BRAIN TUMOR DETECTION AND EXTRACTION USING ARTIFICAL NEURAL NETWORK FROM MRI IMAGES

Neethu Ouseph C[1],Mrs. Shruti K[2]

[1]Student, Digital Electronics,Malabar Institute of Technology, Kerala, India
[2] Asst. Professor,Electronics and Communication, Malabar Institute of Technology ,Kerala, India

ABSTRACT

In current days a proficient detection of brain tumor is being breathtaking challenge in medical field. An Automatic segmentation of brain images has a significant role in reducing the difficulties of manual labeling and increasing the strength of brain tumor diagnosis. The manual segmentation can lead to intra and inter errors. Image segmentation techniques are help to get the meaningful information that are useful in the detection of tumor. Magnetic resonance imaging (MRI) has a high spatial resolution view of brain and it is a very powerful tool used to diagnose a wide range of disorders and it has been proven to be a highly flexible imaging technique. This paper presents a robust detection and extraction method based on Artificial Neural Network that reduces operators and errors. Artificial Neural Networks (ANNs) are mathematical analogues of biological neural systems. This system is made up of a parallel interconnected system of nodes; called neurons. The image processing techniques such as image conversion, feature extraction, bias field correction and histogram equalization have been developed for extraction of the tumor the MRI images of the cancer affected patients. A Fuzzy c means Classifier is developed to recognize healthier tissue from cancer tissue. The project is divided into two phases: Training Phase and Testing Phase. The aim of the project is to detect and extract the tissue that contains abnormalities. The specificity and the sensitivity of the method is evaluated and accuracy is determined. The performance parameters show significant outputs which are helpful in extracting tumor from brain MRI image.

Keyword: - *Brain tumor, Magnetic Resonance Imaging, Artificial Neural Network, Brain tumor segmentation*

---

1. INTRODUCTION

Digital Image processing is a budding field in which treatment centers and surgeons are getting different easy platforms for the examination of complex disease such as cancer, brain tumor, kidney stones, etc. The detection of brain disease is a very difficult task, in which special attention is taken for image segmentation. Brain tumor is a big cause of disability and death worldwide and related abnormalities constitute for major changes in life. A remarkable growth has been done in the last decade for brain tumor in the region of cerebral cancer diagnosis. Cerebral cancer has been noticed that is spreading over the world and many colleges and medical research centres are focusing on the issue. It can be understand with an example in US, in which 3000 children are facing the brain related diagnosis and brain tumors. Most commonly diagnosing methods are Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) [1] that are used to spot brain tumor. MRI is an advance technique to detect the tissues and the disease of brain cancer

In the diagnosis of brain tumor, segmentation of image is required and analysis of image segmentation is a vital part in any type of detection in the image. Image segmentation techniques are help to get the meaningful information that are useful in the detection of tumor. This paper presents a reliable detection method based on ANN that reduces errors. ANN is a parallel distributed processor that has a natural tendency for storing experiential knowledge. They can provide suitable solutions for problems, which are generally characterized by non-linearity, high dimensionality noisy, complex, imprecise, and imperfect or error prone sensor data, and lack of a clearly stated mathematical solution or algorithm. MRI can form different weighted sequences to reflect the different characteristics and biological properties of tissues. Commonly used MRI sequences are T1-weighted, T2-weighted, and Flair weighted sequences.

The image processing techniques such as image conversion, feature extraction and histogram equalization have been developed for extraction of the tumor in the MRI images of the cancer affected patients. ANN is a parallel distributed processor that has a natural tendency for storing experiential knowledge. They can provide suitable solutions for problems, which are generally characterized by non-linear ties, high dimensionality noisy, complex, imprecise, and imperfect or error prone sensor data, and lack of a clearly stated mathematical solution or algorithm. The detection of tumor takes place in main three main stages: (1) pre-processing (2) classification by CNN and (3) post-processing .The aim of the project is to detect and extract the tissue with abnormalities. The specificity and the sensitivity of the method are evaluated and accuracy is determined

2. PREVIOUS METHODS

Medical imaging segmentation is generally addressed in the modern as a classification problem where the previous methods can be divided into two main classes. The first class includes discriminative segmentation methods that are mainly based on image features and the training data. The second class contains generative methods which require additional information about the space domain. The accurate segmentation of tumors and its intra-tumoral structures is significant not only for treatment planning, but also for follow-up evaluations. The manual segmentation is time-consuming and subjected to inter- and intra-rater errors and makes difficult to characterize. Thus, physicians usually use rough measures for evaluation. For these reasons, accurate semi-automatic or automatic methods are required. It is a tough task, since the shape, structure, and location of these abnormalities are highly variable. Additionally, the tumor cells changes the arrangement of the surrounding normal tissues. Also, MRI images may contain some troubles, such as intensity in homogeneity or different intensity ranges among the same images and acquisition scanners.

