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MACHINE LEARNING BASED TECHNIQUES FOR BRAIN TUMOR ANALYSIS: A REVIEW

Boto A Ayemi, Sabhya Rai, Dibya Jyoti Bora

[1,2] *PG Student Department Of Information Technology, School of Computing Sciences, KazirangaUniversity,Assam,India*
[3] *Department Of Information Technology, School of Computing Sciences, KazirangaUniversity,Assam,India*

***Abstract*: This paper is prepared with the aim to come up with a more accurate and less time consuming technique for detecting and classifying Brain tumor using machine learning algorithm. By studying and analyzing the previous various papers published during the recent years and studying each of the proposed systems we will be able to find which matching learning algorithm is more accurate and is less time consuming .This paper will also focus on the various image segmentation techniques, features extraction, image filtering, image normalization and nose deduction techniques in MRI Images through which we get better results.**

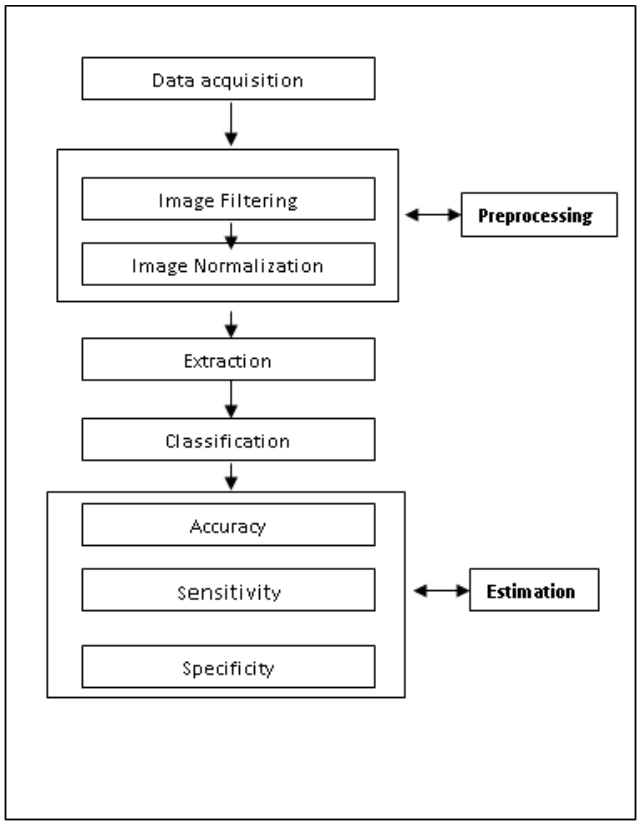
Keywords: Brain Tumor, Machine Learning, Machine learning algorithms, image segmentation techniques, features extraction, image filtering, image normalization and nose deduction techniques, MRI Images.

I. Introduction

Brain Tumor is the uncontrollably shaped abnormal group of cells that can threaten the life of the person, as the brain is the body's essential organ. Brain tumors are of two kinds, Benign (non-cancerous) and Malignant (cancerous) kinds.

The use of an impeccable and automated tumor detection machine learning algorithm is essential to help the physician identify the classification and nature of the tumor. MRI (Magnetic Resonance Imaging) is medical imagery that uses powerful magnetic fields and radio waves.
MRI offers Brain Tumor presence or in-depth data. Image segmentation is the process of dividing an image onto several segments (sets of pixels, also referred to as super-pixels) with the aim of making the image representation easier and more meaningful to analyze. Clustering is used in brain imaging process and analysis for various functions, including brain and tissue segmentation (gray matter, white matter, and brain fluid) and atrophy clustering in various areas of your brain. Image filters are helpful for many applications such as smoothing, sharpening, noise removal and edge detection. A Normalization algorithm adjusts each scan's distribution to match the selected basic scan to enhance picture resemblance and promote MR picture comparability among MRI scans. The Machine Learning Algorithm is used to classify and compare the performance of the MR picture of the brain tumor.

Steps and procedurals for detection and classification of Tumor in brain MRI image:



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II. Literature Review

Some state of the art work relevant to the proposed work is discussed in this section.

Sharma et al. [1] propose system which apply Gray Level Co-occurrence Matrix (GLCM) for extraction of features, Multi-Layer Perceptron and Naïve Bayes is used for classification with maximum accuracy of 98.6% and 91.6% respectively, additionally referenced that the accuracy of the system could probably be improved by considering a larger data set and extracting intensity based features with texture based features.

Natarajan et al. [2] proposed method using Median filter for the preprocessing of the Brian MRI image, for segmentation applied threshold segmentation and morphological operations and then the image subtraction technique is used to get the region of interest in the brain MRI image.

Joshi et al. [3] proposed a system for detection and classification of tumor in Brain MR Images. Firstly extract the tumor region from the brain MRI, then Gray Level Co-occurrence Matrix (GLCM) is used for extracting the texture features and then using neuro-fuzzy classifier tumor is classified.

