Automatic System For Brain Tumor Detection And Classification Using Level Set And ANN

Nisha Babu A
Computer Science Department
LBSITW
Trivandrum, India
nisthesweet@gmail.com

Agoma Martin
Computer Science Department
LBSITW
Trivandrum, India
Agoma.bethel@gmail.com

Abstract— **Even with increasing popularity of MRI imaging techniques, the assessment of lesions in brain area is still performed manually or semi-manually. The major drawbacks to manual image segmentation are time consuming and subjectivity of human decision. Manual assessment of pathological changes is too cumbersome and it is not devoid of errors. Therefore, development of tools for an automatic assessment of lesions in a brain area is one of the most challenging tasks of present day medical image processing. The crucial problem in an automatic assessment of brain tumors is image segmentation. The tumors differ in shape, size and location, and they may appear at different places with different intensities. Therefore, it is very difficult to find the precise tumor in the brain. The proposed method helps in the automatic detection of brain tumor through the help of level set method and the classification of tumor as benign or malignant using the Artificial Neural Network.**

Keywords- Level set, Artificial Neural Network, MR Images, Contour.

I. INTRODUCTION

Imaging is one of the main radiological examinations. It is a non-invasive method of obtaining images corresponding to the sections of the specific structure in the human body.MRI scanners use a magnetic field and radio waves to create detailed images of the human body.MRI is most relevant in studies of the head, specifically, the brain dysfunctions. Diagnosis, patient monitoring and treatment planning are the main purpose of MRI based medical image analysis. Magnetic resonance imaging of the head allows for early detection of intracranial tumors and accurate assessment of tumor boundaries, which are important when planning radiotherapy. However, although increasing popularity of MRI imaging techniques, the assessment of lesions in brain area is still performed manually or semi-manually. Due to the large amount of data, which are currently being generated in the clinic, it is not possible to manually annotate and segment the data in reasonable time. The segmentation is crucial for monitoring the tumor growth or shrinkage during therapy. In current clinical practice, the segmentation is usually still done manually or semi manually, which is time consuming and tedious for the radiologist.

The major drawbacks to manual image segmentation are time consuming and subjectivity of human decision. Manual assessment of pathological changes is too cumbersome and it is not devoid of errors. Therefore, development of tools for an automatic assessment of lesions in a brain area is one of the most challenging tasks of present day medical image processing. The crucial problem in an automatic assessment of brain tumors is image segmentation. The tumors differ in shape, size and location, and they may appear at different places with different intensities. Therefore, it is very difficult to find the precise tumor in the brain. The accurate segmentation of brain tumors is of great interest. An automatic tool for brain tumor segmentation and classification will really be helpful in the biomedical field for early diagnosis of tumor and planning the suitable treatment. Brain tumors can be classified as primary benign tumors that do not spread elsewhere and secondary or malignant brain tumors that spread from the other location of the body to the brain. Brain image segmentation is a challenging task due to the complexity and large variations of anatomical structures of human brain.

Many methods are developed for the segmentation of the brain tumors from the MRI images. Fuzzy connectedness Segmentation is based on the phenomenon of 'hanging togetherness' [2]. Marker Based Watershed Approach is based on the region property and Watershed Transform. Threshold based segmentation and knowledge based technique are some other methods. The main short comes of these methods are that they are not highly automatic; user requires the knowledge of the approach. Moreover it was difficult to identify the tumor correctly, if it is of irregular shape and sometimes the filtering used may introduce some artifacts after segmentation.

The proposed method aims at the automatic segmentation and classification of brain tumor images from the MRI images. Segmentation is done based on the Level set evolution. It is a region based approach, where a contour is initialized in the image, and the contour shrinks or expands to locate the actual tumor. The evolution of the curve is governed by a modified Signed Pressure Function (SPF). After the segmentation process it is possible to clearly delineate the tumor boundaries. It helps in the further treatment planning. In the classification step, the tumor is identified as cancerous or not. Artificial neural network is used for classification. Artificial neural networks are generally presented as systems of interconnected "neurons" which can compute values from inputs. Neural networks have been used to solve a wide variety of tasks that are hard to solve using ordinary rule-based programming. NN consists of training (classification) and testing stages. Features are extracted and are fed to ANN; ANN predicts whether the tumor is cancerous or not based on the trained value

II. RELATED WORKS

A. *Fuzzy Connectedness Segmentation*

Steps involved:

1. MRI data acquisition.
2. Standardization of MRI intensity scale.
3. Registration of images.
4. Volume-of-interest (VOI) and the seeds specification.
5. Fuzzy connected delineation of the tumor region
6. User verification of segmentations.
7. Computation and reporting of volumes.

