Performance Comparison of Soft Computing Schemes for Classification and Detection of Brain Abnormalities in MRI Images

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ABSTRACT
The tumor infection in brain is life dire and the major reason for the death in the present day. Basic objective of neuro medical image analysis of brain abnormalities is very important at the primary stage to extend the life of patient. Brain abnormalities detection and classification is an provocative area in MR images. Recently, the use of computerized knowledge based clinical expert system has been developed. The radiologist facing the challenges of human interpretation of bulk data images. soft computing schemes has been adopted into medical image processing because it has an capability to handle the uncertainties in images. This method has been widely applied for segmentation of images. The soft computing approaches like K-means algorithm, fuzzy C means, Neural network, PSO and PCA have led to increases the system performance and classification rate increases. This paper aims to validate the performance comparison of various soft computing methodologies, Clustering algorithm, Fuzzy C means, K folds algorithm, especially Active Contours with LGDF Energy, PCA and particle swarm optimization with respective parameters. However, a comparative analysis of various algorithms for the image features extraction, selection, segmentation, training and testing of brain images for detection and classification of abnormalities in MR images highlighted in this article.

KEYWORD: MRI, PCA, PSO, NFC, Fuzzy C means.

I. INTRODUCTION:
The Knowledge based information retrieval from medical imaging through soft computing methodologies is now a thriving field for clinical expert system development and researcher. Most of the researcher examine that it is quite tedious to extract the complete information from the medical images with single parameters. The soft computing generating considerable interest in terms of information processing. MRI images are often used in the diagnosis of brain abnormalities due to its remarkable features i.e less computing time, minimum error and suitability with physician & researcher. The computational part of optimization is major problematic. In this computation, It is necessary to minimize the solution to any problem. The given solution can be used to find out the solution to any problem, if after numerous computations, it is clear that given possible solutions were constant. 21st century's clinical researchers and medical engineers sat together on every problem to try to devise systems that can automatically detect diseases. The outcome of these to find out the best set of features and they try to find the best set of features and finally get classifiers for the detection of brain diseases. The system behavior over the changing inputs is largely dependent on the inputs and thus the features used. The human brain is very complex anatomy, it cannot be analyzed by simple imaging technology. The Magnetic resonance Imaging (MRI) technology promising the highest quality image analysis information of the human brain, which is very use full for clinical and biomedical research platform [1-4]. The crux of this proposal is to classify the brain images into normal and abnormal respectively. The abnormal images further classified on the basis of detecting diseases and size of the tumor. Due to adopting stereotype process detection and for classification of the MR images, IT is very difficult to radiologist to predict the disease from the set of MR images, as he is adopting the conventional process for classification of the MR images. The brain MR images provided by the scanner are not providing the detail’s information about the patient's brain, the radiologist is not able to diagnose properly.
In general, to obtain the greater accuracy of brain abnormality classification the supervised methodology adopted. These methodology involve three basic factions to implement classifier as (1) features extraction; (2) feature reduction; and (3) training/testing of classification models. PCA has been introduce to reduce the dimentionality. PSO introduce to optimization with Neural and Fuzzy integrated approach.

It aims to develop techniques which allow a machine to provide solutions & interact with the environment and learn from previous experiments; to exhibit intelligent behavior, the system and adaptive to the demands of the environmental.

**SOFT COMPUTING BASED CLASSIFIER:**
This section focused on the computational capability and intelligence in medical imaging with soft computing approach. Soft computing has an strong learning, cognitive ability and good tolerance of uncertainty and imprecision, which makes wide applications in medical image analysis. these approach followed by fuzzy sets theory, neural networks, k fold fuzzy C means. Combining computational intelligence approaches with medical imaging is undoubtedly a challenging and promising research field. For the betterment of accuracy and performance we develop the hybrid concept of soft computing methodology. The classification based on Neuro fuzzy approach, Feed forward Neural network based and in combination with PCA and PSO has been introduced.

**NEURO FUZZY CLASSIFIER**
Neural networks have proven great strength in solving problems that are not governed by rules. The fault tolerant nature and parallel architecture of the neural network is often utilized to solve the variety of problems in various areas of medical imaging [10,11]. It also find their application in clustering, feature selection, classification, segmentation of imaging in various image processing application.

![Figure 1. Neuro Fuzzy Classifier](image)

The proposed Neuro fuzzy methodology depicted in above figure 1. The MRI images data base of patient has been analyze in primary step with various features extracted from the set of images. The extracted features is the results of DWT preprocessing. The processes of extracting the feature through wavelet are quite complex and time costing. It also increases the size requirement of the storage system. To overcome the basic issue we need to reduce the feature and dimension of the images. This can be effectively done through the Principal component analysis [12]. A PCA is playing a greater role in any classifier. To optimize the database it is necessary to reduce the dimension of the images which also result in less memory. The outcome of phase first used for machine training [13-14]. To overcome the basic issue we need to reduce the feature and dimension of the images. This can be effectively done through the Principal component analysis [12]. A PCA is playing a greater role in any classifier. To optimize the database it is necessary to reduce the dimension of the images which also result in less memory. The outcome of phase first used for machine training [13-14].