Amin and Mageed [4] proposed a system using neural network and segmentation base system to automatically detect the tumor in brain MRI image. Principal Component Analysis (PCA) is used for the extraction and then Multi-Layer Perceptron (MLP) is used for classification for detection of tumor in the brain MRI image.

George and Karnan [5] proposed preprocessing approaches to enhance Brian MRI image. The label are firstly removed from the MRI image and then Median Filter, Histogram Equalization and Center Weighted Median (CWM) filter are applied to remove noise and for the enhancement of the Brian MRI high frequency components removal.

SharmilaAgnal A et al. [6] the study showed that the system can be achieved 100% accuracy even with a very small dataset of 121 training samples. For better output factors to work upon are feature extraction algorithms, data preprocessing and larger datasets. In terms of overall performance and 5-fold cross validation of the proposed system, it outshone the existing system with an 80.3% and 88.8% respectively.

DibyaJyoti Bora et al. [7]proposed that selection of a clustering algorithm is purely depend on the purpose of clustering application and type of data working on. K-means algorithm was suitable for task like exclusive clustering whereas fuzzy clustering algorithms were suitable for overlapping clustering task. Comparing their computational time it was found that the K-means algorithm was faster as compared with fuzzy clustering algorithm and the complexity of the fuzzy clustering algorithm is higher to that of K-means algorithm.

Rajeshwari and Sharmila [8] proposed pre-processing techniques used to improve the quality of MRI image before using it. For noise removal the average, median and wiener filters are used. Resolution enhancement is done by the interpolation based Discrete Wavelet Transform (DWT) technique. Applying Peak Signal to Noise Ratio (PSNR), evaluation of these techniques is done.

Sanjeev Kumar et al. [9] proposed a hybrid approach for classification of tumor in a brain MRI image, which will reduce the time for manual labeling and overcome human errors. DWT (Discrete Wavelet Transform) for the feature extraction and Principal Component Analysis (PCA) for feature reduction and for classification they have used Support Vector Machine (SVM).

Sukomal Mehta1 et al. [10] Proposed a fuzzy-based median filter for de-noising impulsive noise from an image, this method gives a clearer and better image quality as compared with the standard median filter.

Shasidhar et al. in [11] proposed modified Fuzzy C-Means (FCM) algorithm for segmentation of brain MRI image. The modified FCM algorithm is a fast alternative to the traditional FCM technique.

Rajesh and Malar [12] proposed brain MRI image classification based on Rough set theory and Feed-Forward Neural Network classifier. The MRI images features are extracted applying Rough set theory. The features extracted acts as the input for Feed Forward Neural Network classifier which classifies the brain. The accuracy of about 90% is obtained.

Y. Zhang et al. [13] proposed a hybrid technique of SCABC-FNN classifier and obtained 100% classification accuracy on image data set of T2weighted-brain MRI. Discrete Wavelet Transformation for extracting main features of MR Images and to minimize the size of the feature extracted the Principal Component Analysis (PCA) was applied. Based on fitness scaling strategy and chaotic theory, In Forward Neural Network (FNN) parameters are updated using enhanced exercise Scaling Chaotic Artificial Bee Colony (SCABC) algorithm. The system shows 100% accuracy.

JankiNaik et al. [14] worked on two algorithms, Naïve Bayesian and Decision Tree for classifying the medical images for diagnosis. Decision Tree classifier shows an accuracy of 96% and sensitivity of 93%.The measures concerned are pre-processing, feature reduction, association

rule mining and classification. Some cancer identification tests are conducted here with MRI images. The median filtering process is used for pre-processing. The extracted features are used to mine the association rule. The suggested technique increases the identification effectiveness of CT scan images rather than the traditional technique.

Y. Zhang et al. [15] proposed a novel method for classification of brain MRI images by using SVM and DWT (Discrete Wavelet Transform). To reduce the features extracted by Wavelet Transform method PCA (Principal Component Analysis) is used. These techniques were used to diagnose Alzheimer's illness with four distinct kernels and only with 160 MR brain images reach a cumulative accuracy of 99.38% in GRB kernel.

Gadpayleand and Mahajani [16] proposed Brain tumor detection technique by performing segmentation and GLCM for feature extraction. The classification is done by BPNN and KNN classifier to determine types of tumor. The accuracy of KNN and BPNN classifier is 70% and 72.5% respectively.

Ibrahim et al. in [17] proposed technique of the Neural Network for classifying magnetic resonance images of human brain. The features are extracted using Principal Component Analysis (PCA). After that Back-Propagation Neural Network classifies MRI brain images as normal or abnormal. The accuracy of classification is about 96.33%.

Sapra et al. [18] proposed technique for image segmentation to detect brain tumor from MRI images and then use Probabilistic Neural Network (PNN)for automated brain tumor classification. Proposed PNN technique handle the brain tumor classification process more accurately.

Daljit Singh et al. in [19] proposed a hybrid technique for automated classification of MRI images uses Gray-level Co-occurrence Matrix (GLCM) and Principal Component Analysis (PCA) for extracting feature and extracted features are classified by Support Vector Machine (SVM) as normal and abnormal brain image.

