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A Novel Method of Brain Tumor Detection from MRI Images Using Fuzzy C Means Clustering and Neural Networks - A Survey

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Abstract: Magnetic Resonance Imaging (MRI) is the major technique to detect the brain tumor. In the proposed system classification of MRI images are done using data mining techniques. A new hybrid technique is proposed based on neural networks and fuzzy c-means for brain tumor classification. The proposed algorithm is a combination of neural networks and fuzzy c-means clustering. In the proposed algorithm an image is enhanced using enhancement techniques such as mid-range stretch and contrast improvement. Double thresholding and morphological operations are used for skull striping. Fuzzy c-means clustering (FCM clustering) is used for the segmentation of the image to detect the suspicious region in MRI images of the brain. Gray level run length matrix (GLRLM) is used for extraction of feature from the brain image, after which neural networks technique is applied to classify the brain MRI images, which provide accurate and more effective result for classification of brain MRI images.

Keywords: Data mining, MRI, Neural networks, Gray level run length matrix, Fuzzy c-means clustering.

I.INTRODUCTION

Brain tumor is a mass of tissue in which cells are grown abnormally and multiply uncontrollably which is unchecked by the mechanisms that control normal cells to grow. Brain tumors can be metastatic or primary, and either benign or malignant. A metastatic brain tumor is that has spread from anywhere in the body to the brain.

Magnetic Resonance Imaging (MRI) is a significant medical imaging technique used to produce high quality images of different parts in the human body. MRI imaging is frequently used when treating brain tumors, foot and ankle. From these high-resolution images the detailed anatomical information is derived to examine human brain development and discover abnormalities. There are several methodology for classifying MRI images, which are fuzzy methods, atlas methods, neural networks, shape methods, knowledge based techniques, variation segmentation.

Clustering is a process of grouping or partitioning a given pattern into a number of clusters such that similar patterns are assigned to a group which is called as a cluster. There are two main approaches to clustering which is fuzzy clustering and crisp clustering techniques. The methods and derivatives of Fuzzy clustering have been used for pattern recognition, data mining, classification and image segmentation. It has also been used for modelling and medical image data analysis etc.

Data mining is a reliable tool to extract the information from large dataset. Classification is a branch of data mining field there are many classification techniques available for medical images such as decision tree, Bayesian classification, artificial neural network (ANN), fuzzy c-means (FCM) and support vector machine (SVM). Medical imaging techniques such as x-ray, positron emission tomography (PET), computed tomography (CT), magnetic resonance imaging (MRI) for tumor detection but MRI imaging technique is good because of its higher resolution and mostly MRI imaging is used for diagnosing tumor.

The MRI images of the brain which are filtered were enhanced using Mid-range Stretch and Contrast improvement techniques. Once the image is enhanced segmentation step can be done easily. Segmentation is a technique to extract suspicious region from images. In this paper Segmentation technique was done by Fuzzy C-Mean (FCM) clustering. Before applying FCM clustering technique, skull striping has been done. Feature extraction means to obtain the information of image. The method uses Gray Level Run Length Matrix (GLRLM) to extract features.

The reduced GLRLM features are deferred to neural networks for training and testing. The brain MRI images were classified using neural networks techniques which are widely used for data analyzing and pattern recognizing. It creates a hyper plane in between data sets to indicate which class it belongs to. The main objective of this work is to develop a hybrid technique, which can classify the brain MRI images efficiently and successfully via Fuzzy C- means and Neural networks. This work is an efficient classification method is to detect the tumor in MRI Images.

II.RELATED MEDICAL IMAGING TECNIQUES

Magnetic Resonance Imaging (MRI) A MRI of head is an imaging test that uses radio waves and powerful

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magnets to create pictures of the brain and surrounding nerve tissues.

Positron Emission Tomography (PET) Positron emission tomography (PET or PET scan) is a specialized radiology procedure which examines various body tissues to identify certain conditions. It is also used to follow the progress of the treatment of certain conditions. PET is most commonly used in the fields of neurology, oncology, and cardiology.

X-ray X-rays are electromagnetic radiations. It is used to identify cracks, abnormal bones, injury and bone cancers. The advantage is that they are cheaper than other modalities. The disadvantage is that they do not give detailed images and also exposure to X-rays for long period can damage the tissues and also it cannot be used for soft tissues.

Computed Tomography (CT) CT is an imaging procedure. The detailed pictures or scans of areas inside the body are created using special x-ray equipment that uses special x-ray equipment. It is also called computerized axial tomography (CAT).

III.RELATED CLASSIFICATION TECNIQUES

Artificial neural Network (ANN) It is a family of models inspired by biological neural networks (the central nervous systems of animals, in particular the brain) and are used to estimate or approximate functions that can depend on a large number of inputs and are generally unknown. Artificial neural networks are generally presented as systems of interconnected "neurons" which exchange messages between each other.

Fuzzy C-means Clustering (FCM) FCM is a data clustering technique in which a dataset is grouped into n clusters with every datapoint in the dataset belonging to every cluster to a certain degree.

