this paper we are using K-Means segmentation with preprocessing of image. Which contains denoising by Median filter and skull masking is used. Also using object labeling for more detailed information of tumor region. To make this system an adaptive we are using SVM (Support Vector Machine), SVM is used in unsupervised manner which will use to create and maintain the pattern for future use. Also for patterns we have to find out the feature to train SVM. For that here we have find out the texture feature and color features The main purpose of this paper is to identify the region of tumor and to do the detailed diagnosis of that tumor which will used in treating the cancer patient the detailed about the proposed system is given below. Threshold is a specific intensity value which contents a predefined intensity value; it is used to separate object or Region of Interest (ROI) from the image background, chosen in the range of 0 to 255 [13]. But it is detected that clustering methods followed by threshold cannot notice tumor correctly from MRI image, because the image consists of several nonbrain tumor tissue. For this reason, we express the proposed method using K-Means algorithm followed by Object Labeling algorithm also, some preprocessing steps (median filtering and morphological operation) is used for tumor detection purpose. In [7] the author proposed a fully automated segmentation of normal tissues viz., white matter (WM), gray matter (GM) and cerebra spinal fluid (CSF) from brain MRI using an improved machine learning approach that uses Neuro-fuzzy as classifier. The segmentation is carried out using gradient method and orthogonal polynomial transform. The performance of our method is assessed with metrics such as false positive rate (FPR), false negative rate (FNR), specificity, sensitivity and accuracy. Also, the entire procedure is developed as a graphical user interface (GUI) which results in automated classification and segmentation. An automated and improved machine learning approach that uses Neuro-fuzzy as classifier to detect and segment normal tissues like WM, GM and CSF in brain MRI images is proposed in this paper. The extracted features from the images were applied to our classifier which classifies the images into normal and abnormal. The normal images were pre-processed first and then segmented efficiently by our proposed method. The testing was performed with the Brain web images dataset. Our method is evaluated using the performance measures FPR, FNR, sensitivity, specificity and accuracy. The efficiency of the classification of images is very high which is evident from the accuracy outcomes and the segmentation of normal tissues also offers very accurate outcomes. From the results, we have showed that the Neuro-fuzzy classifier utilized in our proposed work achieves a very good accuracy of 95.65% in categorizing the images into normal and abnormal. Also, the developed GUI system simplifies our entire process of loading and viewing the images and obtaining the required results.

II. METHODOLOGY

The main purpose of this paper is to identify the region of tumor and to do the detailed diagnosis of that tumor which will used in treating the cancer patient the detailed about the proposed system is given below. Threshold is a specific intensity value which contents a predefined intensity value; it is used to separate object or Region of Interest (ROI) from the image background, chosen in the range of 0 to 255. But it is detected that clustering methods followed by threshold cannot notice tumor correctly from MRI image, because the image consists of several non-brain tumor tissue. For this reason, we express the proposed method using K-Means algorithm followed by Feature Extraction also, some preprocessing steps (Contrast Stretching and morphological operation) is used for tumor detection purpose.

This project consists of automatic image segmentation, magnetic resonance imaging, K-Means algorithm as the important part of working. The main purpose of this project is to identify the region of disease or tumor and to do the detailed diagnosis, which will be used in treating the patient. In pre-processing, basic image processing techniques are applied such as image enhancement, scale changing, noise removal etc. Segmentation and edge detection are also additive to this preprocess. The purpose of these steps is basically to improve the image and the image quality to get more surety and ease in detecting the tumor.

Initially, the basic image is converted into gray scale image. The resultant image is preprocessed using Contrast Stretching then the skull masking is done. After this basic segmentation is carried out using K-Means clustering. Later on, feature extraction process is conducted. Using machine learning technique, a single MRI input Image is compared with 'N' number of trained images. The characteristics are listed and if any mismatching in the characteristics are observed, then the abnormal area is detected and highlighted by brightening that area using LSTM (Long Short Term Memory) algorithm.

