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An Optimized Method for detecting Brain Tumour using Two-Tier Classifier with Neural Network and Adaptive Segmentation Technique

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Abstract:

Brain tumour is the mass tissue and obsolute identification of brain tumor using MRI image is difficult at all times. Our proposed model is to design a system that is capable of processing the MRI image to identify the defective part. This model uses K-means algorithm for image segmentation and two-tier approach for image classification. In two-tier classification, the first phase is used to handle the featured in each part of MRI image. In second phase is dissimilarities are scruntinized. In classification, additionally we use ANN algorithm to detect abnormal parts in image. ANN algorithm is highly efficient and effective algorithm for pattern recognition.ANN is detect complex nonlinear relationship between dependent and independent variables and includes multiple training algorithm. Another new approach is to use PSO (particle swarm optimization) algorithm, PSO has a higher optimization ability to provide a accurate result and also improve efficiency.

I Introduction

Medical image analysis is one of the most critical studies in the field of medicine. Medical imaging is the general name given to the group of techniques and processes developed for creating anatomical or functional images of human body, which are used for both clinical and scientific purposes . Moreover, recent improvements in the imaging analysis and medical image processing provided a significant reduction in the requirement for crucial invasive intervention in treatment of various diseases or abnormalities . A brain tumour is an intracranial solid neoplasm which is defined as an abnormal growth of cells within the brain or the central spinal canal . Brain tumours can be malignant (cancerous) or benign (non-cancerous) . Low grade gliomas and meningiomas are benign tumours, and glioblastoma multiforme is a malignant tumour which represents the most common primary brain neoplasm. Benign brain tumours have a homogeneous structure which did not contain cancer cells and they may be either radio logically monitored or

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completely removed surgically and they do not persist again. The structure of malignant brain tumours is heterogeneous and it contains cancer cells which can be treated with radiotherapy, chemotherapy or a combination thereof, and they are life threatening. Therefore, diagnosing the brain tumours in an appropriate time is very essential for further treatments . Neurology and basic neuroscience have been significantly advanced by utilising imaging tools that enable in vivo monitoring of the brain .

Brain tumors are not a very common disease in the society, but are among the most fatal cancers. The causes of brain cancer are still largely unknown. Early detections of brain tumors are difficult because the brain is covered by the skull, and the tumors do not exhibit very specific clinical symptoms. brain tumours have a homogeneous structure which did not contain cancer cells and they may be either radio logically monitored or completely removed surgically and they do not persist again.MRI plays a vital role in detecting brain abnormalities by determining the size and location of affected tissues. Computer aided diagnosis system is required to avoid human based diagnostic error.

In the proposed system , initially use two-tier classification technique to preprocess the brain MRI image to eliminate the noise and stripping the skull from the brain MRI image and the pre-processed image is segmented by adaptive pillar K-means clustering algorithm.. For tumour classification, Artificial Neural Network (ANN) classification algorithm is used. ANN is highly efficient and effective algorithm for pattern recognition. Particle Swarm Optimization (PSO) Technique can be used to optimize the image and produce accurate results. PSO has a higher optimization ability.

The rest of the paper is organised as follows. Section 2 reviews previous works related to the automatic classification of normal versus abnormal images in the context of brain magnetic (MR) resonance imaging. Section 3 describes the proposed system for adaptive pillar k-means segmentation and brain MRI tumour classification using two-tier classifier Section 4 presents experimental results and comparative analysis of the proposed system. Finally Section 5 draws the conclusions and gives future work to be done.

II Related Work

Jobin Christ M.C. , Dr. Parvathi R.M.S, [1] This paper presented a fully automatic method to segment brain tumors and edema. Segmentation method quantitatively evaluates the performance of 4 different types of Alignment-Based (AB) features encoding spatial anatomic information for use in supervised pixel classification. This method used a soft-margin Support Vector Machine (SVM) trained using the SVM light optimization strategy, to identify brain tumor.

V.P.Gladis Pushpa Rathi , Dr.S.Palani,[2] This paper uses PCA and Linear Discriminant Analysis (LDA) techniques that are applied on the training sets. The Support Vector Machine (SVM) classifier served as a comparison of nonlinear techniques Vs linear ones.

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Jagadeesh D. Pujari , Rajesh Yakkundimath , Abdulmunaf S. Byadgi,[3] This paper describes Support Vector Machine (SVM) and Artificial Neural Network (ANN) based recognition and classification of visual symptoms affected by fungal disease. Color images of fungal disease symptoms affected on cereals like wheat, maize and jowar are used in this work. The affected regions are segmented using k-means segmentation technique. Color texture features are extracted from affected regions and then used as inputs to SVM and ANN classifiers.

