SEGMENTATION OF BRAIN IMAGES FOR TUMOR DETECTION USING NEURO-FUZZY INFERENCE SYSTEM

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Abstract
Automated classification and detection of tumor in different medical images demands high accuracy since it deals with human life. A brain tumor occurs due to normal and abnormal tissues form within the brain, so segmentation is very important to detect the presence of tumor. Manual classification of Magnetic Resonance (MR) images of brain tumor is a challenging and the time consuming task. The use of Artificial Intelligence Techniques, for instance, a Neural Networks, Fuzzy logic, Neuro-Fuzzy has shown great potential in medical field. With the involvement of soft computing, the pattern matching, classification and detection of algorithms having direct applications in many medical problems have become much easier to be implemented and diagnosed. Hence, this paper tries to find out how the Neuro-Fuzzy system or the hybrid combination of Neural Networks and Fuzzy logic techniques can be applied in the classification and detection purposes, particularly in the medical field.
Keywords: Artificial Neuro-Fuzzy Inference System, Fuzzy Logic, Magnetic Resonance Imaging, Neural Networks.

1. Introduction

Image processing plays a key role in medical image diagnosis. The methodology used in image processing has a capability of converting an image into digital form, which performs certain operations on the image in order to extract some information from an image or to achieve an enhanced image. Generally body is made up of different cells and each has its special function. Most cells grow and divide orderly way in order to create a new cells. This keeps the body healthy and work properly. If cells lose ability to control their growth, forms a mass of tissues which is named as a tumor. The tumor can be of different forms such as benign, malignant and premalignant.

In benign the cells are developed and grows at an excessive rate among the brain. It is a slow rising tumor, which affects the healthy functioning of cells in the brain. It is non-cancerous, which does not spread to other parts of the body. At this stage if once the tumor is cured there is no chance of occurrence in the future. In premalignant toeing the line between benign tumor and malignant tumor. It is in carcinogenic condition which leads to cancer and can be cured with proper treatment. The Malignant is the cancerous tumor, which tend to become progressively worse. Unlike benign and premalignant tumors, the tumor grows and spreads fast. The abnormal cells in this type multiply at a faster rate. It can lead to death of a person if there is no proper treatment. These abnormal cells affect the tissues of other parts of the body.

Artificial Intelligence Techniques are used for implementation of a computational system which proposes the special characteristics of intelligence, which relates to human learning. It enables a system to discover to understand or to reason or to figure out the results, which can be implemented effectively to some level. It this different algorithms are designed which can deal with different tasks which are exhibited by the human brain like reasoning, understanding, analyzing, etc. Computer logic couldn't manipulate data which represent vague ideas, so fuzzy logic is created, which allows distinction

