ISSN (e): 2250 – 3005 || Volume, 07 || Issue, 09|| September – 2017 ||
International Journal of Computational Engineering Research (IJCER)

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

Shrikant Burje*, Prof.Dr.Sourabh Rungta, Prof.Dr.Anupam Shukla
Rungta College of Engineering and Technology,Bhilai,INDIA IIITM Gwalior ,M.P,INDIA
Corresponding Author: Shrikant Burje

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.

Date of Submission: 26-08-2017 Date of acceptance: 09-09-2017

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.

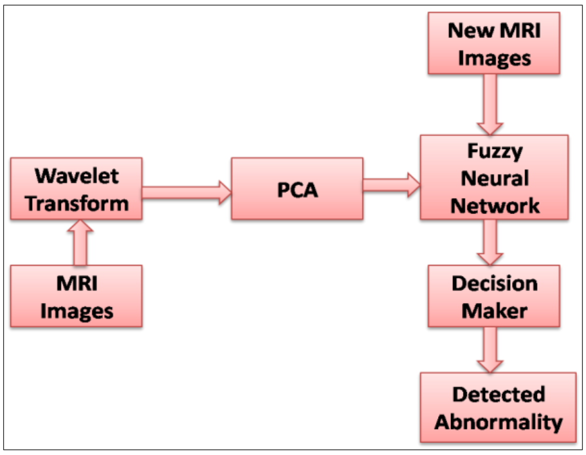

Figure 1. Neuro Fuzzy Classifier

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].

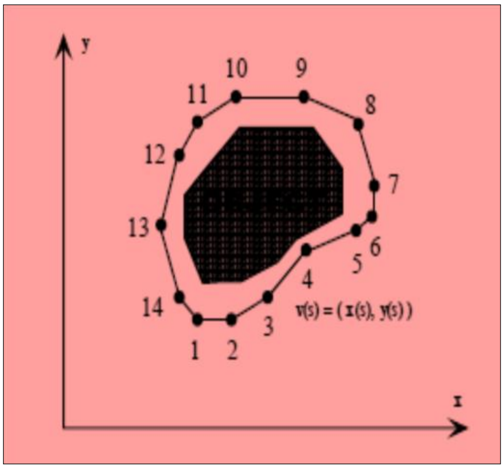

Figure 2 . An Active Contour [14]

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 did through FFNN and finally detection of illness and classification of the tumor. The functionality of this hybrid approach represented in below figure.

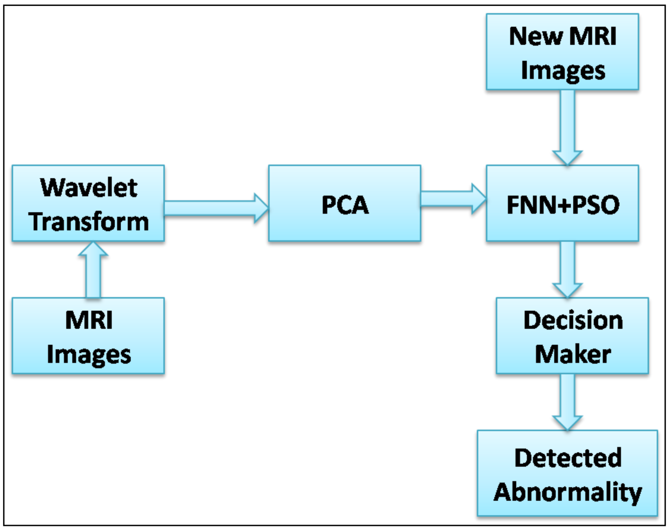

Figure 03.PSO and Neural Network Classifier

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 data base 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 %.