Prof.B.K.Saptalakar, Rajeshwari,[4] This paper describes the detection of the brain tumor by segmentation and extraction of the detected tumor region by filling the tumor region with holes. Image segmentation becomes more significant while normally dealing with medical images. These technique can be efficiently applied to detect and extract the brain tumor from MRI images obtained from patient's data base.

Vishakha V. Hambire, Dr. S. R. GanorkarProfessor,[6] This paper describes automatic hierarchical procedure to classify and stage liver disease using ultrasound images . Initially the contrast enhancement is applied to the input image that helps to identify the object, after that discrete wavelet transform is applied. The classification strategy is performed using the classifier such as Neural Network. It is used to analyze the Liver disease.

Hakeem Aejaz Aslam, Tirumala Ramashri, Mohammed Imtiaz Ali Ahsan [7] This paper presents a new approach to image segmentation using Pillar K-means algorithm. This segmentation method includes a new mechanism for grouping the elements of high resolution images in order to improve accuracy and reduce the computation time. The system uses K-means for image segmentation optimized by the algorithm after Pillar. This algorithm is able to optimize the K-means clustering for image segmentation in the aspects of accuracy and computation time.

Dian PalupiRini, SitiMariyam Shamsuddin, SitiSophiyati Yuhaniz,[9] Particle Swarm Optimization (PSO) is a biologically inspired computational search and optimization method. A number of basic variations have been developed due to improve speed of convergence and quality of solution found by the PSO.PSO is more appropriate to process static, simple optimization problem.

III Problem Statement

In existing system uses Self-Organizing Maps(SOM) technique for clustering and KNN (K-Nearest Neighbour) algorithm for classification. It's not effective one . The number of clusters needs to be specified . This is a major problem in clustering. In proposed system we use ANN(Artificial Neural Network) for classification and Particle Swarm Optimization (PSO) technique for clustering and produce optimized result. Neural networks are a computational approach which is based on a large collection of neural units to solve biological brain problems.PSO is effective in nonlinear optimization problems and also easy to implement.

IV Existing System

Existing system use adaptive pillar K-means for MRI segmentation and a two-tier classifier to classify tumours.

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Initially, preprocessing the brain MRI to remove noise and stripping skull form the image, then the segmentation process is done on the enhanced image by adaptive pillar k means. Crucial features are extracted from the segmented image using DWT combination. Finally the extracted features are trained and classified by two-tier classifier system.. In two-tier classification method the SOM neural network classifier initially trains the extracted features and subsequently, the KNN classifier trains the features. The most important benefit of two-tier classification is better final distortion and produces deterministic reproducible results.

V Proposed System:

The basic purpose of this paper is to show the tumor region. In this paper, we are implementing the system for brain tumor detection from MRI images, the malignant or benign tumor region we will find by this system. The complete system includes preprocessing of MRI, skull removing and segmentation by k-means algorithm, also feature extracted and using PSO to trained a MRI image . In the testing part we are passing the parameter to perform above operation and then using training MRI image compare with testing MRI image by Speedup Neural network. At final , produce whether testing MRI is normal or abnormal and it produce a accurate results compare to existing system.

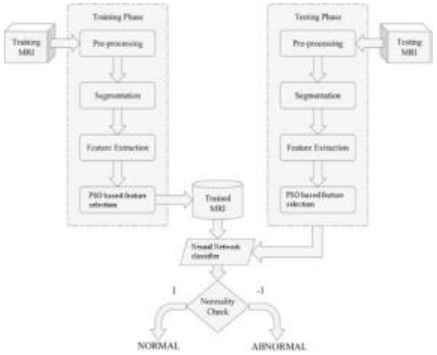

Figure:1 System design of proposed work

Edge Detection Technique:

Edge detection is an image processing technique for finding the boundaries of objects within images .It is a process of locating an edge of an image. Detection of edges in an image is a very important step towards understanding image features. Edges consist of meaningful features and contain significant information. It significantly reduces the image size and filters out information that may be regarded as less relevant, thus preserving the important structural properties of an image.

1.Pre-processing of brain MRI:

Brain MRIs are degraded during the process of imaging due to image transmission and image digitisation by noise and existence of extra-cranial tissues in MRI such as Skull, bone, skin, air, muscles, and fat. Preprocessing is a procedure to eliminate these noises and extra-cranial tissues from the Brain MRI and alters the heterogeneous image into homogeneous image. Though there are lots of filters which have been used for filtering the images, some Fig. 1 System design of proposed work .Sometimes it corrupt the miniature details of the image and some conventional filters will process the image incessantly and consequently harden the edges of the image. Hence, the proposed pre-processing steps namely De-noising and skull stripping provide better Image clarity.