among data with different shades according to the human reasoning. This Fuzzy logic works on imprecise terms, which is based on human thinking. Artificial Neural Networks (ANNs) are influenced by organic neural systems that is utilized by giving weights upon wide number of inputs given which is difficult to understand. In this, neurons are then interconnected which form values for these inputs and also adapt the combination with pattern recognition. Neuro-Fuzzy system is used to combine both the properties of Fuzzy logic and Neural Networks where input data and the trained data are same and the output data from this is used for tumor detection. Due to this the computational time for test input data can be decreased. Many researches worked on this tumor detection using different technologies. Adaptive Neuro-Fuzzy Inference System for segmentation of brain abnormality in MR images proposed by Noorhayati Mohamed Noor et al., [1]. It collects different MR images which are used as test data for the system. The creation of data is performed by combining the sizes and shapes of the various abnormalities. In these backgrounds were tested in order to know the abnormality level. Artificial Neuro-Fuzzy system for detection of brain tumor states by Shashank Bhardwaj et al., [2]. In this brain tumor is detected which minimizes the deviation of the target value by using Backpropagation algorithm. Investigation the tumor in the brain can be performed based on predefined rules to illustrate and for the results of better performance. Artificial Neural Networks Backpropagation method to classify types in brain tumor images classified by N. Periyasamy et al., [3]. Backpropagation Neural Networks method was improved for training and testing the brain tumor images. It gives 90% classification accuracy where this process identifies the defected cells in benign stage. This proposed method achieves increased in classification accuracy and minimization of error rate. The processing time taken by the network is less than a minute. Segmentation to extract a tumor region of normal tissues states by Imran Ahmed et al., [4] explain the segmented region is contained skull boundaries in the form of noise, hence by applying dilation and erosion which remove extra noise caused by segmentation. For analyzing a tumor area morphological and image fusion is applied. After detection of tumor we compute the size of the tumor, which make decisions easier for physicians. In this we can achieve a detection rate with the 93% by using the dataset. Brain tumor classification using Adaptive Neuro-Fuzzy Inference System (ANFIS) from MRI by Tai-Hoon Kim et al., [5] explains that future extraction involves simplifying a large set of data accuracy. It combines the variables to get around the problems such as computing power and the requirement of large memory space while describing the data with sufficient accuracy. In this ANFIS classifier is used to classify the input in comparison with other classifiers such as an Artificial Neural Networks with Backpropagation learning model and K-Nearest Neighbors. Detecting tumor in the brain by using a Neural Networks to explain by Albert Singh et al., [6] proposes that the algorithm used in this which incorporate different steps by using Neural Networks techniques. Here, the Gabor filter is used to extract the texture features in detecting tumor. These features are used to train and classify the brain tumor and also increase the accuracy for detection of brain tumor. Automatic detection and segmentation of brain tumor using Fuzzy logic proposed by Wang Yang et al., [7] states fully-automatic method used in combination of region based and contour based to get better performance results for detection of brain tumor. Good quality segmentation can be achieved by combining the improved kernel Fuzzy c-mean and deformable methods. Detection and classifying of brain tumor automatically in MR images by V. Palanisamy et al., [8] explains the method of optimization which approaches further improvements in order to classify and detect brain tumor. It proves that the existing of the proposed approach is better than the existing approaches. Image segmentation for tumor detection by using Fuzzy Inference System states by P. Meena et al., [9] in which diagnosing and analyzing the anatomy of the body can be performed. It classifies the images by segmenting the MRI brain images. It proposes FIS technique which is used to identify the tumor in brain images with the help of Fuzzy rules. Efficient Fuzzy based method for brain tumor segmentation on MR images obtained by Gunjan pahuja et al., [10] explains the segmentation usage, which able to remove the attention of the object from the background image. This displays the Fuzzy set level with the parameters that are set properly in MATLAB environment. The approach for classification of medical images

using Neuro-Fuzzy logic and ANFIS classifier by Kapil Kumar et al., [11] explains the technique of Fuzzy logic, which depends on expert knowledge which cannot always be accurate, so we go for ANFIS which was evaluated in terms of training performance and classification accuracy. The early detection of brain cancer using a Neural Networks by G. V. Raju et al., [12] where it approaches Neuro-Fuzzy for recognition of the extracted of cancer regions. Here automatic recognition can be performed with the help of Neuro-Fuzzy logic with improved accuracy level. The most efficient approach for brain tumor detection by using a Neural Networks in MR images obtained by C. Chellamuthu et al., [13] which validates the effectiveness of the modified growing region and also evaluate the tumor detection, sensitivity, specificity and accuracy. It shows better results by using a Feed Forward Neural Network. The detection of MR brain images by using Fuzzy C-mean by Jinal. A. Sah et al., [14] explains the segmentation of brain tumor automatically with Fuzzy c-mean and extracts the brain tumor, from the background. Detection of MR images of the brain using Fuzzy C-mean by S. Krithiga et al., [15] explains the segmentation of brain tumor images automatically with the help of the Fuzzy C-mean. The performance of this can be improved when compared to other techniques.

2. Background

Digital image processing using different preliminaries are explained, which includes Artificial Intelligence Techniques. Generally, human brain in this Artificial Intelligence Technique, explains Fuzzy logic, Backpropagation Neural Networks and the Neuro-fuzzy system.