In first step the images are acquired from different sources. Scanner-dependent variations in the MR image intensity causes considerable difficulties in MR image segmentation and analysis. To mitigate this problem an intensity standardization method was applied to the acquired image data. This method was used to map the input intensities into intensities on a standard scale. For registration of the image multiresolution is used. In Volume of interest and seed specification, the region containing tumor is specified by a rectangular box and operations are carried out inside the VOI, So that it runs faster than if the segmentation were applied entire screen. The operator also specifies via the mouse input device a set of voxels in the tumor region by clicking on pixels in image. Typically several voxels distributed within the tumor region are specified. The theory of fuzzy connectedness guarantees that any set of voxels selected within the same segmented region always yields the same segmentation, thus assuring high robustness with respect to seed specification variations among operators. For delineation of the tumor image the global phenomenon of 'Hanging togetherness' [1] is used. User verification of segmentations is carried out afterwards. For quality control, this step is added which allows an operator to quickly examine the results of fuzzy connectedness segmentations. Computation and reporting of volumes is done based on the corrected (if necessary) segmentations. The main drawback of this method is that it is not fully automatic, it requires manual interaction.

B. *Marker Controlled Watershed Transform*

Before applying the Marker controlled Watershed segmentation method on any MR image, the noise and other irregularities from images has to be removed using any efficient filtering method. For this purpose, the image smoothing and image contrast enhancement are introduced as a pre-processing step before implementation of this approach [2].

Image smoothening act as the pre-processing step for image segmentation, as, almost all the images suffers from the problem of noise effect, uneven illumination and local irregularities. The noise and uneven illumination are filtered out from the MR images using Weiner filter which is a type of linear filter. Poor contrast is usually one of the most common defects found in the recorded image. This degradation probably is caused by inadequate lightening, aperture size and noise. The effect of such defects has a great impact on the contrast of the recorded image. In this case, the gray level of each pixel is scaled to improve the contrast of the recorded image. The gradient magnitude is used often to pre-process a gray-scale image prior to using the watershed transform for segmentation. The gradient magnitude image has high pixel values along object edges, and low pixel values everywhere else. In this method, first the Gradient magnitude of image is computed. The internal markers are produced from the gray scale image. Appling watershed transform on the internal markers the external markers is obtained. The internal and external marker of tumor region helps to exactly retrieve the tumor. This mechanism is not fully automatic, it requires manual interaction. Moreover because of filtering applied on the image some artifact may be introduced after the segmentation. it is not fully automatic, it requires manual interaction.

C. Region Growing Method

The various steps involved in the region growing method are the following.

1) Image enhancement;
2) Knowledge-based pixel classifier construction;
3) Removal of unwanted information (example: skin, skull etc);

In the first step that is the Image enhancement, noise and irregularities in the image is removed. Different noises arise due to imperfections of MRI scanner. Median filters are used to enhance the image. It has the ability of noise reduction preserving edges. In the Knowledge-based pixel classifier construction step .A simple model of pixel classification was developed. Voxels belonging to different areas of human brain are characterized by several unique properties [3]. These special characteristics were used to create a classifier which allows removing redundant information that may disrupt the process of image .The main purpose of this step is to remove information connected with the borders of distinct, but similar areas. Specifically, it aims at the tissues between air and skull (e.g. skin) or skull and brain (e.g. sagittal sinus, arachnoid space, subarachnoid space) in the image which often disrupt the three dimensional segmentation. This is caused by the significant distance between consecutive images and similar properties to brain in terms of intensity.

In pre-processing step, removal algorithm is applied for all two dimensional images in the MRI data set. The brain tumor segmentation requires human interaction. The user must indicate seed point located inside the desired region. Starting from the indicated seed the consecutive voxels are joined with the desired area. The growth is constrained by the threshold which determines the scope of permissible difference of intensity between the starting point and the next candidate pixel. In this research selected threshold value was constant and set at 0.2. Post processing aims at removing noise and small remnants of segmentation process. Again in this step, the median filter and mathematical morphology operations (erosion and dilatation) are performed. This step is necessary to obtain a smooth segmented object and has no impact on the segmentation results. The algorithm is not suitable for 3 Dimensional image segmentation; it is mainly for 2 Dimensional images. User interaction is required as the user must select the seed point inside the desired region..