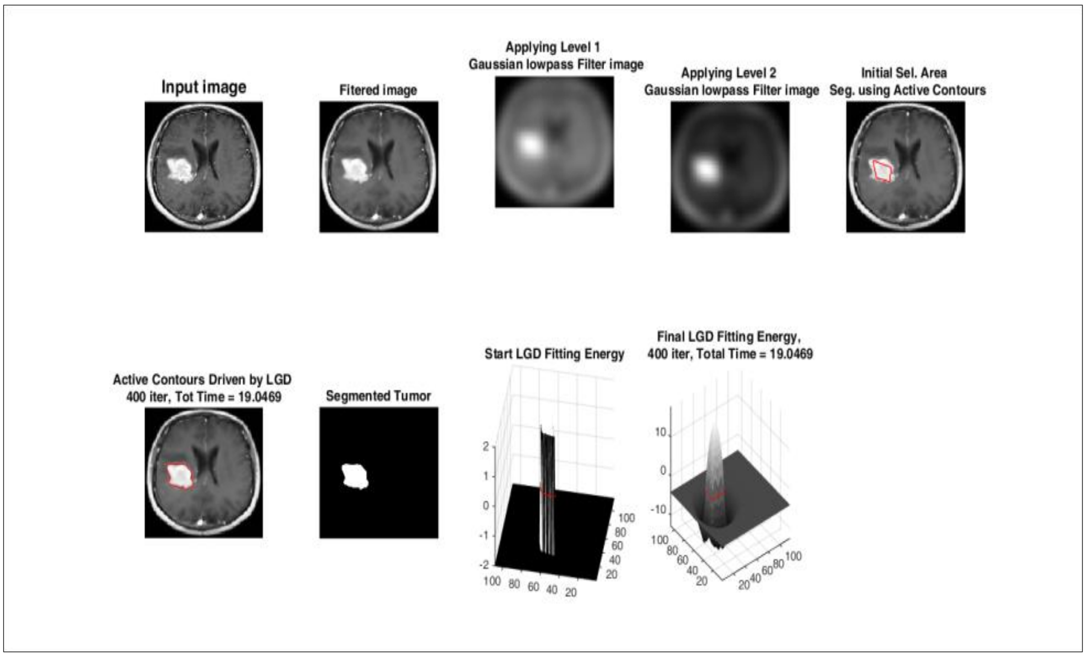

Figure 04(a). Neuro Fuzzy classifier & segmentation with active contours driven by LGD of MRI images