2.1 Image Segmentation

It is one of the processes of partitioning a digital image into multiple segments. The goal of segmentation is to simplify the change in representation of an image into something more meaningful and easier to analyze. It is typically used to locate object boundaries in images. Division of an image into meaningful structures, image segmentation is often an essential step in image analysis, object representation, visualization, and many other image processing tasks.

2.2 Thresholding

Thresholding is a manual approach in which segmentation process is applied to any image, which extract the light objects from the dark background. In this, multilevel images are converted to binary images with a selected threshold ‘T’ in order to divide the image pixels into several regions which separate objects from the background. In any pixel coordinates x and y are considered as a part of an object where its intensity is greater than or equal to the threshold value, i.e., f (x, y) >=T, else those pixels belongs to the background. In the threshold allocation of pixels to categories can be processed according to the range of values.

3. Proposed System

Generally, MR images produce a complete image of the brain, which is visually examined by the physician for detection & diagnosis of brain tumor. However, this method resists with accurate determination of the stage and size of the tumor. To avoid following problems, computer aided method is used for detection and segmentation of brain tumor.

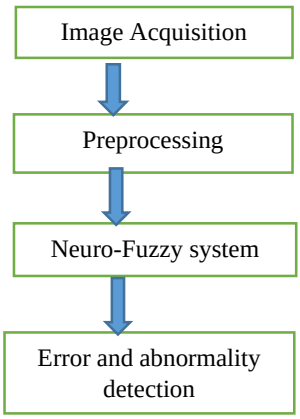


Figure 1.1. Proposed system

3.1 Image Acquisition

Digital imaging or digital image acquisition is the creation of photographic images, such as physical scene or the interior structure of an object. MR (Magnetic resonance imaging) images are considered mostly in the medical field. MRI images doesn't affect the human body because it don't practice any radiation. The chances for arrival of noise in modern MRI scan are very less.

3.2 Preprocessing

The original image is resized to 256*256. Tumor area can be compared since the size is fixed after performing segmentation.

3.3 Neuro-Fuzzy system

Every intelligent technique has some computational properties which have the ability to learn and can explain the decision, which is suitable for a particular problem. So combinations of two or more techniques can provide the advantages of each technique and also provide approximations for all scenarios. The combination of Fuzzy logic and Neural Networks, where individual drawbacks can overcome which provides beneficiary in the usage of the system. In order to get better results we go for two algorithms such as Fuzzy logic algorithm and Backpropagation algorithm.

Fuzzy Inference System (FIS) mainly involves Membership Functions, linguistic variables and If-then rules. Fuzzification converts crisp value to linguistic variable using MF. The Inference is used to convert fuzzy input to fuzzy output using If-then rules. Defuzzification converts fuzzy output to a crisp value using same Membership Functions. In this tumor area and mean are considered inputs for FIS, so to get the inputs first we have to calculate the tumor area for the brain image we consider. Standard deviation is also calculated to quantify the amount of variation of a set of data values.

3.3.1 Back propagation algorithm

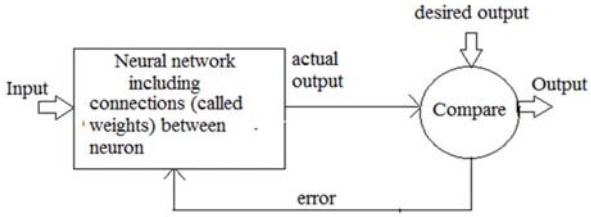


Figure 1.1. Block diagram of Backpropagation neural network operation

It is a multi-level error feedback algorithm where hidden layer operates in the log sigmoid transfer function which employs the classification of normal and abnormal tumors. Full connectivity is maintained between the upper and lower layers and no connection is maintained between neurons in each of the layers. The weights on these connections encode the knowledge of a network. The data which enters at the input passes through a network, layer by layer, until it arrives at the output. The parameters of a network were adjusted according to the trained network on a set of reference data, called training set. The trained network was performed under Backpropagation to identify the presence of error. The trained network is used to predict labels for the performance of new data.