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1. **De-noising**: In the pre-processing of brain MRI, the noise will be removed by utilising the non-local mean filter which does not update a pixel's value with an average of the pixels around it, instead updates it using a weighted average of the pixels judged to be most kindred. The weight of each pixel depends on the distance between its intensity grey level vector and that of the target pixel. De-noised image of each pixel i of the non-local means is computed.

$N(i, j) = j[Dw(i, j)D(i, j)]$ where, j is the noisy image and N is the de-noised image, and weights w(i, j) meet the following conditions $0 \leq w(i, j) \leq 1$. Each pixel is a weighted average of all the pixels in the image which is based on the similarity between the neighbourhoods of pixels i and j.

2. **Skull stripping**: After consummating the de-noising process of the brain MRI, the brain portion is extracted from the skull by utilising skull stripping technique. The skull is surrounded at outer part of the brain, that is, the abstraction of its non-cerebral tissues. Segmentation of the non-cerebral and the intracranial tissues are the main quandary in skull-stripping due to their homogeneity intensities

2. Effective segmentation using adaptive pillar K-means algorithm: Identifying the cardinal tissue structures accurately from brain MRI is the major goal of the brain MRI segmentation. The automatic segmentation has the potential to positively impact the classification process and it aids in diagnosis and disease modelling. Numerous methods are subsist to segment the brain MRI in which K means clustering algorithm is one of the traditional segmentation technique which produces strong sensitivity to outliers and noise. The proposed system uses adaptive pillar k-means algorithm for segmenting brain MRI which overcomes limitation of K means clustering algorithm. The average distance from each data point to its associated cluster centroid ensures the overall quality of clustering. The proposed research is inspired by the performance of the Euclidean distance and its uses; hence adaptive pillar K-means algorithm uses Euclidean distance to determine the distance between an object and its cluster centroid. The main advantage of Euclidean distance is reportedly faster than most other means of determining the correlation and it compares the relationship between actual ratings which means how similar ratings are for specific preferences or items.

3. Feature extraction:

In feature extraction starts from an initial set of measured data and builds derived values (features) intended to be informative and non-redundant, facilitating the subsequent learning and generalization steps, and in some cases leading to better human interpretations. Feature extraction is related to dimensionality reduction. Feature extraction involves reducing the amount of resources required to describe a large set of data. When performing analysis of complex data one of the major problems stems from the number of variables involved. Analysis with a large number of variables generally requires a large amount of memory and computation power, also it may cause a classification algorithm to overfit to training samples and generalize poorly to new samples. Feature extraction is a general term for methods of constructing combinations of the variables to get around these problems while still describing the data with sufficient accuracy.

a) **GLCM Features**

`graycomatrix` calculates the GLCM from a scaled version of the image. By default, if `I` is a binary image, `graycomatrix` scales the image to two gray-levels. If `I` is an intensity image, `graycomatrix` scales the image to eight gray-levels. You can specify the

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number of gray-levels `graycomatrix` uses to scale the image by using the `'NumLevels'` parameter, and the way that `graycomatrix` scales the values using the `'GrayLimits'` parameter.

4. Feature Selection:

In the group of feature selection methods, the goal is to select a subset of full-informative features from the original set of features. In other words, the removed features should be irrelevant, redundant and useless in the set of original features .Feature selection methods are categorized into four subcategories such as filer, wrapper, embedded and hybrid. PSO is one of the best swarm intelligence-based optimization techniques that was born fromp social behavior of animals such as bird folk and fish swarm. PSO consists of a population of particles in which each particle is a feasible solution in problem space and search the space in order to move toward final best solution by adjusting its path and moving toward the best personal experience and also the best swarm experience.

A.Feature selection step:

The main contribution of this paper is proposed in feature selection step. As the mentioned before, there are several feature extraction methods which are applied for steganalysis problem. Tn this paper, at first, two feature extraction methods, CC-PEV and SPAM, are applied on input image dataset to produce feature vectors with 548 and 686 elements, respectively. Since length of the feature vectors are too long, the storage and computational cost of a steganalysis system will be high, and so, it is necessary to eliminate irrelevant and ineffective feature elements or select full-informative and influential feature elements. The proposed scheme of this paper for feature selection is utilization of PSO which searches the feature space to select the best feature elements.