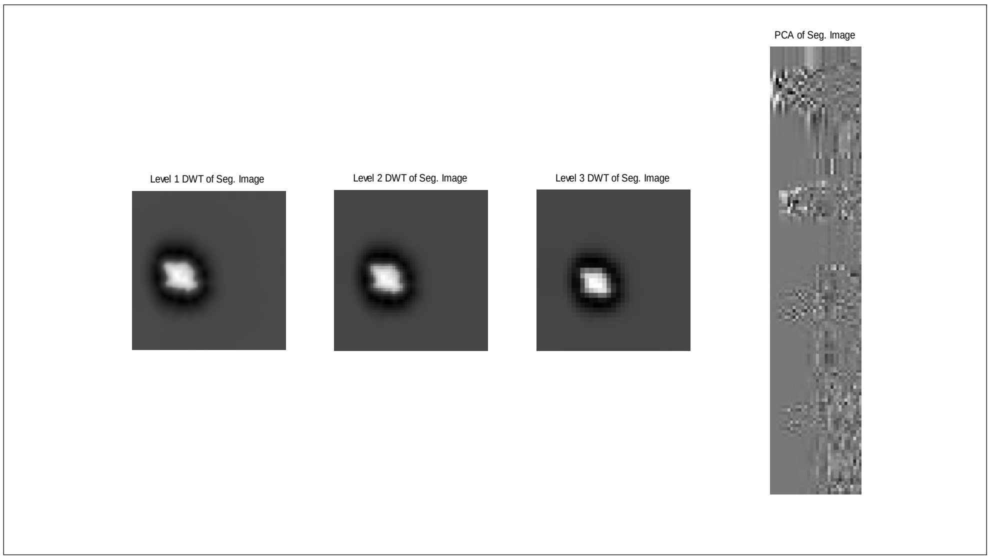

Figure 04 (b). Image Segmentation with Neuro Fuzzy PCA

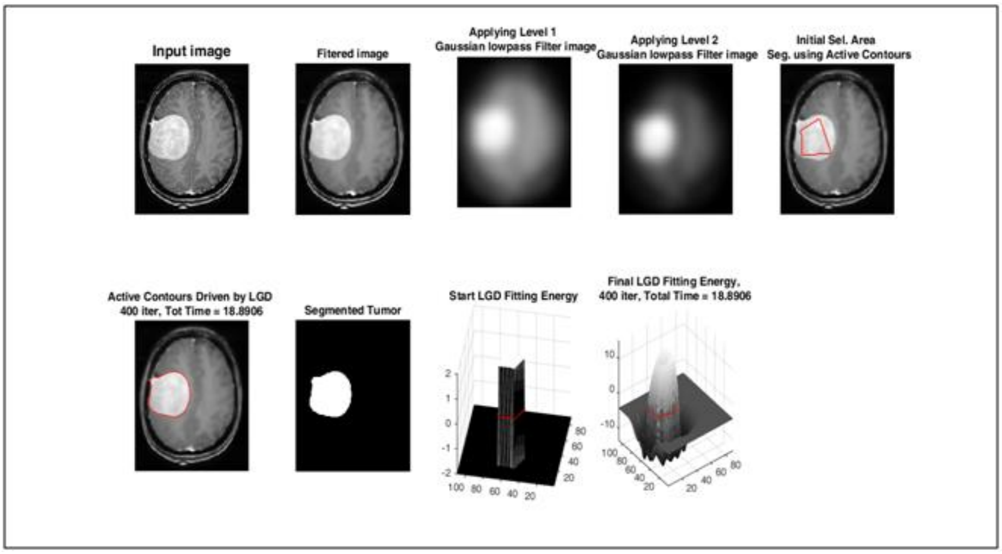

Figure.05 (a) PSO NFC & segmentation with active contours driven by LGD of MRI images

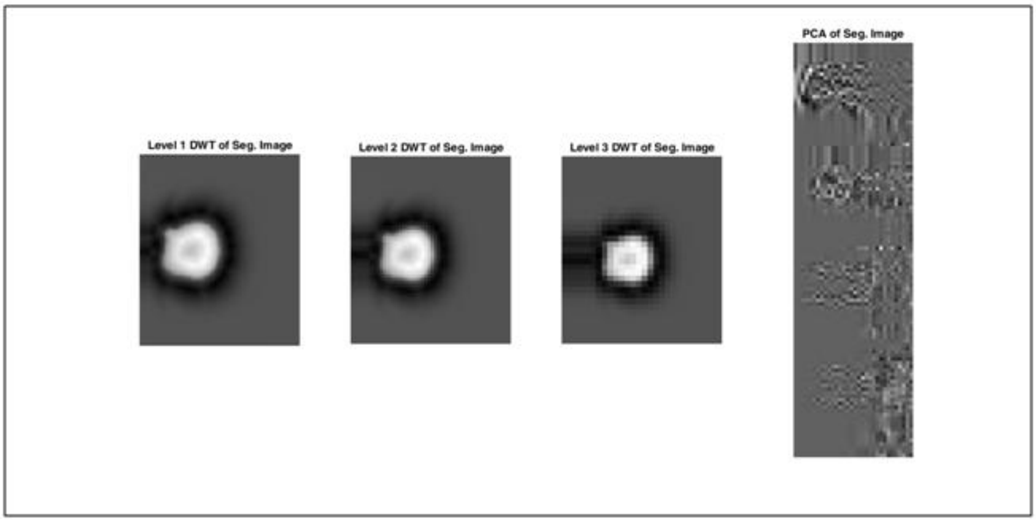

Figure 05(b). Image Segmentation with NFC PCA

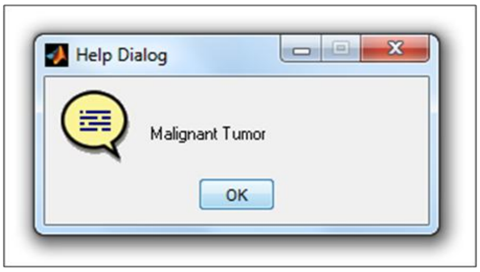

Figure 06 Dialog box for both methodology

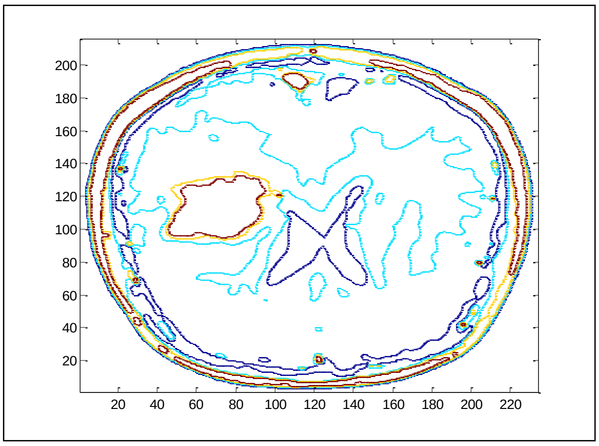

Figure.07 (a) Counter image of segmented input.