D. Threshold Baes Segmentation

The level set approach can be used as a powerful tool for 3D segmentation of a tumor to achieve an accurate estimation of its volume. A major challenge of such algorithms is to set the equation parameters, especially the speed function. Level set is the numerical technique for tracking interfaces and shapes. Makes it very easy to follow shapes that change topology. Active surfaces/contours are other popular methods that are widely used for the segmentation of 3D objects, implicitly in the form of a level set function or explicitly as a snake function. In the recent years, the level set method has become popular due to its ability to handle complex geometries and topological changes. The level set is in fact a shape-driven tool which, using a properly defined speed function can grow or shrink to take the shape of any complex object of interest. Unlike the traditional deformable models, the level set method does not depend on the parameterizations of the surface. This makes it very attractive and flexible in shape modeling and image segmentation. Another attractive advantage of the level set method is that, given an initial zero level set (initial hyper surface), the entire segmentation procedure is fully automatic. Moreover, unlike other methods, the extension of the algorithm to 3D is straightforward and does not require additional machinery. These properties make the level set one of the state of the art methods for segmentation, especially 3D segmentation. The level set is initialized inside the contour. The mean and standard deviation are calculated. The initial threshold is calculated. Until we reach the stopping criteria the following steps are performed. Compute the speed function, grow the level set. Compute the mean and standard deviation inside the tumor. Then update the threshold [4].

E. Artificial Neural Network

Artificial neural network are network of simple processing element called neurons operating on their local data and communicating with other elements. The concept of ANN was adopted from the working of the real brain but its architecture and processing element have gone far from the biological inspiration. There are many type of artificial network. But the basic principles are very similar. Each neuron in the network is possible to get an input signal, process them and to send an output signal. Each neuron is connected to at least one neuron, and each connection is evaluated by a real number, called the weight coefficient, that denotes the degree of importance of given connection in the neural network.

In principle the neural network have the power of universal approximator that is it can realize arbitrary mapping of one vector space onto another vector space. The main advantage of the neural network is the fact that they are able to use some priori unknown information hidden in data (but they are not able to extract it). Process of capturing the unknown information is called 'learning of neural network' or 'training of neural network'. In mathematical formalism, to learn means to adjust the weight coefficients in such a way that some conditions are fulfilled.

There exist two type of training process. They are Supervised and unsupervised training. Supervised training example: multi layered feed forward(MLF)neural network means ,that neural network knows the desired output and adjusting of weight coefficient is done in such a away, that the calculated and desired output are as close as possible. Unsupervised training means that the desired output is not known, the system is provided with a group of facts(pattern)and then left to itself to settle down(or not) to a stable state in some number of iteration.

1) Multi Layered Feed Forward Neural Network

MLF neural network, trained with a back propagation learning algorithm, are the most popular neural networks. A MLF neural network consists of neurons that are ordered into layers. The first layer is called the input layer, the last layer is called the output layer, and the layers between are called hidden layers.

2) Training

The MLF neural operates in two modes. They are training and prediction mode. For the training of the MLF neural network and for the prediction using the MLF neural network, two data sets are required. The training set and the set that we want to predict.

The training mode begins with arbitrary values of the weights; they might be random numbers and proceeds iteratively. Each iteration of the complete training set is called an epoch. In each epoch the network adjusts the weight in the direction that reduces the error. As the iterative process of incremental adjustment continues, the weights gradually converge to the optimal set of values. Many epochs are usually required before training is completed [6].

III. PROPOSED SYSTEM

In the proposed System level set method is used for the segmentation of the image and artificial neural network is used for the classification process. The main attractive advantage of the level set method is that, given an initial zero level set, the entire segmentation process is fully automatic. In level set method, initial contour can be anywhere within the image with any arbitrary size. The position of the initial contour does not affect the final result. The level set method makes it easy to follow shapes that changes topology. There is no need to tune any parameter manually. Many tumors have irregular boundaries and they may change the shape gradually. So, for a tumor with constantly changing topology and weak boundaries, the region based level set method can identify the boundaries of the tumor correctly. This is the main advantage of the proposed method. The contour initialized can expand or shrink to obtain the different object. Once the objects are indentified then thresholding scheme is used to obtain the tumor.

Artificial Neural Network has many attractive properties that help in the classification. The main advantage of artificial neural network is that, adaptive learning. The artificial neural network is based on the concept of abstract learning. The neurons of artificial neural network are flexible enough to various input signal patterns and adapt to a diverse array of unknown situations. They are constantly accepting and replacing previously learned information, keeping their repository of problem solving technique updated.

The main shortcoming of the previous method were they are not highly automatic .Manual interaction is required at some point of processing. So, user must be well aware of the tumor and its regions. Moreover filtering used in the previous method removes the noise in the image, but some artifacts are introduced which had a negative effect on segmentation process. In this work the filtering is excluded, as the tumor obtained after segmentation have clear boundaries without filtering. The main advantage of the proposed segmentation process and classification is that it is highly automatic; there is no need to tune any parameter manually. Moreover, Tumor boundaries can be detected correctly, if it is an irregular one. The system works well for both the 2 Dimensional and 3 Dimensional images.

