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BRAIN ABNORMALITY CLASSIFICATION AND DETECTION BY PARTICLE SWARM OPTIMIZATION-NEURAL NETWORK IN MR BRAIN IMAGES

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ABSTRACT
Knowledge-based medical intelligence system played a key role in the diagnosis of diseases represents crucial role in the design of expert systems in medical diagnosis. The main intention of this proposal is to detect and classification of brain diseases from the Magnetic resonance image. Magnetic Resonance medical image analysis is most important tasks in clinical diagnosis. The abnormalities in brain define by tumor benign and malignant. In the analysis of brain MR images, we review the best methods used for feature extraction and reduction. The proposed method integration of Discrete Wavelet Transform, Principal Component Analysis (PCA), Feed forward neural network Classifier (FFNC) and PSO. The PSO algorithm is contributing towards minimizing the objective. The methodology embraces various mechanisms like features extraction, image segmentation, feature selection and dimension reduction. We considered approaches to design the expert system for diagnosis of abnormalities in the brain. The various basic machine learning algorithm very often used in the artificial neural network. In Proposed hybrid method, feed-forward neural networks based on particle swarm optimization achieve the highest classification accuracy 99.33%. This study brings out the performance analysis of the hybrid system regarding accuracy and computational cost.

KEYWORD: PSO, MR, PCA, FFNC, DWT.

I. INTRODUCTION
In the era of clinical engineering, the Medical expert system is an innovative system that playing a great role in interfacing with artificial world. The current system has good efficiency and performance and adaptive over time. The MRI is one of the most expressive imaging techniques often used in the detection of early stages brain diseases.[1-2] 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. In Brain MRI images, selection of optimal features is difficult. PSO is an evolutionary stochastic optimization technique which promising the great performance and potential to solve the real-time optimization problem.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. An understanding of the features results in better systems that perform the task of detection of brain diseases much better.[3-4] Classification of normal and abnormal Brain MRI is carried out using hybrid classifiers i.e. PSO with feed forward neural network. Here the focus on working on hybrid systems as classifiers. The hybrid systems are a collection of the basic systems of soft computing. These systems make use of a combination of cascade systems to get the added advantages of both systems in use.

The limitation of one system is beaten by the advantage of the other system and vice versa. This causes these systems get prompt for use in soft computing. Classifier systems are no exception; here hybrid systems have been a great boon and have efficiently solved many systems that could not have been solved by the use of single systems. By the use of hybrid systems, we can expect improved performance.[4]

II. Related Work
The various article reviewed for this research, few are

explained below. V. Sheejakumari et.al[2] has proposed work on a classification of tissues with new improved PSO in MRI images. It represent various stages included in basic classification.

Siddiqui et.al[3] presented automated classification system for brain MRI. This article focused on the computerized medical support system for the brain illness. This automated system is designed by the fast DWT, PCA, and LS-SVM method, which gives a promising accuracy in classifying the illness in human brain as normal or abnormal.

III. METHODOLOGY

In this article, we proposed an efficient approach for detection and classification of brain abnormality in MRI images with PSO and Feed forward neural network (FFNN).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 did through FFNN and finally detection of illness and classification of the tumor. The functionality of this hybrid approach represented in below figure no.1.

This approach brings out the information regarding brain illness, especially detection of a particular tumor, their location and the stage of the illness. The system follows the three primary process, Training phase, testing phase and detection & classification of MR images. The first stage consists of a brain diseases MR images, Wavelet Transform and PCA.

