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Review of Classification algorithms for Brain MRI images

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Abstract - — *MRI (Magnetic Resonance Imaging) is a medical test which uses strong magnets to produce magnetic field and radio waves to generate 2/3 Dimensional image of different body organs and analyse it .This technique produces clear and high quality images in various medical image format like '.dcm', '.xml', '.ima', '.mnc', etc. The brain is composed of 3 types of materials: white material (WM), grey matter (GM) and cerebral spinal fluid (CSF) which are considered while studying the image. MRI has certain parameters like TR (Repetition time) , TE (Echo Time), Inversion time, Flip angle etc. whose value change depending on the sequences which include T-1 weighted, T-2 weighted, Proton density, etc. Radiologists use these images to analyse and predict the results as abnormal or normal. Focus of this paper is to study various existing classification techniques of MRI images and also propose an effective system for assisting radiologists. The proposed system takes multiple images as an input, pre-processing is performed on these images for obtaining above mentioned parameters. Now, classification algorithm (Decision tree) is applied on obtained parameters to classify whether the given patient's MRI is abnormal or normal and further predict the condition if found abnormal. The classifier model makes use of training data set of truth images for classifying the input data set. To improve the accuracy and response time, boosting technique is applied to decision tree. Boosting allows combining of many weak learners (tree which cannot firmly classify the input) to produce a strong learner for better prediction.*

***Key Words*: MRI (Magnetic Resonance Imaging), Classification, Decision Tree, Image Processing, Boosting.**

1.INTRODUCTION

Brain MRI is taken using a scanner which has strong magnets built-in which produces magnetic field and radio waves that scan patient's brain to produce high quality images. These images contain attributes like echo time, repetition time, inversion time, slice information, flip angle etc. which help doctor find whether that patient is suffering from any brain related diseases or not.

In this paper, authors have studied various classification algorithms to classify the brain MRI images as normal or abnormal. From the study it was observed that before applying classification algorithms, some image processing techniques were applied on the MRI images.

2. Literature Review

One of the paper suggests an approach which classifies the given MRI image into two types, Normal and abnormal. This classification is done by first preprocessing the given image then calculating grey level coordinate matrix and retrieving statistical features using GLCM. This technique uses slicing methodology to scan various parts of brain. Depending on given values, the input vector is created which is classified using neural networks and training is done using Scale Conjugate Decent Gradient Algorithm providing optimal results for moderate size data. This approach achieves a result of 100% accuracy over classification of Brain MRI images to normal and abnormal.[6]

In another two stage system, first the given MRI image is taken as input, preprocessing is carried out to extract important features. After that, FP tree algorithm is used in order to discover association rules among the features extracted from the MRI database and the category to which each image belong. The classification algorithms used here are 1) Naive Bayes which provides 88.2% accuracy and 2) Decision tree which provides 91% accuracy of classifying image into two types i.e. normal and abnormal. [7]

Another methodology which pre-processes the given MRI image and divides the parameters into three main features. First is Edge Detection used for analysis to derive similarity criterion for a pre-determined object. Second is gray parameter and third is Contrast parameter used to characterize the extent of variation in pixel intensity. Segmentation of Region of Interest is used to analyse the resultant 2D image and determine the results. This methodology shows better results than manual segmentation.[8]

A methodology in which the given MRI image is taken as input and normalisation is carried out to extract important features based on 1)Shape 2)Intensity and 3)Texture. Then one of the feature selection i.e forward selection or backward selection is used for classification which can be either Principle Component Analysis(PCA) or linear Discriminant Analysis(LDA). This method shows 98.77% accuracy.[9]

In one of the method, system texture features are extracted from the scanned image with the help of Gray level co-occurrence matrix (GLCM) and then the image is classified into normal or abnormal using Probabilistic Neural Network (PNN) classifier and then the tumour is located exactly in the image using segmentation technique and morphological operations. The system is 88.2% accurate.[10]

An efficient algorithm for tumour detection based on segmentation of brain MRI images using K-Means clustering. The proposed brain tumour detection comprises three steps: image acquisition, pre-processing, and K-Means clustering. MRI scans of the human brain forms the input images for the system where the grayscale MRI input images are given as the input. The pre-processing stage will convert the RGB input image to grayscale. Noise present if any, will be removed using a median filter. The image is sharpened using Gaussian filtering mask. The preprocessed image is given for image segmentation using K-Means clustering algorithm.[11]