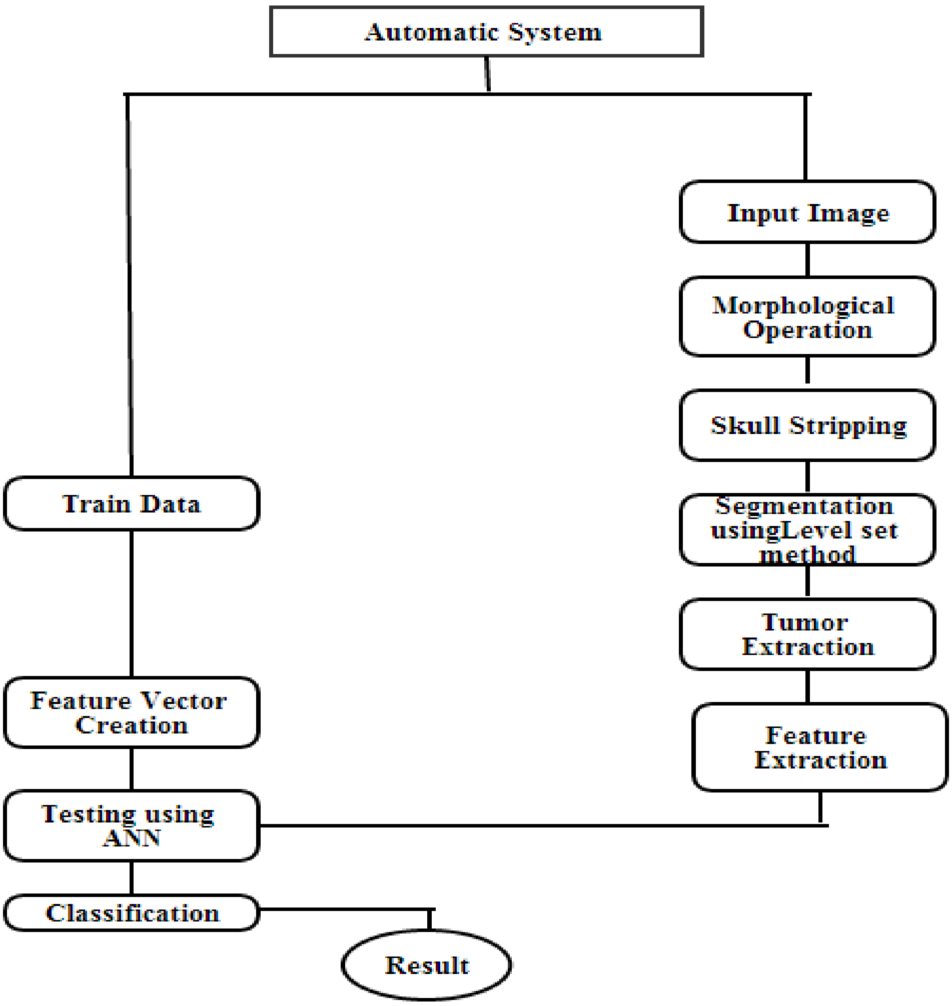

Figure 1: System Design

The system Design is shown in Fig 1. The proposed System consists of two phases Segmentation and Classification. Segmentation is done using level set method and for the classification purpose Artificial Neural Network is used.

A. Segmentation Phase

Segmentation is the process of partitioning an image into groups of pixels which are homogeneous with respect to some criterion. Different group must not intersect with each other and adjacent groups must be heterogeneous. Segmentation algorithms are area oriented instead of pixel-oriented. The result of segmentation is the splitting up of image into connected areas. Segmentation is concerned with dividing an image into meaningful regions.

Segmentation can be classified into Local segmentation and Global Segmentation. For Local segmentation the number of pixels available for segmentation is less and for Global segmentation the number of pixels available of segmentation is large. Global segmentation can again be classified as region based, boundary based and edge based approach. In region based approach, each pixel is assigned to a particular object or region. In the boundary approach, the attempt is to find the boundaries that exist between the edges. In the edge based approach, the edges are identified first and they linked together to form boundaries.

Thousands of different segmentation techniques are present in the literature, but there is not a single method which can be considered good for different images, all methods are not equally good for a particular type of image. Thus, algorithm development for one class of image may not always be applied to other class of images. Hence, there are many challenging issues like development of a unified approach to image segmentation which can be applied to all type of images, even the selection of an appropriate technique for a specific type of image is a difficult problem. Thus, in spite of several decades of research, there is no universally accepted method for image segmentation and therefore it remains a challenging problem in image processing and computer vision.