FLOWCHART

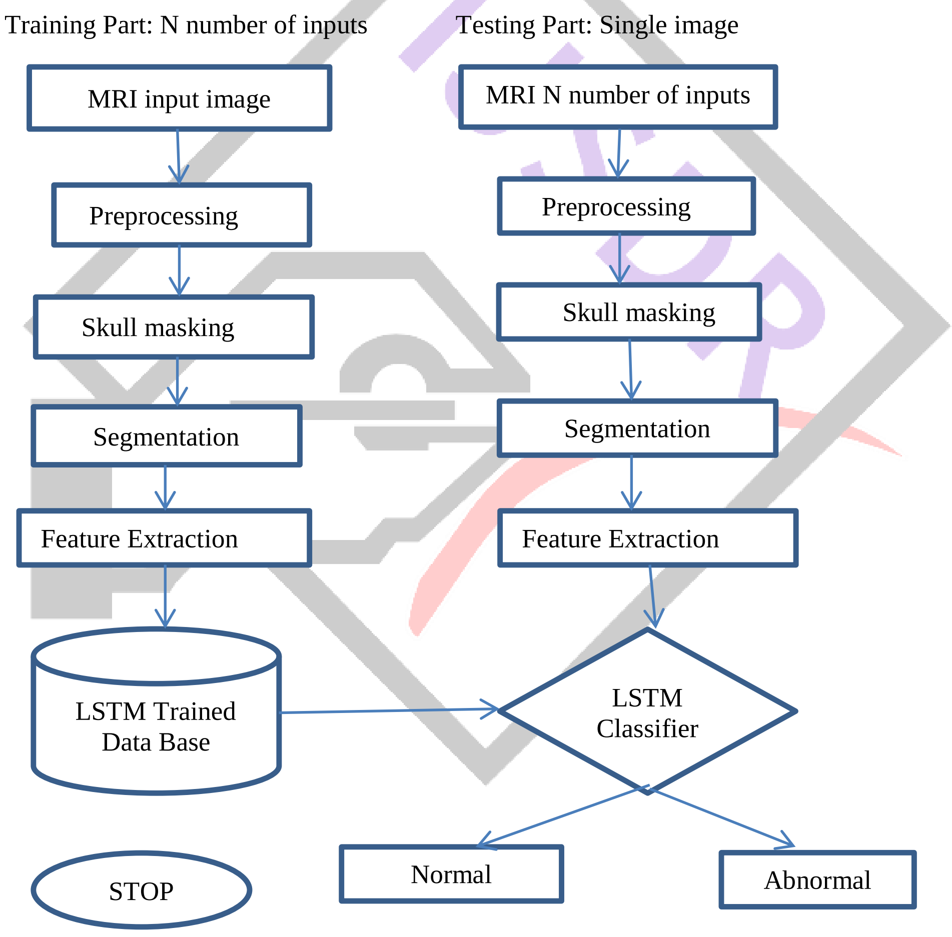


Fig1. Flow Chart

i. **Pre Processing:**

In the image processing the gray scale image is processed by using different techniques like brightness, threshold and Filtering, Brightness makes the image by which white objects are distinguished from gray and light items from dark objects. Hence by changing the brightness of the image the tumor detection in the MRI image is easier. Thresholding isolates objects, keeping those that interest us and removing those that do not. Also thresholding converts the image from a gray scale image, with pixel values ranging from 0 to 255, to a binary image, with pixel values of 0 or l. The processing window in vision assistant displays a preview of the threshold operation using the current set of parameters. The pixels showed in red have strengths that fall inside the threshold range. The threshold operator sets their values to 1. The pixels depicted in gray have values outside the threshold range. The threshold operator sets their values to 0. Filters can smooth, sharpen, transform, and remove noise from an image so that we can extract the information needed to sharpen edges, counting the edges of any holes inside a particle, and create contrast between the elements and the background.

When applied Convolution-Highlight Details with size 7x7 the image. Preprocessing of brain MR image is the first step in our projected technique. Preprocessing includes image filtering and skull masking for further processing. Our intention behind performing preprocessing is improvement of the image quality to get more surety and ease in spotting the tumor. Contrast Stretching by Histogram Equalization is used to get better quality image.

ii. **Contrast Enhancement:**

Contrast Enhancement is one of the important research issues of image enhancement. Image contrast enhancement is a fast and adaptive method. There are many contrast enhancement methods which has been proposed in the literature. Contrast generally refers to the difference in luminance or gray level values in an image and is an important characteristic. It can be defined as the ratio of the maximum intensity to the minimum intensity over an image. Contrast ratio has a strong bearing on the resolving power and detects ability of an image. Larger this ratio, more easy it is to interpret the image. Satellite images lack adequate contrast and required contrast improvement. Contrast enhancement techniques expand the range of brightness values in an image so that the image can be efficiently displayed in a manner desired by analyst. The density values in scene are literally pulled farther apart, that is expanded over a greater range. The effect is to increase the visual contrast between two areas of different uniform densities. This enables the analyst to discriminate easily between areas initially having a small difference in density.