B. **Fitness function:**

The second innovation of this paper is utilization of AVC measure as the fitness function of PSO. AUC function measure measures the discriminative power of binary classifiers. The input of this function is a particle and its output is a scalar value in range [0 1] in which high AVC value shows the remarkable performance for binary classification. AVC measure is based on Receiver Operating Characteristic (ROC) which is a two dimensional curve to compute the classification accuracy of a binary classifier .The ROC curve is constructed using four variables: True Positive (TP), False Positive (FP), True Negative (TN) and False Positive (FP) where TP is the number of predicted positive cases that are actually positive, TN is the number of predicted negative cases that are actually negative, FP is the number of predicted positive cases that are actually negative and FN is the number of predicted negative cases that are actually positive. Tn ROC curve, the horizontal and vertical and vertical axes which are named Sensitivity and (1 -Specificity) are measured as follows:

$$\textbf{Sensitivity} = \frac{TP}{TP + FN}$$

$$\textbf{Specificity} = \frac{TN}{TN + FP}$$

$$\textbf{Predictivity} = \frac{TP}{TP + FP}$$

5. Neural Network classifier:

ANN Classifier is used to detect candidate circumscribed tumor. ANN'S are networks of interconnected nodes. The input of a specific node is the weighted sum of the output of all the nodes in which it is connected. The output value of a node is, in general, a non-linear function (referred to as the activation function) of its input value. An Artificial Neural Network is an adaptive, most of nonlinear system that learns to perform a function (an input/output map) from data.

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Adaptive means the system parameters are changed during operation, normally called the Learning/Training phase. There have mainly two methods for performing operation in that feed Forward & Back-propagation we had implementing Feed-Forward method where ANN's used in this study consist of one input layer, one or two hidden layers, and one output layer. The Artificial Neural Network is used to adjust the weights such that the error decreases with each iteration and the neural model gets closer and closer to producing the desired output. ANN is an algorithm in this case we have to apply this algorithm on segmented image because of that will get the specified tumor. In this paper we trained the neural network with 60 MRI brain tumor samples.

6. Testing phase of brain MRI:

In the testing phase, each new brain MRI is analysed and its principal features are located and compared with the principal features of trained brain MRI. If some matches were found then the image is classified by the two-tier classifier according to the previously defined rules. Initially, the test query brain MRI is to be received from the user, then preprocessing, segmentation, feature extraction are done as mentioned in the above Sections. Finally, the proposed two-tier classifier used in the training phase. This Image identifier detect the type of image and then it search for the presence of related images in the database. If the related image is found it collect all of them then send both input image and images from database for Preprocessing. By these step noise and extra cranial tissue present in the image are removed.

Then the images are taken to segmentation process for segment the image for accurate identification of the principle tissue structure present in the brain image. Next phase is Feature extraction here features for segmented images are taken for disease detection. Finally in training phase the training samples are collected these are stored in local sub. These stored training samples are utilised in the testing phase for the identification of the availability of disease present in MRI.

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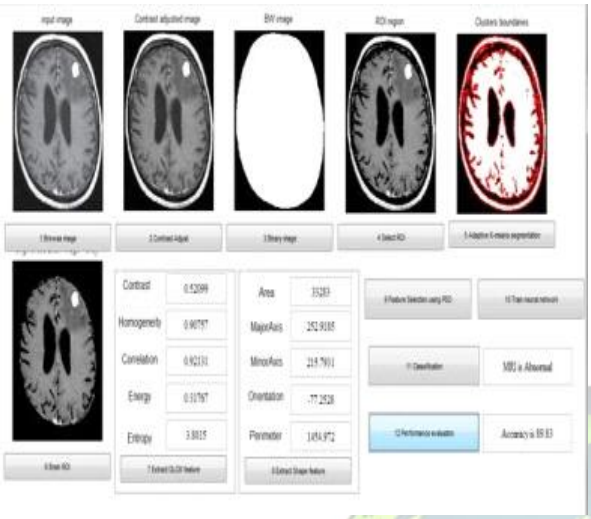
Fig. 3 shows the GUI with cluster image, extracted features value, classified to detect the affected image



VII CONCLUSION

The proposed two-tier classification system with the efficient segmentation technique classifies the normal and abnormal MRI
brain. It is implemented in MATLAB R2014a. The performance of the two-tier classifier system in terms of statistical measures such as sensitivity, specificity and classification accuracy is analysed. The results indicated that the proposed system yielded superior performance when compared with ANN based classification technique. It further suggests that the proposed two-tier classifier is a promising technique for image classification in a medical imaging application and it can be used in computer aided intelligent health care systems. This automated analysis

system could be further used for the classification of images with different pathological condition, types and disease status.

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