Tumor growth models are used to know the effect of diseases, the area covered by the tumor and the grade of the tumor. Zhao et. al used MRF[2] to segment brain tumors. Generative models [3] well in unseen data but it may be difficult to explicitly generalize prior knowledge into appropriate probabilistic model. Classifiers such as SVM [4], [5] and RF [6] are successfully used in segmentation of tumor. On other hand deep learning methods are used for the segmentation by automatically learning a hierarchy of increasing complex features from data. The Self Organizing Map (SOM) [7], Principle Component Analysis (PCA) [8], Gradient Vector Flow (GVF) are some of the previous method used for the brain tumor segmentation and feature extraction. Other methods known as Deep Learning deal with representation learning by automatically learning an hierarchy of increasingly complex features directly from data. So, the focus is on designing architectures instead of developing hand-crafted features, which may require specialized knowledge

3. PROPOSED METHOD

In brain tumor segmentation there are several methods that explicitly develop a parametric or non-parametric probabilistic model for the underlying data. These models usually include a likelihood function corresponding to the observations and a prior model. Being abnormalities, tumors can be segmented as outliers of normal tissue, subjected to shape and connectivity constrains. Here we have developed an automatic detection of brain tumor technique by using artificial neural network. The designed and developed system works in two phases namely Learning/Training Phase and Recognition/Testing Phase. In Learning/Training Phase the ANN is trained for recognition of various tumor regions. The known MRI images are first processed through various image processing steps such as Histogram Equalization, MRI Pre-processing, bias correction etc. The whole system is mainly divided into three stages: (1) Pre-Processing, (2) Classification via ANN and (3) Post –Processing. The unknown MRI images affected by cancer are used for testing in Recognition/Testing Phase

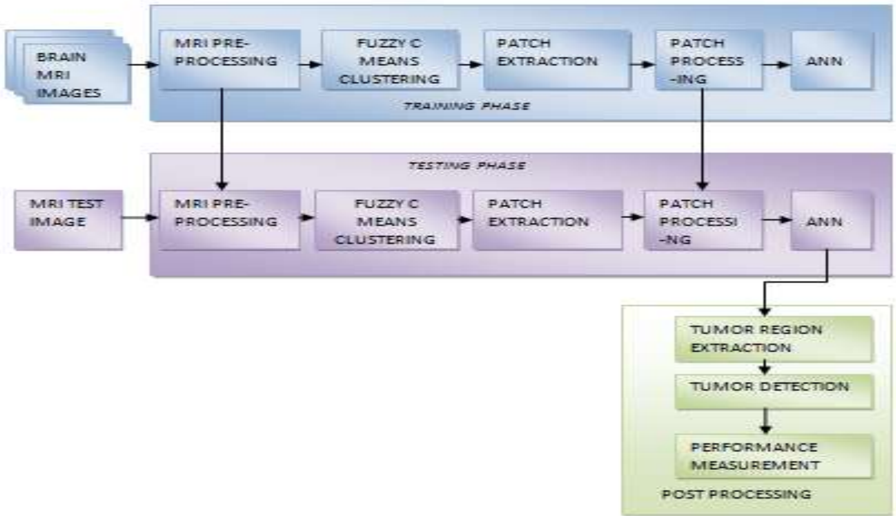


Fig-1: Proposed Block Diagram

3.1 MRI Pre-Processing

The input MRI images required for brain tumor detection are processed to improve the accuracy of tumor detection. MR images are generally ruined by bias field effect. It may contain noises and distortions. This makes the intensity of the same tissues to vary across different reasons for the same MRI sequence. In order to make the contrast and intensity range similar intensity normalization method [9] is used. In this intensity normalization method a set of landmarks are learned for each image from training set. The bias correction is applied on the MRI images by linearly transforming the original intensities thus making the histogram of the each sequence more similar. The histogram of the bias corrected image and the original image is compared in order to ensure the efficiency of the following process.