Contrast enhancement techniques have various application areas for enhancing the visual quality of low contrast images. To study and review the different image contrast enhancement techniques because contrast losses the brightness in enhancement of the image. By coinciding this fact, the mixture of global and local contrast enhancement techniques may enhance the contrast of image with preserving its brightness. Contrast enhancement changing the pixels intensity of the output image to utilize maximum possible bins. Advantage of contrast enhancement is fast calculation and smooth result. Contrast enhancement is based on five techniques such as local, global, partial bright and dark contrast.

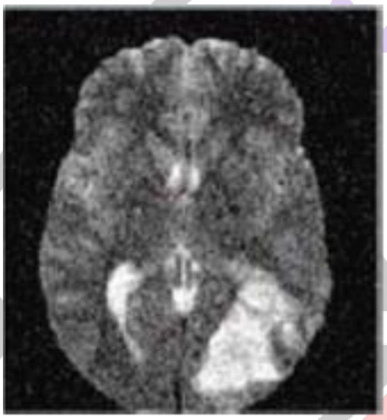


Fig 2: Noisy Image

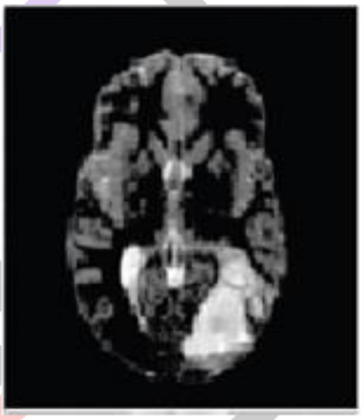


Fig 3: Enhanced Image

iii. **Skull Masking:**

Detection of skull is used to control the boundaries of the object. The edge information helps to find out the region of interest (ROI) i.e. the portion of the image covering the tumor. This work is done with the help of the calculating the centroid in the image. Extraction of brain tissue from non-brain tissues in MR images which is referred to as skull stripping is an important step in many neuron imaging studies. In this, we used automatic threshold value selector to automatically choose threshold value. Then, mathematical morphology operations on a binaries image are applied stage by stage to achieve acceptable skull stripped brain images. The proposed skull stripping method comprises four steps. Initially image banalization is completed using threshold value and narrow connections are removed from binaries image using morphological opening. Then, largest connected component from binarised image is selected by considering the fact that brain is the largest connected structure inside the head.

Thirdly, a mathematical morphology operation such as filling holes and dilation is carried out on selected largest binarised image. Finally, we found skull stripped brain image.

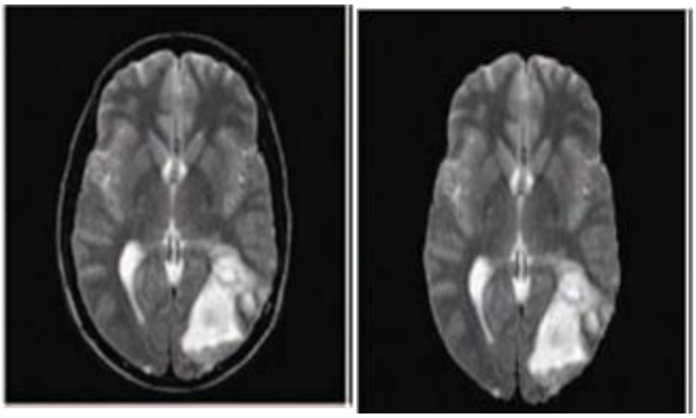


Fig 4: Image with Skull Fig 5: Skull Removed image

Create images and masks:

In this, the region properties of an image are used. By using centroid property of an image, a line is drawn in the center of stripped skull. This divides the skull into two equal parts. One part is referred as a test image and other is referred as reference image. Locating bounding box around tumor: In each input MR slice (axial view), there is a left–right axis of symmetry of the brain. A tumor, which is considered a deviation in the brain, typically perturbs this symmetry. Parallel rectangle on the left side that is very unlike from its replication about the axis of symmetry on the right side. i.e., the intensity histograms of two rectangles are most different, but the intensity histograms of the outside of the rectangles are comparatively similar. We assume that one of the two rectangles will restrict the tumor appearing in one hemisphere of the brain.

iv. **Image segmentation:**

Image Segmentation is the procedure of partition a digital image into numerous regions or sets of pixels. Essentially, in image partitions are different objects which have the same texture or color. The image segmentation results are a set of regions that cover the whole image together and a set of contours extracted from the image. All of the pixels in a region are similar with respect to some characteristics such as color, intensity, or texture. Neighboring regions are considerably different with respect to the same individuality. The different approaches are

(i) By finding limits between regions based on discontinuities in intensity levels

(ii) Thresholds based on the distribution of pixel properties, such as intensity values

(iii) Based on finding the regions directly.