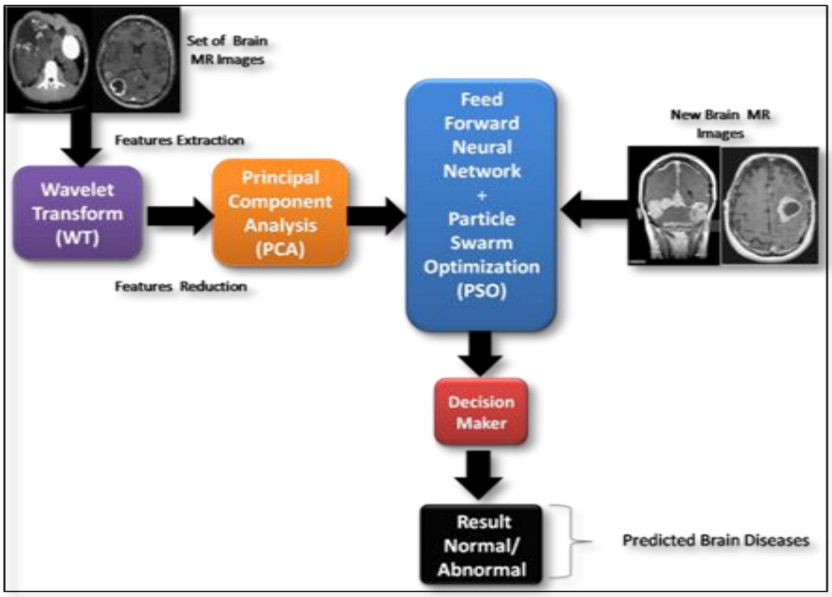

Figure. 1 Proposed PSO-FFNN system.

The various age group has been consider for building the database of common brain diseases. discreet wavelet transformation (DWT) applied To extract the common features from the MR images. Reduction of dimension is a task of interrelating components between higher and lower pattern classification (Lotlikar and Kothari, 2000).[4] It extracts the distinct features and dimension of the numerous set of images. It is quite convoluted and time consuming process. 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. 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.[6-7] Concerning first stage, the second stage depicting the testing of the new data with base one. This can be achieved by PSO-FFNN classifier.

In a feed-forward neural network, information flows from the inputs to the outputs, without any cycle in their structure.

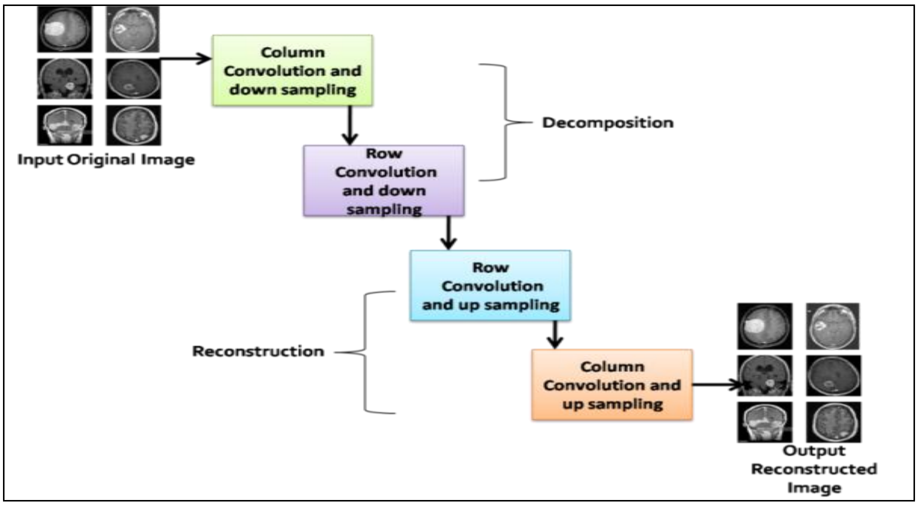

Figure. 2 DWT-based image decomposition and reconstruction

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.[8], [15-16]

IV. FEATURES EXTRACTION AND DIMENSION REDUCTION

Many times we may be required to adopt feature extraction techniques that extract relevant features from the situation that forms the system's input. Here we are following the same principles of acquiring data, preprocessing and selection of features it, and then these extracted features were used for training and testing. The same mechanisms are followed, and similar discussion and treatment of the problems are adopted in these brain tumor illness classification systems. In this Extraction and Selection of features before the classification playing great role and the for the signal processing the multi resolutions analysis tool has been combines with combines discrete wavelet transform (DWT).[6,14] The main benefit of DWT over DFT is in its multi-resolution time-scale analysis ability.

Image segmentation represents an important initial step of image processing. Figure 2 presents Decomposition and Reconstruction of the image through DWT.[19] This also represents an image matrix of multidimensional [g(n,m)]N, M. The high pass filter and low pass filter apply in column and row followed by down sampling and reconstruction of an image.[9][19]

Principal Component Analysis (PCA) is the standard first technique use for the extracted features dimension reduction. This carried out us to linearly project high-dimensional samples into a low-dimensional feature. It selects the best one from the given components. The SIFT used Euclidean distance to resolve corresponding vectors in different images. Where each component has a different level of relevance to the entire vector. The main job of the PCA is to break up the entire high-dimensionality vector into these components for simplification of computation. In PCA-SIFT the requirement of storage is less as compare to DWT. The selection of best components property of PCA by exploiting the redundancy in data allows high-level performance even use of low attributes. This method finds a great deal of application in soft computing based biomedical domains.[10-11]

V. PSO-FFNN CLASSIFIER

PSO has a great potential in feature selection as well as effective computation cost than other approaches and algorithms. It identifying for the minimum solution which applies to the whole problem. It is adaptive in nature in which gradient information is required for evaluation of fitness of the solution.[18] In this more mathematical and systematic approach has been applying for finding the solution. The PSO algorithm analyzes entire space with plotted populations in all dimensional. It finds the minimum solution by tracking the nearest points.