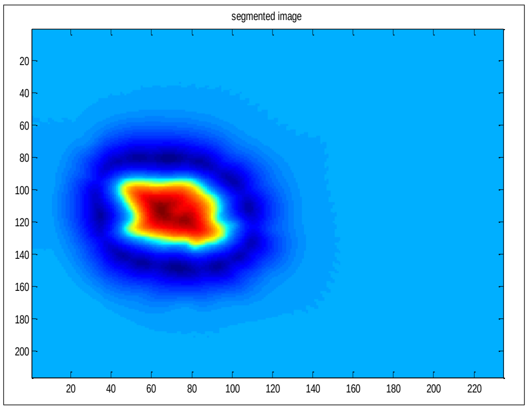

Figure.07 (b) Segmented tumor

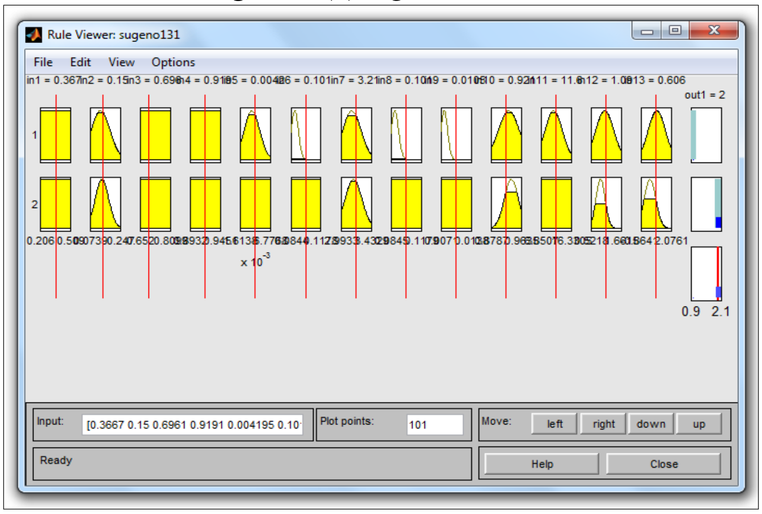

Figure.08 Rule base view

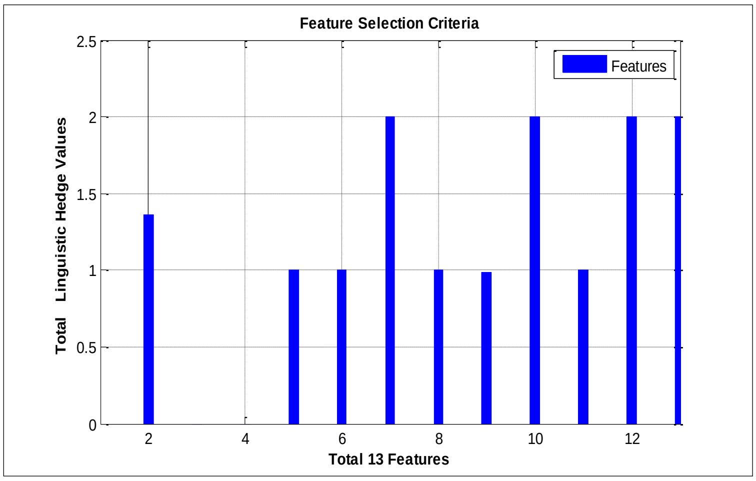

Figure.09(a) Feature selection criteria

Features	'Contrast'	'Correlation'	'Energy'	'Homogeneity'	'Mean'	Standard Deviation'	'Entropy'	'RMS'	'Variance'	'Smoothness'	'Kurtosis'	'Skewness'	'Inverse Difference Movement'
'Filter Image Feature'	0.000518753	0.734796585	0.99960004	0.999902604	80.67187572	71.16764064	0.003466435	97.77862445	3425.190254	0.999999923	3.140424105	1.021211636	118989.5677
'Level 1 GLP Filter Image Feature'	0	NaN	1	1	80.18015566	52.64224851	0	86.78472706	1273.945341	0.99999969	4.020338411	0.749136666	58331.35625
'Level 2 GLP Filter Image Feature'	0	NaN	1	1	11392.10581	12041.15828	0	13991.95977	95193224.83	0.999999998	8.168325013	2.08879696	9895020.289
'Segmented Image Feature'	0.075775474	0.982893585	0.90624133	0.997748074	-3.060363445	3.322961043	0.29592057	4.281529799	9.853995257	1.000002037	15.37546559	2.507271816	-3035.43962
'Level 1 DWT Segmented Image Feature'	0.16875364	0.961170722	0.90657569	0.996318127	-6.126840708	6.539796108	0.28267951	8.500505852	38.3393379	1.000003941	15.88539172	2.549730402	-3072.572135