Decision tree Decision trees are trees that classify instances by sorting them based on feature values. Each node in a decision tree represents a feature in an instance to be classified, and each branch represents a value that the node can assume. Instances are classified starting at the root node and sorted based on their feature values.

Bayesian Classification A Bayesian Network (BN) is a graphical model for probability relationships among a set of variables features.

The Bayesian network structure S is a directed acyclic graph (DAG) and the nodes in S are in one-to-one correspondence with the features X. The arcs represent casual influences among the features while the lack of possible arcs in S encodes conditional independencies.

IV.METHODOLOGY

The proposed methodology consists of a set of stages starting from collecting brain MRI images. The main steps are shown in fig.1. This hybrid technique involves the following main steps such as enhancement, skull striping, segmentation, feature extraction and training the Neural networks classifier using MRI images with GLRLM features, storing the database and testing. All the above said steps are involved in testing phase, using the new MRI images with GLRLM features to neural networks a brain MRI images are classified. This study used dataset of 120 patients MRI brain images and classified them as normal and abnormal. The image is processed through

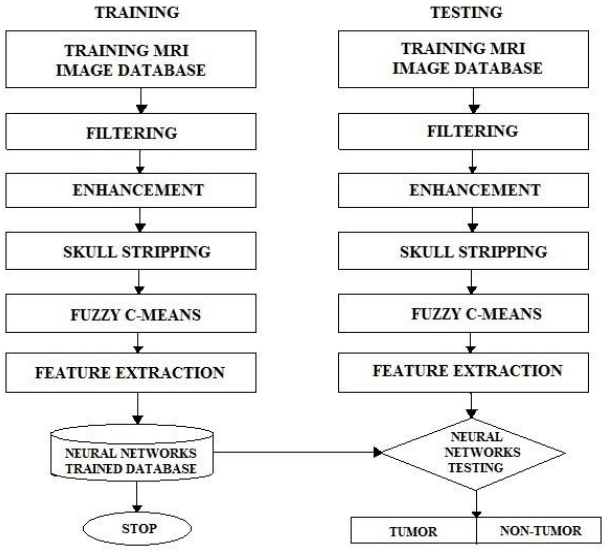

Fig.1 Architecture of MRI image processing

Filtering The images of Brain MRI were filtered from the database of various medical centers. These images were converted into 2-dimentional matrices using MATLAB ().

Enhancement of MRI images Enhancement technique is used to improve the quality of images. It is needed to improve the image formation for human viewers, so that accurate outcomes are achieved. Several methods are used for enhancement of brain MRI images. The first step is enhancement of MRI in which the brightness of the images are increased to enhance perceptibility. The techniques to improve quality of the brain images are contrast improvement and mid-range stretch.

Contrast improvement The MRI images are converted from RGB images to gray scale images. These gray scale images are called intensity images. imadjust (MATLAB function) maps the intensity values into low and high intensity values.

Midrange stretch Intensity values are stretched to improve the quality of brain images. The gray scale image pixels are mapped between 0 and 1 value by dividing 255 intensity values

$X_{ij}=Image_i/255$

Here i for row index of brain image matrix and j for column.

Skull stripping It is an important step. The steps involved in skull stripping are double thresholding, erosion and region filling.

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Double thresholding The segmentation technique converts the gray scale image into binary image. This technique generate the mask by setting each pixel in range of 0.1*255-0.88*255 to 1 means white and remaining pixels to 0 means black. Here two threshold upper and lower are considered so it is known as double thresholding technique.

Erosion In this step unwanted pixels are removed from MRI image after threshold. Thus the skull portions are removed.

Region filling The holes in the images are filled using this method. After the erosion, region filling algorithm is used to fill eroded images. Here the background pixels are converted into foreground pixels because the holes present in the eroded images are removed in brain MRI image.

Fuzzy C-Means Segmentation is the technique of separating an image into multiple slices and object region. The skull stripes images are used in image segmentation. This provides good result for tumor segmentation. In this work, fuzzy c-means algorithm was used in MRI image segmentation. Fuzzy C-Means (FCM) algorithm is used to find out the suspicious region from brain MRI image. This fuzzy c-means clustering method provides good segmentation result.

Feature Extraction It is a technique to find the relevant features from images, which are used to understand the images easier. This input data set images are converted into compressed form is called feature extraction. It can reduce the work for further processing such as image classification. Here the GLRLM feature extraction technique is used. GLRLM is used after the fuzzy c-means algorithm. Derive the gray level run length matrix (GLRLM) for two level high frequency sub bands of the discrete wavelet decomposed image with 1 for distance and 0,45,90 and 135 degrees. Feature extraction is isolating the relevant features which lead to understand the brain MRI images well.

Neural Network fig.2 demonstrates the strategy of the Feed Forward for detecting the existence of the tumor in the input MRI image. Neural network classifier is used to classify the image.