Thus the choice of image segmentation technique is depending on the problem being considered. Region based methods are based on continuity. These techniques split the entire image into sub regions depending on some rules like all the pixels in one region must have the same gray level. Region-based techniques rely on common patterns in intensity values within a cluster of neighboring pixels. The cluster is referred to as the region in addition to group the regions according to their anatomical or functional roles are the goal of the image segmentation.

Threshold is the simplest way of segmentation. Using thresholding technique regions can be classified on the basis range values, which is applied to the strength values of the image pixels. Thresholding is the transformation of an input image to an output that is segmented binary image. Segmentation Methods based on finding the regions directly find for abrupt changes in the intensity value. These methods are called as Edge or Boundary based methods. Edge detection is the problem of fundamental importance in image analysis. Edge detection techniques are generally used for finding discontinuities in gray level images. To detect consequential discontinuities in the gray level image is the important common approach in edge detection. Image segmentation methods for detecting discontinuities are boundary based methods.

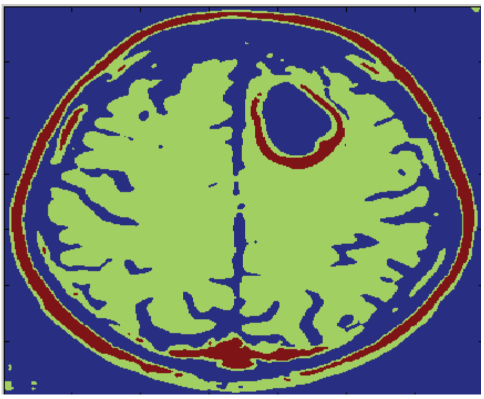


Fig 6: Segmented Image

v. **K-means clustering:**

A cluster is a collection of objects which are similar between them and are dissimilar to the objects belonging to other clusters. It deals with finding a structure in a collection of unlabeled data. A loose description of clustering could be the process of organizing objects into groups whose members are similar in some way. 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 the data and the corresponding cluster centroid. Thus the function of K-Means clustering is to cluster the data. Commonly used initialization methods are Random Partition. The Forgy method randomly chooses k observations from the data set and uses these as the initial means. The Random Partition method first randomly assigns a cluster to each observation and then proceeds to the update step, thus computing the initial mean to be the centroid of the cluster's randomly assigned points. The Forgy method tends to spread the initial means out, while Random Partition places all of them close to the center of the data set. According to Hamerly the Random Partition method is generally preferable for algorithms such as the K harmonic means and fuzzy k-means. For expectation maximization and standard K-Means algorithms, the Forgy method of initialization is preferable.

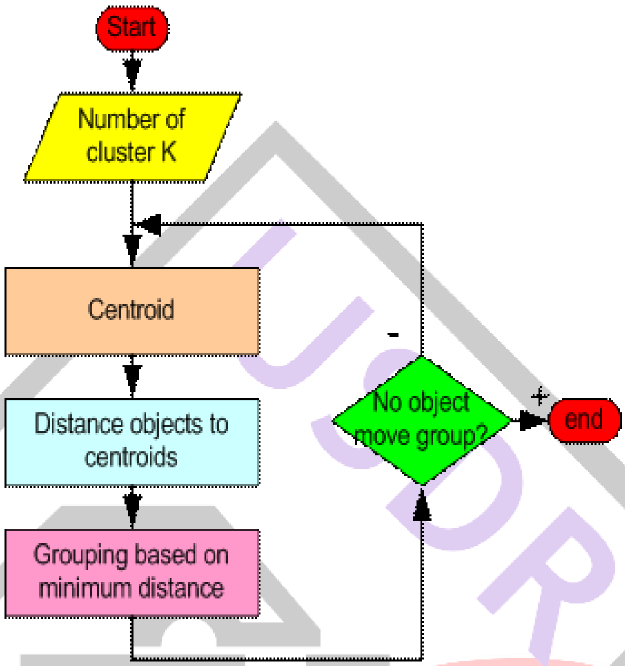


Fig 7: K-Means work flow

Working of the K- Mean clustering algorithm:

Step1: Begin with a decision on the value of k=number of clusters.