The different segmentation method include: region based segmentation; Region growing is a procedure that group's pixels in whole image into sub regions or larger regions based on predefined criterion. Segmentation can be based on Clustering techniques; Clustering is an unsupervised learning task, where one needs to identify a finite set of categories known as clusters to classify pixels.

Active Contour is one of the most powerful methods that have been applied to the image segmentation. The basic idea is to evolve a curve around the object to be detected, and the curve moves toward its interior normal and stops on the true boundary of the object based on the minimization energy [5]. The active contour method can be classified.

1. Snake

2. Level set method.

Snake is a semi-automatic method based on an energy minimizing spline guided by the external constraint forces and pulled by image forces toward the contours of the targets. The main drawbacks of the snake method are its sensitivity to the initial conditions and the difficulties associated with the topological changes for the merging and splitting of the evolving curve [5]. In recent years, the level set method has become popular because it can handle the complex geometries and topological changes. The level set is in fact a shape driven tool, which using a properly defined speed function, can grow or shrink to take the shape of any complex object of interest.

The level set method is a numerical technique for tracking interfaces and shapes. The advantage of the level set method is that, it is possible to perform numerical computation involving curves and surfaces. The level set method makes it very easy to follow that changes topology, for example when a shape splits in two, develops holes, or reverse of the operation**.** The main attractive advantage of the level set method is that, given an initial zero level set, the entire segmentation process is fully automatic. In level set method initial contour can be anywhere within the image with any arbitrary size. The position of the initial contour does not affect the final result.

In segmentation phase, the MRI image is given as input and the morphological operation such as erosion and dilation is performed on the input image. The enhanced image is obtained by adding the input image with the image obtained after the morphological operation. Then skull stripping is performed in the enhanced image. Segmentation is done on the skull stripped image by using the level set method. After Segmentation the tumor with exact boundaries is obtained.

1) Algorithm for Tumor Detection

Step 1: Morphological operation; Dilation and erosion are performed in the input image I.

Step 2: The enhanced image is obtained by adding the morphological gradient applied image to the original image.

Step 3: Skull Stripping is performed in the enhanced image.

Step 4: Tumor segmentation

(i).). Level set is initialized.

(a).Repeat the following steps for ' n' number of iteration.

(b).SPF (Signed pressure function) is computed.

(c). Level set function uses the SPF value to locate the objects.

(ii). After 'n' number of iteration the tumor part with exact boundaries is obtained.

Firstly, the morphological operation is performed in the input image. Morphology is a broad set of image processing operations that process images based on shapes. Morphological operations apply a structuring element to an input image, creating an output image of the same size. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors. Erosion and Dilation are the morphological operation applied in the input image.

Erosion is the process in which the binary image shrinks. The way the image shrinks is determined by the structuring element. The structuring element is reflected from left to right and from top to bottom, at each shift, the process will look for any overlapping similar pixel between the structuring element and that of the binary image. If all the pixels of the structuring element overlap with the considered image pixel, then the pixels under the center position of the structuring element will be turned to 1 or black.

Dilation is a process in which binary image is expanded from its original image. The way the binary image is expanded is determined by the structuring element. Structuring element is smaller in size compared to the image itself. The structuring element is reflected from left to right and from top to bottom, at each shift, the process will look for any overlapping similar pixel between the structuring element and that of the image. If there exists an overlapping then the pixels under the center position of the structuring element will be turned to 1 or black.

Next, the enhanced image is obtained by adding the morphological gradient applied image to the original image.

That is I'=M+I .

Where I denotes the original image, M denotes the morphological gradient applied image, I' denotes the enhanced image.

The skull portion in the input image is stripped prior to the segmentation process. Level set method is used for the segmentation process.

In region based approach, each region of interest is identified using a certain region descriptor to guide the motion of the active contour. It utilizes the statistical information inside and outside the contour to control the evolution of the curve, and is independent of edge information. They have better performance over the images that have weak edge boundaries. It is less sensitive to the initial position of the contours.

Within the level set method the following assumptions are made.

$\{x \in \Omega: \emptyset(x) > 0 = inside(C)\}$

$\{x \in \Omega: \emptyset(x) = 0\} = C$

$\{x \in \Omega: \emptyset(x) < outside(C)\}$

For segmentation the level set is initialized first. The region based level set method with a modified Signed Pressure Function (SPF) is used to segment the tumor precisely. The signed pressure function changes the signs of the pressure of the force inside and outside the object of interest. The contour shrinks if it is outside the interested object and expands if it is inside the object to locate the precise object that has to be determined.