In PSO the same approach of Genetic algorithm has been applied to find global minima. Here, in genetic algorithm the particles moved individually and it was by mutation and crossover operators. In this PSO, systematic approach with the more mathematical and analytical has been applied to finding the solution. The same natures phenomenon of flocking girds has been introduce in PSO.[4][13]

The mathematical set of equations performed on the optimization approach. Assume any particle i at time interval iteration t of speed is given by v_i^t . Let at this instant iteration the particle position be x_i^t and in coming iteration t+1. the updated position and velocity of particle represented by mentioned equations 1 and 2.[4]

$$v_i^{t+1} = v_i^t + c_1 * r * (x_{bi}{}^t - x_i^t) + C_2 * r * (x_g^t - x_i^t) \quad (1)$$

$$x_i^{t+1} = x_i^t + v_i^t \quad (2)$$

Where, C1 and C2 are unity constant. The r is any random number, x_{bi}^t is the best solution up to iteration i and x_{gi}^t is represented the global best solution. By this manner, the algorithm fixed the solution. There may be some particle move toward new points in case of the particle set at any point better than the global point.

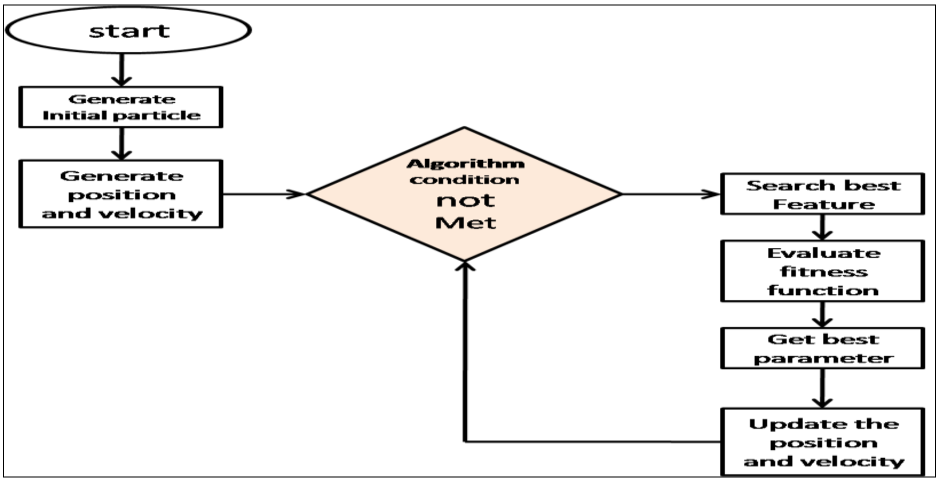

Figure. 3 Particle Swarm Optimization Algorithms

The simple, functional flow chart of PSO algorithm is depicted in figure 3. Here the genetic algorithm approach has been applied for finding the solution. In primary level, the initial set of solutions has been generated and distributed throughout the space. Then each particle assigns the velocity. Furthermore, the parameters i.e., velocity has been updated with iteration applying the mathematical approach. After updating, determine the best position for all particles. There is a continuously moving the particle it get the stop as soon as the algorithm criteria settled. Any particle maximum velocity is fixed, but during the excitation, if it results from more than v_m then it is restricted to v_m.[4]

VI. RESULTS AND DISCUSSION

This section represents the simulated results of NFFNN-PSO classifier. In figure 4 input data base of MRI images shown where as figure 5 and figure 6 depicted threshold and segmented images respectively.