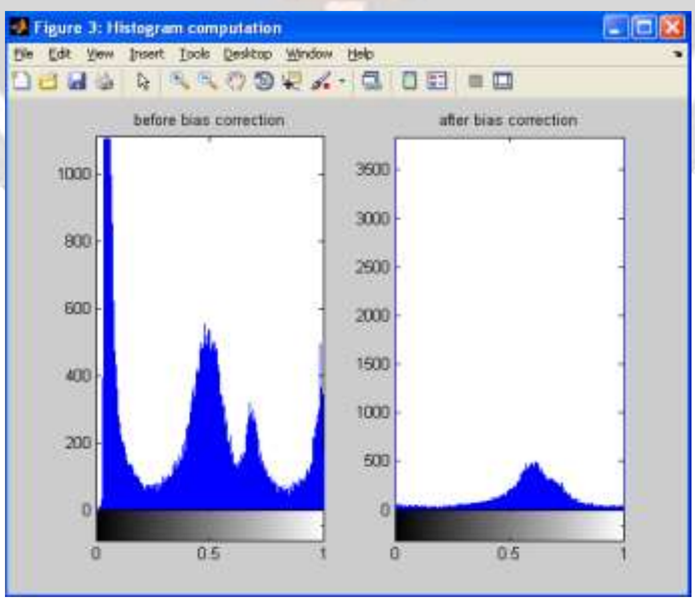


Fig- 2: Image Showing the Histogram Computation

3.2 Clustering

The clustering is a process of dividing different data samples into groups depending on how close their features are. The purpose of clustering is to identify natural grouping of data from large data set to produce a short representation of a system's behavior. Fuzzy C means clustering [10] is used here. It is based on minimizing an objective function that represents the distance from any given data to a cluster centre weighted by that data point's membership.. It starts with an initial guess for the cluster centre which is intended to mark the mean location. By iteratively updating the cluster centre and the membership grades of each data point, fcm iteratively moves the cluster centre to the right location within a dataset.

3.3 Patch Extraction and Pre-Processing

The patches can be an edge, corner or a uniform texture of an image. The patch extraction is performed to identify the part that contains abnormalities. Patch pre-processing is done to compute the mean intensity value, standard deviation and the variance of the images at the training phase. The values obtained during the normalization process are stored as feature values which are used in the testing phase.

Fig-3: Input Image

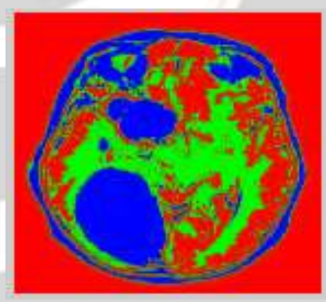


Fig 4: Partition Image

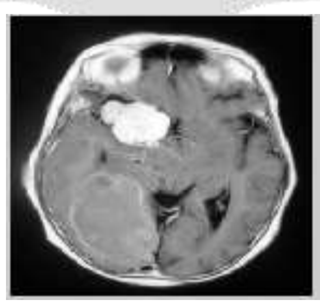


Fig 5: Bias Corrected Image

3.3 Artificial Neural Network

Neural network have received much attention for their successful application in pattern recognition. Once a neural network has been configured, it forms an appropriate internal feature extractors and classifiers based on training examples. Neural networks consist of a set of interconnected neurons which operates together to perform a particular task. Each neuron is associated with its weight. In training phase, network uses training set to update weights of its neuron in order to reduce network error. After the training phase, trained network is used for classification. The representation internally distributed across the network as a series of independent weights has many advantages: noise immunity, pattern generalization and interpolation capability. An ANN is created by combining artificial neurons into a structure containing three layers. The first layer consists of neurons that are responsible for a face image sample. The second layer is a hidden layer which allows an ANN to perform the error reduction necessary to successfully achieve the desired output. The final layer is the output layer wherein the number of neurons in this layer is determined by the size of the set of desired outputs, with each possible output being represented by a separate neuron.