Fuzzy logic technique needs less convergence time but it depends on trial and error method in selecting either the fuzzy membership functions or the fuzzy rules. These problems are overcome by the hybrid model namely, neuro-fuzzy model. The system removes essential requirements since it includes the advantages of both the ANN and the fuzzy logic systems. In the paper the classification of different brain images using Adaptive neuro-fuzzy inference systems (ANFIS technology). The proposed hybrid systems have wider scope/acceptability and presents dual advantages of a type-2 fuzzy logic based decision support using ANN techniques. this technique increases accuracy.[12]

The method employed in one of the paper can segregate the given MRI images of brain into images of brain captured with respect to ventricular region and images of brain captured with respect to eye ball region. First, the given MRI image of brain is segmented using Particle Swarm Optimization (PSO) algorithm, which is an optimized algorithm for MRI image segmentation. The algorithm proposed in the paper is then applied on the segmented image. The algorithm detects whether the image consist of a ventricular region or an eye ball region and classifies it accordingly.[13]

A hybrid intelligent machine learning technique for automatic classification of brain magnetic resonance images is presented. The proposed multistage technique involves the following computational methods, Otsu's method for skull removal, Fuzzy Inference System for image enhancement, Modified Fuzzy C Means with the Optimized Ant Colony System for image segmentation, Second Order Statistical Analysis and Wavelet Transform Method for feature extraction and the Feed Forward back-propagation neural network to classify inputs into normal or abnormal. The experiments were carried out on 200 images consisting of 100 normal and 100 abnormal (malignant and benign tumors) from a real human brain MRI data set. Experimental results indicate that the proposed algorithm achieves high classification rate and outperforms recently introduced methods while it needs a least number of features for classification.[14]

The system consists of 2 stages namely feature extraction and classification. In the first stage features related to the mri images are obtained using discrete wavelet transformation (DWT). The features extracted using DWT of magnetic resonance images have been reduced, using principal component analysis (PCA), to the more essential features. In the classification stage, two classifiers have been developed. The first classifier is based on feed forward back propagation artificial neural network (FP-ANN) and the second classifier is based on k-nearest neighbour (k-NN). The features hence derived are used to train a neural network based binary classifier, which can automatically infer whether the image is that of a normal brain or a pathological brain, suffering from brain lesion. A classification with a success of 90% and 99% has been obtained by FP-ANN and k-NN, respectively.[15]

Technique of Rajasekaran and Pai (sBAM) was found to give most successful results of classifying tumour into their correct classes. The computation time taken by sBAM was also less as compared with other algorithms. sBAM technique wasn't tested on brain tumour MR images before but when it is subjected to test, it provided prominent results. The success rate of sBAM was also relatively high with its counterparts.[16]

Automatic hybrid image segmentation model that integrates the modified statistical expectation maximization (EM) method and the spatial information combined with Support Vector Machines (SVM). To improve the overall segmentation performance different types of information are integrated in this study, which is, voxel location, textural features, MR intensity and relationship with neighboring voxels. The modified EM method is used for intensity based classification as an initial segmentation stage. Secondly simple and beneficial features are extracted from target area of segmented image using gray-level cooccurrence matrix (GLCM) technique. Subsequently, Support Vector Machine (SVM) is applied to rank and classify computed features from the extracted features, which is an enhancement step. The experimental results have indicated that the proposed method achieves higher kappa indexes compared with other methods currently in use.[17]

The features related to MRI images using discrete wavelet transformation. An advanced kernel based techniques such as Support Vector Machine (SVM) for the classification of volume of MRI data as normal and abnormal is deployed. SVM is a binary classification method that takes as input labeled data from two classes and outputs a model file for classifying new unlabeled/labeled data into one of two classes. It is proved that this kennel technique helps to get more accurate result. SVM actually cannot work accurately for a large data due to the training complexity of SVM itself which is highly dependent on the size of data. Several testing have been done with some Brain MRI images. The classification results with RBF kernel has got an accuracy of 65%.[18]