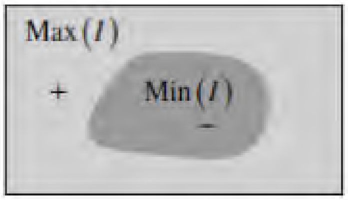

Figure 2: The sign of the SPF function inside and outside the object are opposite.

The modified signed pressure used in the proposed method is shown in (1). .

$$Spf(I(x)) = \frac{I(x) - \frac{c1+c2}{2}}{\min(|I(x) - \frac{c1+c2}{2}|)} \quad (1)$$

Where C_1 and C_2 denotes the average intensity inside and outside the contour. C_1 and C_2 are calculated using the (2) and (3) respectively.

$$C_1(\emptyset) = \frac{\int_\Omega I(x).H(\emptyset)\,dx}{\int_\Omega H(\emptyset)dx} \quad (2)$$

$$C_2(\emptyset) = \frac{\int_\Omega I(x).(1-H(\emptyset))dx}{\int_\Omega (1-H(\emptyset))dx} \quad (3)$$

The level set equation for the proposed method is as follows

$$\frac{\partial\emptyset}{\partial t} = spf(I(x)).|\nabla\emptyset| \quad (4)$$

The level set function defined in (4) uses the modified signed pressure function to locate the different objects. Once different objects have been identified the Thresholding scheme is used to identify the tumor precisely. The object with maximum area, mean and standard deviation is identified as tumor. The level set segmentation is applicable to both the 2-Dimensional and 3 Dimensional image. Once the tumor have been identified correctly next is to classify it as benign or malignant.

B. Classification Phase

Artificial Neural Network based on feed forward is used for classification. In this network, the information moves in only one direction, forward, from the input nodes, through the hidden nodes and to the output nodes. There are no cycles or loops in the network. A feed forward neural network with Inputs, Targets and 4 neurons are created. The network is trained using inputs and Targets. The trained network can be simulated using the features extracted from the input image. For the tumor classification the following features are used Energy, Correlation, Entropy, Mean, Sum variance, Area, Centroid, Perimeter and roundness. There is slight difference between the benign and malignant tumors. There shape, properties etc varies. Usually the benign tumors have proper boundaries and the malignant tumors have irregular boundaries. The entropy energy, Correlation etc will be different for the benign and malignant tumors. So making use of these properties will help in a good classification of the tumor as benign and malignant.

ANN consists of two phases.

i. Training phase

Calculate the feature vector for each image in the training set

i. Store the feature vector

ii. Testing phase

i. Calculate the feature vector of test image
ii. Simulate the neural network. Compare the feature vector of the test image with all the feature vector computed in the training set
iii. Output prediction based on the similarity between the features.

1) Algorithm for Classification

Step 1: Feature Extraction process.

Step1.1: Create a vector that contains Energy, Correlation, Entropy, Sum average, Sum Variance from the input image and area, perimeter, roundness and centroid from the tumor extracted.

Step 2: Create a feed forward neural network with Inputs, targets and 4 neurons.

Step 3: Train the network using inputs and Targets.

Step 4: Simulate the network using the features extracted from the input image.

The mean used in the feature vector is calculated as follows

$$\mu=\frac{1}{x\times y}\sum_{x=0}^{x-1}\sum_{y=0}^{y-1} I(x,y) \tag{5}$$

The variance is calculated as follows

$$\text{Var}=\frac{1}{x\times y}\sum_{x=0}^{x-1}\sum_{y=0}^{y-1}(I(x,y)-\mu)^2 \tag{6}$$

The energy express the repetition of the pixels pairs in an the image is. It is calculated using the (7)

$$K1=\sum_{i=0}^{N-1}\sum_{j=0}^{k-1} p_{\mu}^{2}(i,j) \tag{7}$$

Entropy is the measure of the non uniformity in the image based on the probability of co-occurrence value.It also denotes the complexity of the image.It is calculated as follows

$$K2=-\sum_{i=0}^{k-1}\sum_{j=0}^{k-1} p_{\mu(i,j)}\log(p_{\mu(i,j)}) \tag{8}$$

The strength of the linear association between two variables is quantified by the correlation coefficient. The correlation coefficient always takes a value between -1 and 1, with 1 or -1 indicating perfect. A positive correlation indicates a positive association between the variables (increasing values in one variable correspond to increasing values in the other variable), while a negative correlation indicates a negative association between the variables (increasing values is one variable correspond to decreasing values in the other variable). A correlation value close to 0 indicates no association between the variables. Since the formula for calculating the correlation coefficient standardizes the variables, changes in scale or units of measurement will not affect its value. For this reason, the correlation coefficient is often more useful than a graphical depiction in determining the strength of the association between two variables. Correlation coefficient between an image and the same image processed with a median filter is calculated using the below equation.