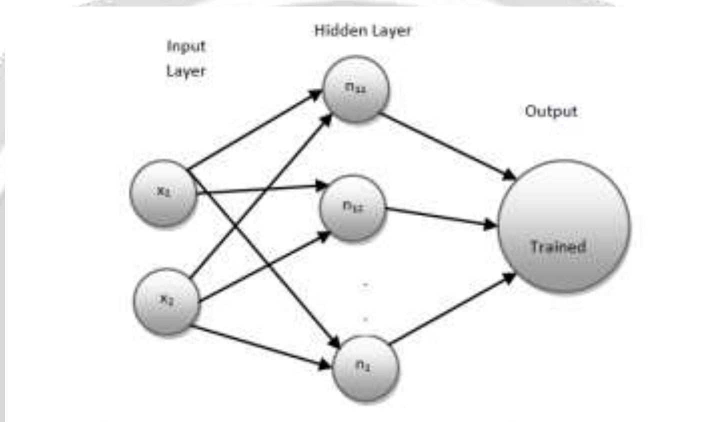


Fig-6: Artificial Neural Network Model

Multi-layer networks use a variety of learning techniques, the most popular being feed forward neural network. Here, the output values are compared with the correct answer to compute the value of some predefined error-function. By various techniques, the error is then fed back through the network. Using this information, the algorithm adjusts the weights of each connection in order to reduce the value of the error function by some small amount. After repeating this process for a sufficiently large number of training cycles, the network will usually converge to some state where the error of the calculations is small. In this case, one would say that the network has *learned* a certain target function. To adjust weights properly, one applies a general method for non-linear optimization that is called gradient descent. For this, the derivative of the error function with respect to the network weights is calculated, and the weights are then changed such that the error decreases (thus going downhill on the surface of the error function).

3.4 Post-processing

Brain tumors form a large connected region. So, the post-processing includes tumor segmentation, detection and extraction from the MRI images. It removes the smallest connected components. In this stage it detects the tumor along with the area covered by the disease.

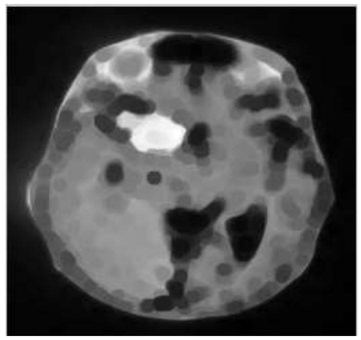


Fig -7: Erosion image

4. SOFTWARE IMPLEMENTATION

The Proposed method was implemented in MATLAB R2014a and is tested on various brain tumor MR images of size 256×256. The experiments are performed on PC having Intel ™ Core 2 Duo R 2.0 GHz processor with 3 GB RAM

5. RESULTS

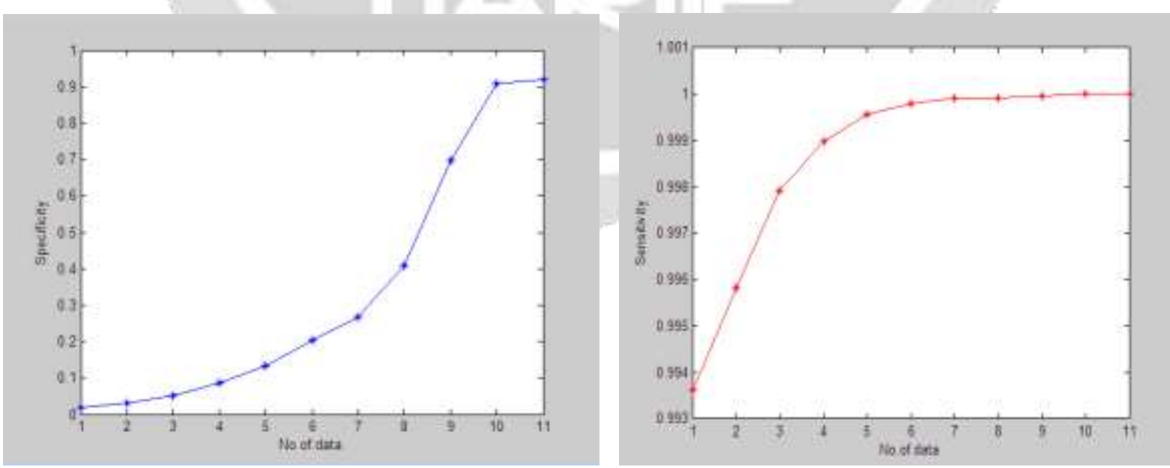
The developed system efficiently detects and extracts the tumor from the input MRI image of Brain Cancer affected patients. The MRI images of patients affected by Brain Cancer are used during testing phase. For the input image used for Testing, the system shows the Tumor Region Extracted from the outer skull of brain. The result in figure10 shows the Tumor Region which is extracted from the MRI image and the area covered by the tumor. The performance parameters can be calculated through following mathematical expression:

Sensitivity = TP / (TP + FN)*100

Specificity = TN / (TN + FP)*100

Accuracy = (TP +TN) / (TP +TN + FN + FP)*100

Where, TP=True Positive, TN=True Negative, FP= False Positive, FN= False Negative



(a) (b)

Fig – 8: Image showing (a) Specificity and (b) Sensitivity of ANN

Fig - 9: Tumor Detected Region

Fig- 10: image showing contour region and area

6. CONCLUSION

The brain tumor detection is a great help for the physicians and a boon for the medical imaging and industries working on the production of CT scan and MRI imaging. The MR image segmentation is an important but inherently difficult problem in medical image processing. In general, it cannot be solved using straightforward, conventional image processing techniques. This paper aims at giving more information about brain tumor detection and extraction. The target area is segmented and the evaluation of the nature of the tumor using the tool suggested here helps the doctors in diagnosis the treatment plan making and state of the tumor monitoring. The advantages of this system are it improves the segmentation level and spatial localization of the image and also improves the efficiency compared to the other system. It consumes less time for computation and becomes easier to train with fewer parameters than other network.

7. ACKNOWLEDGMENT

I express my grateful thanks to my guide Asst. Prof. Mrs. Shruti K, Malabar Institute of Technology for her remarks, support, suggestions and time. And also to the head of the ECE department, Asst. Prof Jacob Zachariah and Principal Mr. Dr. C Sorna Chandra Devadass for providing with all vital facilities.

8. REFERENCES

[1] S. Bauer *et al.*, "*A survey of MRI-based medical image analysis for brain tumor studies*," *Phys. Med. Biol.*, vol. *58*, no. *13*, pp. 97–129, 2013.

[2] B. Menze *et al.*, "The *multimodal brain tumor image segmentation benchmark (BRATS*)," *IEEE Trans. Med. Imag.*, vol. *34*, no. 10, pp. 1993–2024, Oct. 2015

[3] B. H. Menze *et al.*, "A *generative model for brain tumor segmentation in multi-modal images*," in *Medical Image Computing and Comput.- Assisted Intervention-MICCAI 2010*. New York: Springer, 2010, pp. 151–159

[4] S. Bauer, L.-P. Nolte, and M. Reyes, "Fully automatic segmentation of brain tumor images using support vector machine classification in combination with hierarchical conditional random field regularization," in *Medical Image Computing and Comput.-Assisted Intervention-MICCAI 2011*. New York: Springer, 2011, pp. 354–361.

[5] C.-H. Lee *et al.*, "Segmenting brain tumors using pseudo-conditional random fields," in *Medical Image Computing and Comput.-Assisted*

[6] *Intervention-MICCAI 2008*. New York: Springer, 2008, pp. 359–366

[7] R. Meier *et al.*, "A hybrid model for multimodal brain tumor segmentation," in *Proc. NCI-MICCAI BRATS*, 2013, pp. 31–37.

[8] Vinod Kumar, Jainy Sachdeva, Indra Gupta *" Classification of brain tumors using PCA-ANN"* 2011 World Congress on Information and Communication Technologies

[9] Sergio Pereira, Adriano Pinto, Victor Alves, and Carlos A. Silva "*Brain Tumor Segmentation Using Convolutional Neural Networks in MRI Images"*IEEE TRANSACTIONS ON MEDICAL IMAGING, VOL. 35, NO. 5, MAY 2016

[10] Rasel Ahmmed, Md. Foisal Hossain "*Tumor Detection in Brain MRI Image Using Template based K-means and Fuzzy C-means Clustering Algorithm"* 2016 International Conference on Computer Communication and Informatics (*ICCCI* -2016), Jan. 07 – 09, 2016, Coimbatore, INDIA