Step2: Put any initial partition that classifies the data into k clusters you may assign the training samples randomly or symmetrically as the following:

• Take the first k training samples as single element clusters

• Assign each of the remaining (N-K) training samples to the cluster with nearest centroid after each assignment. Recomputed the centroid of the gaining cluster.

Step3: Take each sample in sequence and compute its distance from the centroid of each of the clusters. If a sample is not currently in the cluster with the closest centroid, switch this sample to that cluster and update the centroid of the cluster gaining the new sample and the cluster losing the sample.

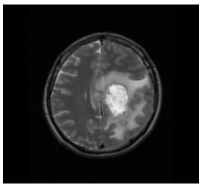
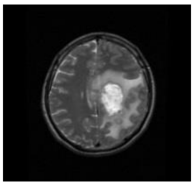
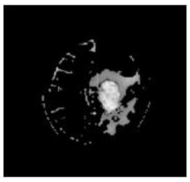
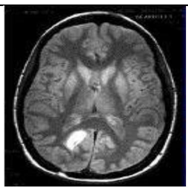
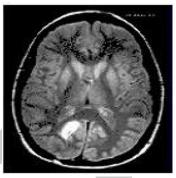
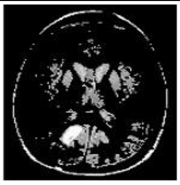
Step4: Repeat step 3 until convergence is achieved, that is until a pass through the training sample causes no new assignments.

K-Means clustering method:

If k is given, the K-Means algorithm can be executed in following steps:

- Partition of objects into k non-empty subsets.
- Identify the cluster centroids (mean points) of current partition.
- Assigning each point to a specific cluster.
- Compute the distance from each points and allot points the clusters where the distance from the centroid is minimum.
- After re-allotting the points, find the centroid of each cluster formed.

Table 8: showing segmentation with cluster 2and cluster 3

Original image	Cluster 2	Cluster 3
		
		

vi. **Feature extraction:**

The Feature is defined as a function of one or more measurements, each of which specifies some quantifiable property of an object, and is computed such that it quantifies some significant characteristics of the object. Feature Extraction plays an important role for identification of an object. When the input data to an algorithm is too large to be processed and it is suspected to be redundant then it can be transformed into a reduced set of Features. This process is called Feature Extraction. The selected features are expected to contain the relevant information from the input data, so that desired task can be performed by using this reduced representation instead of the complete initial data. In many application of Image Processing Feature Extraction is used. Color, texture, morphology, edges etc. are the features which can be used in Brain Tumor Detection. Texture means how the color is distributed in the image, the roughness, hardness of the image.

vii. **Long Short Term Memory Algorithm:**

The problem of estimating an unknown desired signal is one of the main subjects of interest in contemporary online learning literature, where we sequentially receive a data sequence related to a desired signal to predict the signal's next value. This problem is known as online regression and it is extensively studied in the neural network, machine learning, and signal processing literatures, especially for prediction tasks. In these studies, nonlinear approaches are generally employed because for certain applications, linear modeling is inadequate due to the constraints on linearity. Here, in particular, we study the nonlinear regression in an online setting, where we sequentially observe a data sequence and its label to find a nonlinear relation between them to predict the future labels.

The key of LSTM is the cell state, the horizontal line running through the top of the diagram. The cell state is kind of like a conveyor belt. It runs straight down the entire chain, with only some minor linear interactions. It's very easy for information to just flow along it unchanged.

The LSTM does have the ability to remove or add information to the cell state, carefully regulated by structures called gates. Gates are a way to optionally let information through. They are composed out f a sigmoid neural net layer and a pointwise multiplication operation.