In one paper , intellectual classification system is used to recognize normal and abnormal MRI brain images. Image preprocessing is used to improve the quality of images. Median filter is used to remove noises while retaining as much as possible the important signal features. Skull masking is used to remove non-brain from MRI brain image. For skull masking morphological operation is used. Morphological operation is followed by region filling and power law transformation for image enrichment. Skull masked image is used to extract features. The classification process is divided into two parts i.e. the training and the testing part. Firstly, in the training part known data (i.e. 28 features * 46 images) are given to the classifier for training. Secondly, in the testing part, 50 images are given to the classifier and the classification is performed by using SVM and SVM-KNN after training the part. SVM with Quadratic kernel achieved maximum of 96% classification accuracy and Hybrid classifier (SVM-KNN) achieved 98% classification accuracy rate on the same test set.[19]

A hybrid approach for classification of brain tissues in magnetic resonance images (MRI) as normal or abnormal based on genetic algorithm (GA) and support vector machine (SVM) is presented. SVM is based on the structural risk minimization principle from the statistical learning theory. Its kernel is to control the empirical risk and classification capacity in order to maximize the margin between the classes and minimize the true costs The inputs to the SVM algorithm are the feature subset selected using GA during data pre-processing step and extracted using the SGLDM method. In the classification step, the RBF kernel is chosen and the technique used to fix its optimal parameters is a grid search using a cross-validation. The experimental results show that the accuracy rate varies from 94.44 to 98.14 %. The approach is limited by the fact that it necessitates fresh training each time whenever there is a change in image database. [20]

3. Proposed System

The proposed system uses Decision tree classification algorithm for analysis and prediction. Decision tree builds classification or regression models in the form of a tree structure. It breaks down a dataset into smaller and smaller subsets while at the same time an associated decision tree is incrementally developed. The final result is a tree with decision nodes and leaf nodes. A decision node (e.g., Outlook) has two or more branches (e.g., Sunny, Overcast and Rainy). Leaf node (e.g., Play) represents a classification or decision. The topmost decision node in a tree which corresponds to the best predictor called root node. Decision trees can handle both categorical and numerical data.

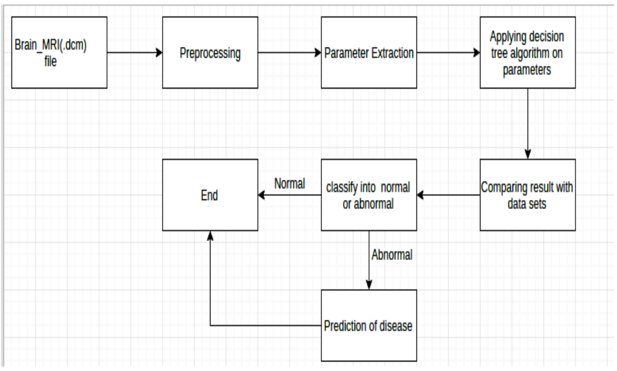

Fig -1: Block diagram of proposed system

To overcome the above limitations, we propose the use of Adaptive boosting or Gradient Boosting technique. These methods combine many types of learning algorithms to improve the system's performance. Once outputs are obtained, they are combined into weighted sum that represents final output of boosted classifier. AdaBoost is adaptive in the sense that subsequent weak learners are tweaked in favor of those instances misclassified by previous classifiers. AdaBoost is sensitive to noisy data and outliers. In some problems it can be less susceptible to the over fitting problem than other learning algorithms. The individual learners can be weak, but as long as the performance of each one is slightly better than random guessing (e.g., their error rate is smaller than 0.5 for binary classification), the final model can be proven to converge to a strong learner. Gradient boosting is a machine learning technique for regression and classification problems, which produces a prediction model in the form of an ensemble of weak prediction models, typically decision trees. It builds the model in a stage-wise fashion like other boosting methods do, and it generalizes them by allowing optimization of an arbitrary differentiable loss function.

4. CONCLUSIONS

This paper gives an overview of various techniques for classifying brain MRI images. Authors of this paper suggest use of Adaboost/Gradient boosting along with Decision tree classification algorithm. This allows analysis and prediction of brain MRI images at faster rate and provides accurate results in minimum time frame than other methods. Decision tree allows analysis of historical data from data-sets which helps doctor to easily predict the condition of brain.

5. Future Scope

The accuracy of the system is increased with the help of boosting method.The System can be made more intelligent by addition of several other diseases and including more MRI images.

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