The backpropagation step is performed in the usual way, where the output 0_i of the i^{th} node in the feed-forward step and D_i is the desired output. The difference between these two is considered as back propagated error. This Backpropagated error can be denoted at the j^{th} node by δ_j, we can the express partial derivative of E with respect to W_{ij} as:

$$\frac{\partial E}{\partial W_{ij}} = 0_i \delta_j \quad (1)$$

We can perform the gradient descent method by adding to each weight W_{ij} with the increment to modify the weights as:

$$\Delta W_{ij} = -\gamma 0_i \delta_j \quad (2)$$

This correction is needed to transform the Backpropagation algorithm where learning method is performed on Neural Network. In Artificial Neuro-Fuzzy Inference system we convert the Mamdani type which is used in FIS into Sugeno type and then the data is saved in the

workspace, the changes of these MF parameters are loaded in ANFIS both for training and testing the data from the workspace. To train this FIS optimization methods such as hybrid or Backpropagation are used where MF parameters are tuned.

3.4 Error and abnormality detection

The optimization method chooses hybrid or Back Propagation which are used to train MF parameters. Enter epochs and error tolerance to set stopping criteria for training. Validating the trained data FIS, validates the model uses test or check data in order to train the FIS.

4. Experimental Results

TABLE 1.1. Prediction, valid performance and gradient for different images using Backpropagation in NN

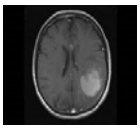
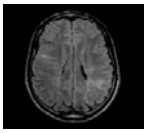
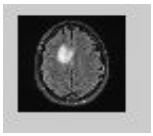
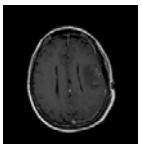
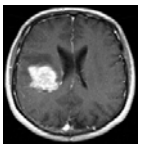
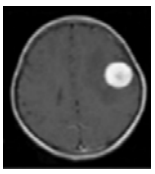
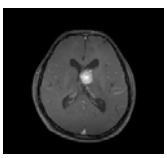
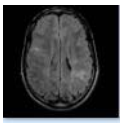
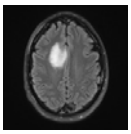
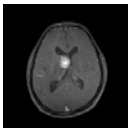
Image	Prediction	Valid performance	Gradient
	Abnormal	0.002678	0.000832
	Normal	0.0084127	0.0012236
	Abnormal	0.003247	0.000732
	Normal	0.007218	0.0012326
	Abnormal	0.002689	0.000734
	Abnormal	0.003982	0.000824
	Abnormal	0.002432	0.000712

TABLE 1.2. Calculations for different images using Fuzzy logic algorithm

Image	Mean	Standard deviation	Varience	Skewness	SNR
	0	0	0	0	0
	185.34	43.09	$1.8575e^{003}$	-0.7300	4.3005
	102.4937	43.2153	$1.8676e^{003}$	1.5177	2.3717