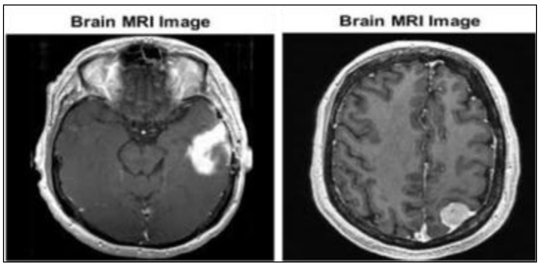

Figure.4 MRI input image case-A case-B

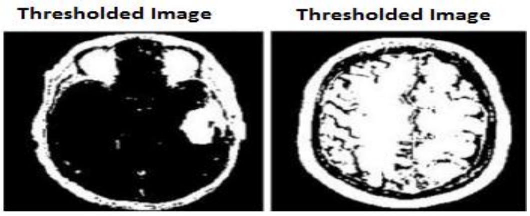

Figure.5 Threshold image case-A case-B

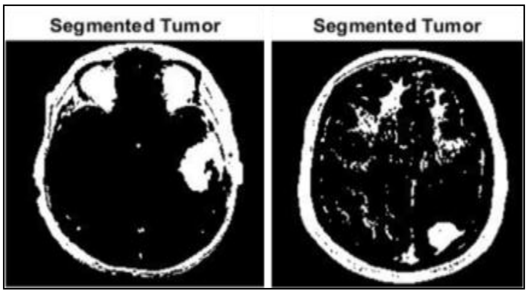

Figure.6 Segmented Image Case A Case B

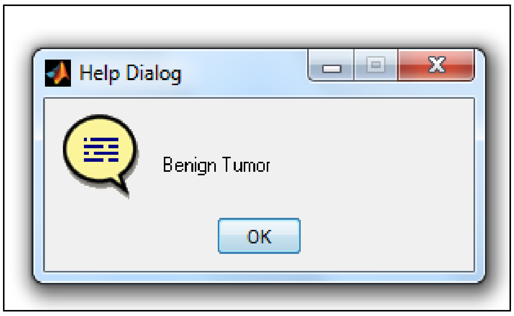

Figure.7 Classifier output dialog box case-A case-B

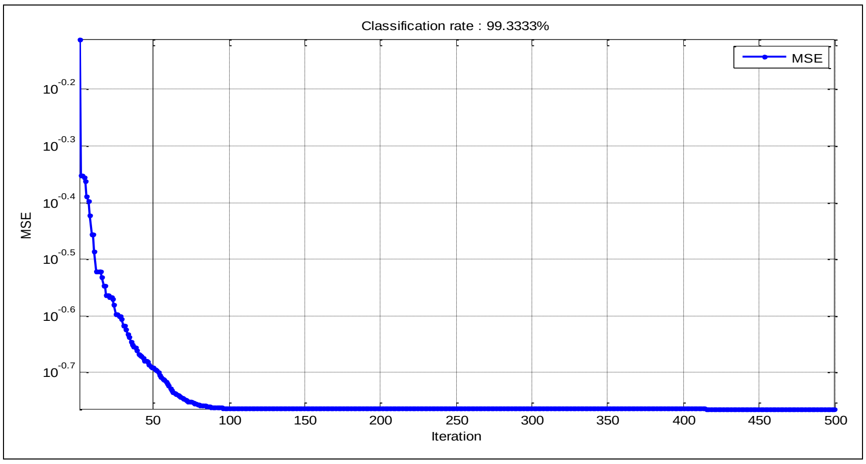

Figure.8 Classifier Performance for both case.

Finally, the classifier predicts the illness in brain shown in MATLAB dialog box figure 7. The performance of the PSO FFNN classifier has been examined and found with 99.33% rate. The brain MR images of various common deceases have been taken as a database.

The system uses a database of 20 images for training purpose. The common brain diseases 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.

The various few no of features has been carried out from MR images, such as Inverse Difference Movement, Mean, Standard Deviation, Contrast, Energy, Correlation, Homogeneity, Entropy, Variance Smoothness, RMS, Kurtosis and Skewness. The FF 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 tool.

VII. CONCLUSIONS

As per discussion in above section, this proposal based on the medical expert system for detection and classification of brain abnormalities in MR images. This system has concatenated approach (DWT + PCA + PSO + Feed forward neural network) which displays high classifier accuracy.

The selection of features of data sets with different criteria has been examined as mentioned in above section. It is also examined that the computational time and storage requirement optimized. From the result, it is clear that, the given approach has a great potential and robust classifier. It also capable for various data sets. The system is easy to operate, understandable by the physician and also easy to interface with other biomedical system. The classifier achieved great accuracy rate around 99.33%.

Compliance with Ethical Standards

No supporting funding agency involved in this publication.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors. The data base of human brain MR images collected from the various hospitals in soft form. No direct participation of human entertains in this article.

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