The sigmoid layer outputs numbers between zero and one, describing how much of each component should be let through. A value of zero means "let nothing through", while a value of one means "let everything through". An LSTM has three gates, to protect and control the cell.

a) Finding the Tumor Cluster and Area Calculation: In this step we have examined all the clusters of the segmented image and we observed that the cluster which has the highest centroid value it produces the tumor region in abnormal cases. So all the pixels belonging to that cluster is set to 1 and rest of them to 0. Then we have applied morphological 'Open' operation to remove the unwanted regions from the tumor cluster and the concept of filling holes to fill the complete tumor region.
Next we have calculated the area of all the remaining portions including the tumor and from a number of training data set we found a threshold range for the tumor area and less then or above that range all the portions are removed. Based on the size we have classified the tumor into 3 stages. The default unit of the tumor area is in pixel.

b) Detecting the Edge of the Tumor: Edge detection is the process of tracking the boundary of objects or regions and it is helpful for extracting meaningful information in images.
Here we have applied the Sobel edge operator to detect the tumor edge. It uses derivative approximation to find edges. Therefore it returns edges at those points where the gradient of the input image is maximum. With the output of edge detection step we have masked it with the image obtained after pre-processing to visualize the original image with the tumor.

III. RESULTS

We have proposed a system that can be used for segmentation of brain MR Images for Detection and identification of brain tumor. In this project we present a study on the preprocessing and segmentation methods that are available for finding the tumor in brain MRI. A proper segmentation is required so that the image can be process further for feature extraction and to declare the image weather it is normal or abnormal or the tumor size features.

Fig 9: Input Image

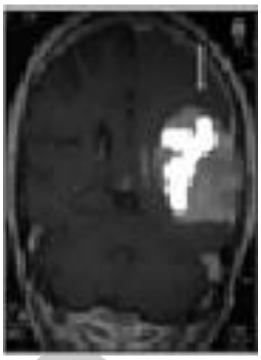


Fig 10: Tumor Detected Image

Fig 11: Input Image

Fig 12: Tumor Detected Image

IV. CONCLUSION

Medical image processing is one of the most challenging research fields. Processing of brain MRI is again a most interesting and complex process. Although there is number of available methods or techniques but still researchers are trying to find more efficient and reliable methods. There is always a continuous effort towards finding new methods to achieve more accurate results to previous methods.

Thus we have obtained our goal by applying thresholding, watershed segmentation and morphological operators. The output image clearly shows the tumor cells which have been separated from the healthy cells. The Threshold and Watershed segmentation is very simple and popular but using morphological operators is the new introduction to this problem which on applying to the output image of other two provided a better detection of tumor. The factor used in thresholding is very difficult to determine because the factor used for one image may not work for other image. This factor may be different for different images. The watershed method has the disadvantage that it is highly sensitive to local minima, since at each minima, a watershed is created. If we have an image with noise, this will influence the segmentation. so we have not used it directly on our input images. The application of median filter and high pass filter in the initial stages also proved beneficial in removing noise from the MRI image which were then passed for further processing. More work can be done to classify the detected tumor according to its malignancy level. This could be done using some classification algorithms such as perceptron, support vector machine, correlation clustering etc. In this paper, we have proposed a system that can be used for segmentation of brain MR Images for Detection and identification of brain tumor.

V. FUTURE WORK

Image Segmentation is an important and challenging factor in the field of medical sciences. It is widely used for the detection of tumors. The brain is the anterior most part of the nervous system. Tumor is a rapid uncontrolled growth of cells. Magnetic Resonance Imaging (MRI) is the device required to diagnose brain tumor. The normal MR images are not that suitable for fine analysis, so segmentation is an important process required for efficiently analyzing the tumor images.

Future scope for detection and segmentation of brain tumor is that if we obtained the three dimensional image of brain with tumor then we can also find out its tumor size and also can evaluate its tumor type and also its stage of tumor.

VI. ACKNOWLEDGMENT

We express our deepest gratitude and respect to our guide **Mr. Sachin Bhat**, **Assistant Professor**, Department of Electronics and Communication Engineering, for his valuable guidance and encouragement while doing this project work.

We are indebted to **Prof. Dr. Thirumaleshwara Bhat**, Principal and **Prof. Dr. H.V. Balachandra Achar**, Head of the Department, for their advice and suggestions at various stages of the work. We also extend our heartfelt gratitude to Prof. PQR for his assistance.

We extend our thanks to the Management of **Shri Madhwa Vadiraja Institute of Technology and Management**, Bantakal, Udupi for providing good laboratory and library facilities. We also remain grateful to the co-operation and help rendered by the teaching and non-teaching staff of the Electronics and Communication Engineering Department.

Lastly, we take this opportunity to offer our regards to all of those who have supported us directly or indirectly in the successful completion of this project work.

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