Xuan and Liao [20] proposed tumor segmentation technique based on statistical structure analysis. The feature based on intensity, symmetry and texture are extracted from MR image. AdaBoost is then used to classify the MR image into normal and abnormal brain images. The total accuracy achieved is around 96.82%.

Uchita and Lalit [21] proposed unsupervised MRI brain-classification neural network learning technique. The MRI brain images are first pre-processed including the removal of the noise edge detection and segmentation of the tumor. Self-Organizing Maps (SOM) are used to classify the brain as normal or abnormal, i.e. whether or not it contains tumor. The Gray-Level Co-occurrence Matrix (GLCM) and then Self organization Maps (SOM) are used in the texture.

Vijaya Kumar Sagenela et al. [22] proposed FMIINR (Fuzzy Mean Filter for Immense Impulse Noise Removal) that can also restore 90 percent damaged pixel. As mentioned, filter noise is done with the function of the triangle membership and the classic mean filter reconstructs. The filter reveals the shocking quality for 90% of the damaged image. We can therefore say that FMIINR filter can also be deployed for real-time applications. For medical images it is very useful. It can also be used for SAR photo picture noise or de-noise.

Bahadure et al.[23] proposed Image analysis for MRI identification of brain tumors by using BWT and SVM methods. In this technique, 96.51% precision was accomplished by cutting skulls, eliminated for tracking purposes all non-brain tissues.

J.Kalpana Devi1 et al.[24]paper focus on the effective image filter algorithms using median, wieners and fuzzy filters. This paper suggested an Adaptive Median Filter to reduce the likelihood of detecting the impulsive noise as healthy pixel and noisy pixels as healthy. In case of the median filter if the impulse noise's spatial density is low or not large it works but the adaptive median filter can even deal impulsive noise that are even higher than 0.2.

III. Proposed Methodology

Following are the major steps involved in the proposed methodology:

1. **Data Acquisition**
   The most important phase of the system, the data that have been acquired during research plays a very vital role as the accuracy, efficiency and performance depends on the real world row data

2. **Pre-processing**
   The main objective of the pre-processing is to convert the incomplete and inconsistent real world data into feasible data for analysis for achieving better result.

   2.1. Fuzzy Median Filter
   Fuzzy Median Filter is non-linear tool for de-noising signal such as images. It actually removes the noise from the image unlike Mean Filter which only spread the noise evenly

3. **Segmentation**
   The separating and studying of an individual pixel in an image so as to identify each pixel uniquely through their pixel values is known as segmentation. This step is carried out to extract the features of the image through the pixel values.

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3.1. Fuzzy clustering algorithm

Fuzzy clustering algorithm is a segmentation technique, which uses fuzzy sets for clustering the pixels of an image.

4. Feature Extraction and Dimensionality Reduction :

After the image has been segmented, we extract the feature of the image through the pixels value of the image.

Dimensionality reduction is a method which reduces the initial set of raw data into non-redundant and more relevant information.

4.1. DWT(Discrete Wavelet Transform)

DWT is a feature extraction technique which is widely used and preferred due to its ability to preserve the signal information, such as frequency information of the image and also the time information of the image.

4.2. PCA (Principal Component Analysis)

Principal Component Analysis removes the problem of over fitting as the Principal Components are orthogonal in nature i.e., independent of one another. It also improves the algorithmic performance. PCA is used for dimensionality reduction.

5. Classification:

Classification categorizing given set of reduced data set into specific class to identify which class a new observation belongs.

5.1. Kernel SVM

Support Vector Machine (SVM) segregates the input data set with the help of maximum marginal hyper-plane between the support vectors into two categories.

In SVM, Kernel trick is used by taking a lower dimensional input space and transferring it into a higher dimensional space i.e., it convert non-separable problem into separable problem.

Types of K-SVM:

1) RBF Kernel (Radial Basis Function)
2) Linear Kernel
3) Polynomial Kernel
4) Quadratic Kernel

5.2. Multi-class SVM

Multi-class SVM segregates more than two classes; each sample is assigned to a specific class. The given data will belong to the class with higher decision value.

V. Conclusion

This paper studies and analyze the existing system and have suggested some techniques which provide better results than the other techniques.

By going through the mentioned research works and performing the analytical study, we have seen that there exists various techniques and method through which we can detect and classify between normal and abnormal brain tumor and non-tumor brain from a brain MRI image. As per our understanding and analysis we have chosen the base algorithm as the one which is showing the best results and output from the above works.

Following are the techniques we found most effective:

[1] Fuzzy median filter : For image filtering
[2] Fuzzy Clustering Algorithm : For image segmentation
[3] DWT and PCA : For feature extraction and deduction
[4] KSVM : For classification of normal and abnormal brain
[5] Multi SVM : For classification of Tumor

To determine whether the brain is normal or abnormal, we should not only focus on the machine learning algorithm for classification but also all the preprocessing steps involved there. The brain MRI image should be well filtered and free of noise and clear at the same time, features texture of the MRI brain image should be highly extracted, and image segmentation techniques must be chosen according to the types of data involved. By following these procedures, one can build a system that can be claimed as highly accurate one.

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