$$r=\frac{\sum_m\sum_n(A_{mn}-A_{mean})(B_{mn}-B_{mean})}{\sqrt{\sum_m\sum_n(A_{mn}-A_{mean})^2\sum_m\sum_n(B_{mn}-B_{mean})^2}} \tag{9}$$

Roundness is the measure of how closely the shape of an object approaches that of a circle .Roundness calculated from the segmented tumor region using the below equation

Roundness=(4*Area*pi)/(Perimeter.^2) (10)

IV. EXPERIMENTAL EVALUATION

A. Implementation Details

The System is tested with a database containing 2 Dimensional images and 3 Dimensional images .The database contains tumor images of different shape, size, location and intensities. For the 3 Dimensional image it have to be converted to the 2 Dimensional image. The input MR image is resized to 150x160 pixels in size with 256 levels of grey. The algorithm given was tested using the MATLAB 2013.The changes that take place at each stage are depicted below..:

B. Test Results

The changes that take place for the input image at each stage are depicted below.

Figure 3. Input Image

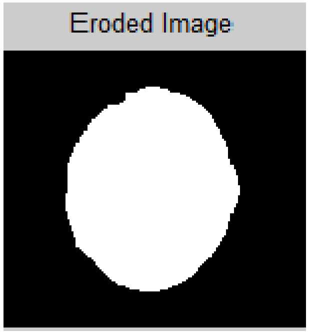

Figure 4. Eroded Image

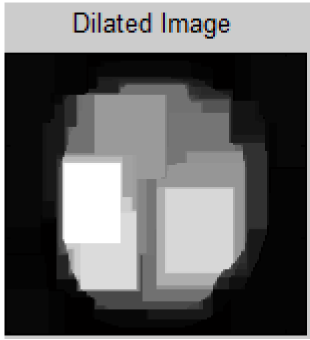

Figure 5. Dilated Image

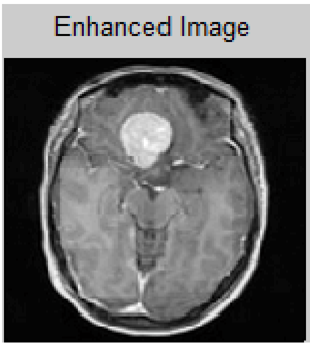

Figure 6. Enhanced Image

Figure 7. Skull Stripped

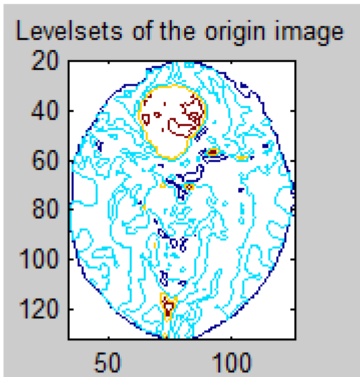

Figure 8. Level set of origin image

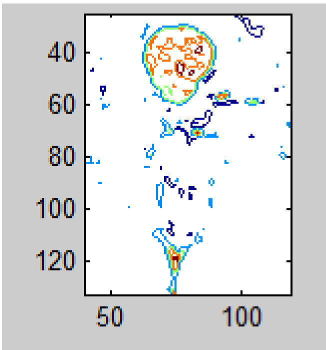

Figure 9. Level set of output

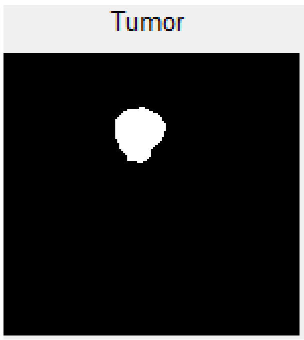

Figure 10. Tumor Extracted

Figure 11. Output Image

Fig 3 denotes the image that is given as input to the proposed system. The image is resized and then the morphological operations are performed on the image. Fig 4 and Fig 5 represents the Erosion and Dilation operation respectively. After the morphological operation the enhanced image is obtained, by adding the input image with the morphological operation applied image. Pre-processing step called skull stripping is performed in the enhanced image. The image after skull stripping is shown in Fig 7. Level set of the origin image is shown in Fig 8. The image after segmentation is shown in Fig 9. Fig 10 shows the extracted tumor.