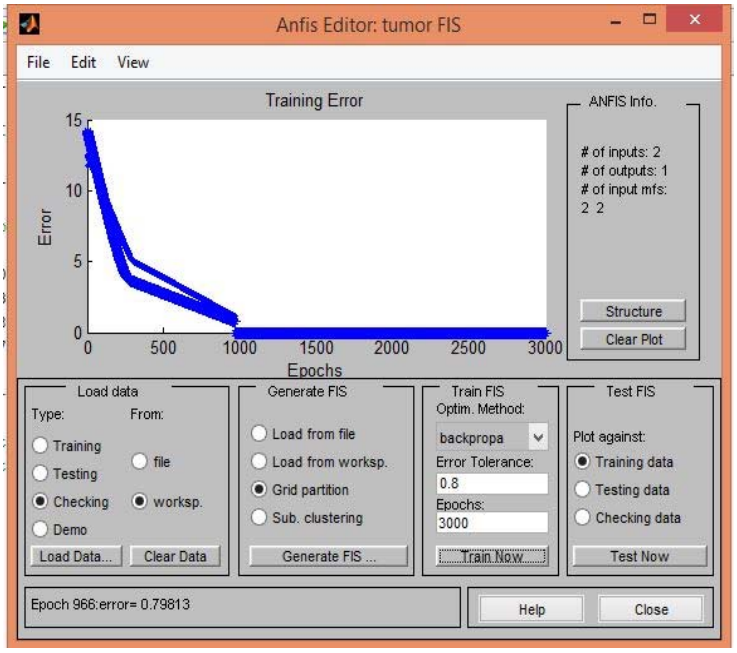


Figure 1.2. ANFIS editor toolbox 1

5. Conclusions

In this paper, normality/abnormality can be classified by using the method based on Mamdani in Fuzzy logic and Backpropagation algorithm in Neural Network. In Fuzzy logic, inputs for tumor on left and right side of bran image, tumor area and mean are calculated. When Neural Networks are considered, different brain images are trained in network and for the different test images of the same network, best validation performance and gradient are observed. These changes occur according to the size of tumor for different iterations. To fasten this process, Backpropagation optimum method

can be used in ANFIS. From the performance outcomes, it was observed that proposed Mamdani in Fuzzy logic and a Backpropagation algorithm with ANFIS method will achieve maximum error of 0.789 for 966 iterations.

References

[1] Noorhayati Mohamed Noor, Noor Elaiza Abdul Khalid, Rohaida Hassan, Shafaf Ibrahim, Ihsan Mohd Yassin, "Adaptive Neuro-Fuzzy Inference System for Bran abnormality segmentation", IEEE Control and System Graduate Research Colloquium, 2010.

[2] Shashank Bhardwaj, Neeraj Singhal, Neeraj Gupta, "Adaptive Neuro fuzzy system for tumor", CIPECH14, 2014.

[3] N. Peryasamy, J.G.R. Sathiaseelan, "Detection and classification of brain tumor images using back propagation Fuzzy Neural Network", IJRASET, Volume 3, Issue 8 , 2015.

[4] Imran Ahmed, Qazi Nida-Ur-Rehman, Ghulam Masood, Muhammad Nawaz, "Analysis of Brain MRI for Tumor Detection & Segmentation", ISBN, Volume 1 , 2016.

[5] Sudipta Roy, Shayak Sadhu, Samir Kumar Bandyopadhyay, Debnath Bhattacharyya and Tai-Hoon Kim, "Brain Tumor Classification using Adaptive Neuro-Fuzzy Inference System from MRI", IJBB, Volume 8, pp. 203-218, 2016.

[6] V. Amsaveni, N. Albert Singh"Detection of brain tumor using Neural Networks", IEEE 4th ICCCNT, 2013.

[7] Wang Yang, Ma Silang, "Automatic detection and segmentation of brain tumor using fuzzy Classification and deformable models", IEEE, 4th BMEI, 2011.

[8] R. Karuppathal, V. Palanisamy, "Fuzzy based automatic detection and classification approach for MRI brain tumor", APRN, Volume 9, No.12 , 2014.

[9] V. Janani, P. Meena, "Image segmentation for tumor detection using Fuzzy Inference System", IJCSMC, Volume 2, Issue 5, pg.224-248 , 2013.

[10] Anjali Gupta, Gunjan Pahuja, "Efficient Fuzzy based method for brain tumor segmentation on MR images", IJARCSSE, Volume 6, Issue 8, 2016.

[11] Anant Bhardwaj, Kapil Kumar Siddhu, "An approach to medical image classification using Neuro Fuzzy logic and ANFIS classifier", IJCTT, 2014, Volume 4, Issue 3.

[12] G. Vijay Kumar, Dr GV Raju, "Biological early brain cancer detection using artificial Neural Network", IJCSE, Volume 2, No.8, 2010.

[13] A. R. Kavitha, Dr. C. Chellamuthu, Kavina Rupa, "An efficient approach for brain tumor detection based on modified region growing and Neural Network in MR images", ICCEET, 2012.

[14] Jinal A. Shah, S.R.Suralkar, "Brain Tumor detection from MRI Images using Fuzzy C-Means Segmentation", IJAR, 2016.

[15] S.Krithiga, S.Suganya Hepzi Jeba, Kavitha Balamurugan, "Brain Tumor Detection using Fuzzy C- Means Segmentation", IJPCSC, 2015.