**SEGMENTATION WITH ACTIVE COUNTER**
An active contour is used to energy minimization by detecting specific features within an image. It is use to automatic segmentation. figure shows the set of control points connected by straight lines in entire image. It I defined by the number of control points as well as sequence of each other. It analyze the curve and user initialized contour for the result [14].
PSO-FEED FORWARD NEURAL NETWORK CLASSIFIER

The particle proposed concept divided into the basic flow chart. The proposed concept divided into the basic flow chart. It includes Set of input MR images, Feature Extraction, Selection and Reduction and Optimization with neural network i.e., training and testing. Further, it is subdivided into a set of MR images of brain disease, Wavelet transformation for features extraction, Image segmentation and selection of features, reduction of features dimension done through the PCA, optimization done through PSO and testing done through FFNN and finally detection of illness and classification of the tumor. The functionality of this hybrid approach represented in below figure.

Figure .03 PSO and Neural Network Classifier

The primary phase consists of a set of brain MR images of normal and abnormal, Wavelet Transform and Principal component analysis. The data base is a collection of various brain diseases with different patients category like child and adult. The set of all images with various category used to pick out the common features from the magnetic resonance brain images with the help of signal processing wavelet tool especially discreet wavelet transformation (DWT). Reduction of dimension is a task of interrelating components between higher and lower pattern classification (Lotlikar and Kothari, 2000) [15]. The dimension of the images has been analyses for the features mapping. Features extraction through wavelet is somewhat crucial process, it is time and memory costing To overcome the basic issue we need to reduce the feature and dimension of the images. This can be effectively done through the Principal component analysis [16]. PCA is used In the task of extracting features from the image that is given as an input to the system. This results in a finite or manageable number of features use as an input to the classifier. A PCA is playing a greater role in any classifier. To optimize the database, it is necessary to reduce the dimension of the images which also result in less memory. The outcome of phase first used for machine training [17-18].Concerning primary phase, the secondary phase illustrating the testing of the new data base of MR images with the primary
one. This can be done through PSO–FFNN classifier. In a feed-forward neural network, information flows from the inputs to the outputs, without any cycle in their structure. These simple neural networks are easy to work. Still, they have great capabilities for problem-solving. The outputs of these networks are a function of the provided input. The testing of new MR images with a trained set of the database will perform with the help of PSO–FFNN classifier. The selected features take into account for prediction of abnormality in the MR images of the brain. The accuracy of the classifier reaches to high rate with this scheme. Here the hybridization of component concept playing a magical role to sort out limitations of others MR image analysis methodology [19], [26–27].

II. EXPERIMENTAL RESULT & DISCUSSION

The correlation between Fuzzy C means neural network classifier and PSO Feed forward Neural Network classifier has been studded with MATLAB platform. The data base of brain MRI images has been collected from medical diagnostic center and hospital. This section organized with three phases 1) features extraction 2) feature selection and 3) training and testing of environment. There are numerous abnormal and normal brain MRI images used to make database for purpose of training and testing. The first set of analyses highlighted the impact of features extraction with discrete wavelet transformation (DWT) and Segmentation using Active Contours Driven by Local Gaussian Distribution Fitting Energy. The results shown in figure 04 and figure 05. In which the experimental result shows the input image, filtered image, Segmentation using Active Contours Driven by Local Gaussian Distribution Fitting Energy with 400 iterations and total computing time 17.17 sec, it also shows three dimensional view of segmented with fitting energy. Figure 05 represented the DWT PCA based segmentation, in which level-1, level-2 and level-3 of DWT depicted. The output dialog box shown by Figure 6. The counter image and segmented image are presented by figure 7(a) & 7(b) respectively. Neural network rules view of features based value shown by figure 8. On the rule view based selection criteria of various features discussed in above section has been shown by figure 9(a) and total 12 features with their respective value shown by figure 9(b).

The performance of classifier with Neuro fuzzy classifier and PSO–FNN Classifier has been depicted in figure 10(a) and figure 10(b) respectively. It is to be founded that the classifier rate of neuro fuzzy classifier is 90.023% and PSO FNN has 99.33%.

**Figure 04(a).** Neuro Fuzzy classifier & segmentation with active contours driven by LGD of MRI images
Figure 04 (b). Image Segmentation with Neuro Fuzzy PCA

Figure 05 (a) PSO NFC & segmentation with active contours driven by LGD of MRI images

Figure 05(b). Image Segmentation with NFC PCA
Figure 06 Dialog box for both methodology

Figure.07 (a) Counter image of segmented input.

Figure.07 (b) Segmented tumor

Figure.08 Rule base view
Figure. 09(a) Feature selection criteria

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Figure. 09(b) Various Feature Selection from Segmented image.

Figure. 10 (a) Neuro Fuzzy Classifier Rate
The brain MR images of various common daisies have been taken as a database. The system uses a database of 20 images for training purpose. These images are various common brain diseases such as, common brain diseases such as meningioma, Alzheimer’s & visual agnosia as abnormal brain which is shown in figure 4. For testing purpose we are considering two different cases having same diseases, case A, Case B. As per discussed in above methodology section the Discrete wavelet transform used for feature extraction from the brain MR images. The feature extraction and preprocessing on image done by various MATLAB functions. During extraction of features the dimension of the features has been taken care by PCA, it reduces the dimension and size too, causes the cost effective regarding computational time and storage. Figure 5 shows the threshold image for both cases, then process for segmentation, feature selection carried out.

Various thirteen features has been carried out from the set of images, such as Contrast, Correlation, Energy, Homogeneity, Mean, Standard Deviation, Entropy, RMS, Variance Smoothness, Kurtosis, Skewness, Inverse Difference Movement. The feed-forward neural network with PSO presents a remarkable performance and accuracy of system 99.33% during the testing task. All the analytical mathematical analysis examine through MATLAB.

III. CONCLUSION

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REFERENCES


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[27] B. Yegnanarayana, “Artificial Neural Networks”, PHI ,2004


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