After tumor extraction next is the classification process. For classification, from the tumor the features such as area, perimeter, centroid and roundness is computed and from the entire image the features such as entropy, energy, Correlation, Variance and Average are computed. The Artificial Neural Network is simulated using these

10 features. The ANN classifies it as benign or malignant. ANN classification of the given input depends on the trained dataset. :

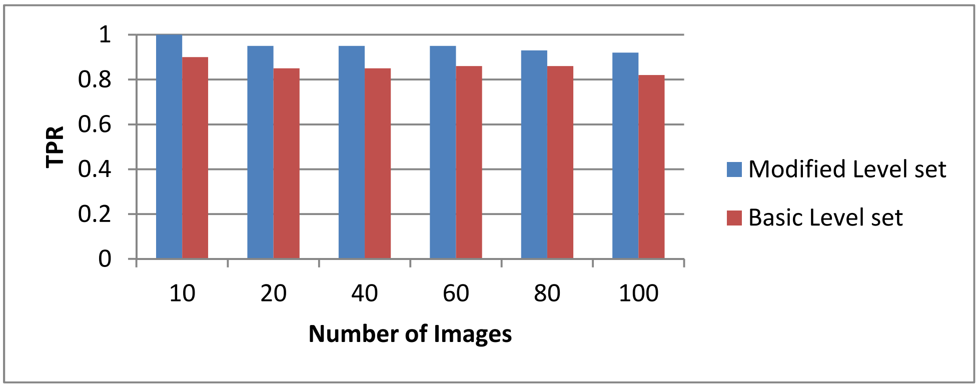

Figure13. Tumor Detected by the basic level set and the proposed method

TABLE1 Experimental output obtained for the proposed method on various inputs.

No of Images	Successfully Recognized Tumor	Unrecognized Tumor	Efficiency
5	5	0	100
10	10	0	100
20	19	1	95
40	38	2	95
80	75	5	93
100	92	8	92

It is clear from the experimental result that the efficiency of the system is about 96 %

V CONCLUSION AND FUTURE WORK

Due to the large amount of data which are currently being generated in the clinics, it is not possible to manually annotate and segment the data in reasonable time. The primary use of MRI based medical image analysis for brain tumor is in diagnosis, patient monitoring and treatment planning, but it is also useful in clinical trials. The segmentation is crucial for monitoring tumor growth or shrinkage in patients during therapy. In current clinical practice, the segmentation is usually still done manually, which is time consuming and tedious for the radiologist and is also of limited use for an objective quantitative analysis. The proposed method aims at the automatic detection and classification of brain tumors as benign or malignant. The maximum efficiency offered by the system is 96%.

The proposed method focus on the segmentation of MRI image and tumor classification as benign or malignant. This work can further extended to classify the tumor based on the type. For better classification Image Registration can be included prior to the Segmentation. Image registration aims at aligning two different images in a common reference plane.

ACKNOWLEDGMENT

I wish to place on records my earnest gratitude to Dr. K.C Raveendranathan, Principal, LBS Institute of Technology for Women and Dr. Shreelekshmi R, Head of Computer Science Department and thesis coordinator, for providing me with all the facilities for the completion of this work.I am extremely happy to mention a great word of gratitude to Mrs. Agoma Martin, Assistant professor, Department of Computer Science, for her valuable suggestions and guidance.

REFERENCES

[1] Liu J, Udupa J, Odhner D, Hackney D, Moonis G, "A system for brain tumor volume estimation via MR imaging and fuzzy connectedness". Comput Med ImagingGraph , Vol. 29, pp. 21–34, 2005.

[2] Laxman Singh, R.B Dubey, Z.A.Jaffery, Zaheeruddin, "Segmentation and characterization of brain tumor from MR images",IEEE International Conference on Advances in Recent Technologies in Communication and ComputingARTcom, pp. 815-819, 2009.

[3] Tomasz Weglinski, Anna Fabijanska, "Brain tumor segmentation from MRI data sets using region growing approach",IEEE International Conference on Perspective Technologies and Methods in MEMS(MEMSTECH) Design, pp. 185-188, 2011.

[4] Taheri S, Ong SH, Chong VFH, "Level set segmentation of brain tumor using threshold based speed function. ", Image Vis Comput, Vol. 28, pp. 26–37, 2010.

[5] Kiran Thapaliya, Jae-Young Pyun, Chun-Su Park, Goo-Rak Kwon, " Level set method with automatic selective local statistics for brain tumor segmentation in MR images." , Comput Med ImagingGrap, Vol. 37, pp. 522-537,2013.

[6] Daniel Svozil,Vladimir Kvasnicka,Jiri Pospichal, "Introduction to multi layer feed forward neural network ", Chemometris and Intelligent Laboratory System , vol. 39, pp. 43-62, 1997.