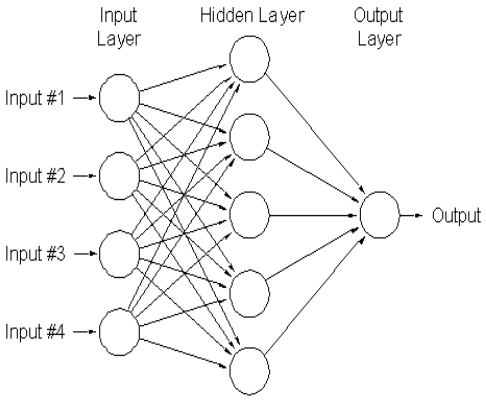

Fig.2 Feed Forward Network

The activation function considered for each node in the network is the binary sigmoid function defined function defined (sign=1) as output =1 / (1+e^{-x}), where x is the sum of the weighted inputs to that particular node. This is a common function used in many BPN. This function limits the output of all nodes in the network to be between 0 and 1. Neural networks are basically trained until the error for each training iteration stops decreasing. The features which are extracted from image are listed below and flow of information is shown in fig.3.

Angular second moment:

$$f_1 = \sum_i \sum_j P(i,j)^2 \quad (1)$$

Contrast:

$$f_2 = \sum_{n=0}^{Ng-1} n^2 P_{x-y}(n) \quad (2)$$

Correlation:

$$f_3 = \frac{\sum i \sum j \, (i,j)\, P(i,j) - \mu_x \mu_y}{\sigma_x \sigma_y} \quad (3)$$

Sum of square: Variance:

$$f_4 = \sum_i \sum_j (i-\mu)2 \quad (4)$$

Inverse difference moment:

$$f_5 = \sum_i \sum_j \frac{1}{1+(i-j)^2} P(i-j) \quad (5)$$

Sum Average:

$$f_6 = \sum_{i=2}^{2Ng} i P_{x+y}(i) \quad (6)$$

Sum Variance:

$$f_7 = \sum_{i=2}^{2Ng} (i-f_6)^2 P_{x+y}(i) \quad (7)$$

Sum Entropy:

$$f_8 = -\sum_i^{2Ng} P_{x+y}(i) \log P_{x+y}(i) \quad (8)$$

Entropy:

$$f_9 = -\sum_i \sum_j P(i,j) \log P(i,j) \quad (9)$$

Difference Variance:

$$f_{10} = -\sum_{i=0}^{Ng-1} (i-\mu_x-y)^2 P_{x-y}(i) \quad (10)$$

Difference entropy:

$$f_{11} = -\sum_{i=0}^{Ng-1} P_{x-y}(i) \log(P_{x-y}(i)) \quad (11)$$

Standard deviation:

$$f_{12} = \frac{\sum_{i=1}^{n} (X_i - X)^2}{(n-1)} \quad (12)$$

Where P(i,j) is (i,j)th entry in a normalized gray-tone spatial dependence matrix.

Px(i) is ith entry in the marginal-probability matrix obtained by summing the rows of P(i,j) = $\sum_j^N g, P(i,j)$.
Ng Number of distinct gray levels in the quantized image.
μx, μy, σx, and σy are the measured standard deviations of Px, Py.

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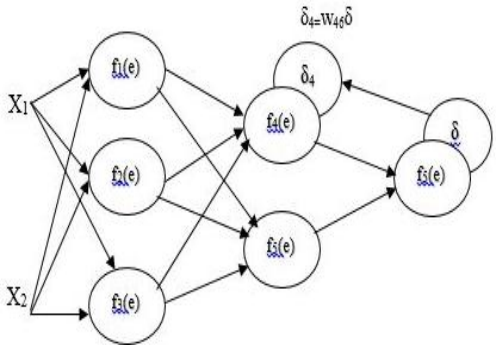

Fig.3 Information flow from output node to hidden layer

IV. PERFORMANCE MEASURES

Classification, the sensitivity, specificity and accuracy were calculated using below formulas:

True Positive (TP) Abnormal brain correctly identified as abnormal.

True Negative (TN) Normal brain correctly identified as normal.

False Positive (FP) Normal brain incorrectly identified as abnormal.

False Negative (FN) Abnormal brain incorrectly identified as normal.

1) Sensitivity = TP/ (TP+FN) *100%
2) Specificity = TN/ (TN+FP) * 100%
3) Accuracy = (TP+ TN)/ (TP+ TN+FP+FN) * 100%

All these three parameters are used to check the classifiers performance.

V.RESULT AND ANALYSIS

Neural network technique with fuzzy c-means is used for segmentation and classification of brain MRI images. Real data set of 20 patients MRI brain images have been used to detect 'tumor' and 'non-tumor' MRI images. The soft tissues in brain MRI images are segmented with Double Thresholding, Morphological operations and fuzzy c-means algorithm for clustering and gray level run length matrix for feature extraction.

The Neural network classifier is trained using many brain MRI images, after that the remaining brain MRI images was used for testing the trained Neural network. First Neural network is trained by using many MRI brain image training set. Once the Neural network is trained, the classification accuracy is validated using the testing set. The result for classification provides accurate for large data sets.

VI.CONCLUSION

In this proposed system brain MRI images proved to be a significant way to detect the brain tumor. The hybrid methodology of combining neural networks and fuzzy c-means clustering for classification gives accurate result for identifying the brain tumor.

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