'Level 2 DWT Segmented Image Feature'	0.333699634	0.919126956	0.90834078	0.993685243	-12.27673125	12.67313328	0.263654444	16.76093547	145.1273837	1.000007388	16.92390475	2.630214732	-3159.955814
'Level 3 DWT Segmented Image Feature'	0.572727273	0.845156533	0.91296361	0.989772727	-24.63933026	23.7240738	0.235762635	32.6082972	516.3666477	1.000012942	19.30256386	2.786462143	-3361.828299
'PCA Segmented Image Feature'	0.125992063	0.112532678	0.86272372	0.962939539	0.000843025	0.066812704	2.740202401	0.06681531	0.004440956	0.912173372	11.52160332	0.825736458	0.024147623

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

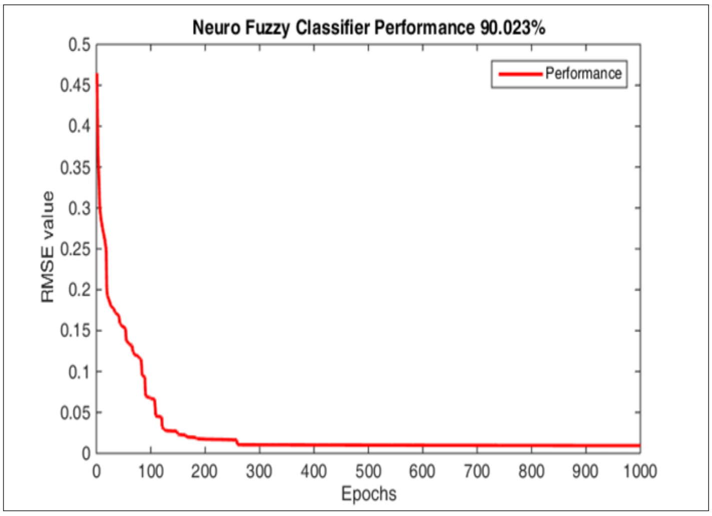

Figure.10 (a) Neuro Fuzzy Classifier Rate

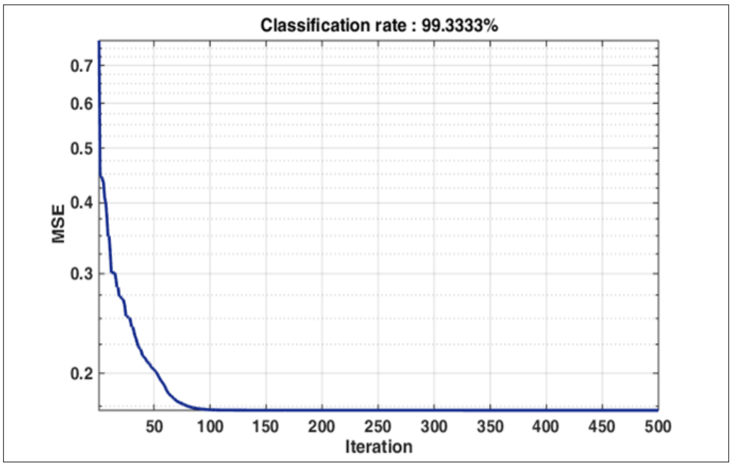

Figure.10(b) PSO-FNN Classifier Rate

III. CONCLUSION

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.

REFERENCES

[1] Muhammad Faisal Siddiqui, Ahmed Wasif Reza, and Jeevan Kanesan ,"An Automated and Intelligent Medical Decision Support System for Brain MRI Scans Classification". PLoS One. 2015; 10(8): e0135875. , Published online 2015 Aug 17. doi: 10.1371/journal.pone.0135875 , PMCID: PMC4539225 www.ncbi.nlm.nih.gov/pmc/articles/PMC4539225/

[2] Y. Zhang and L. Wu , "An Mr Brain Images Classifier Via Principal Component Analysis and kernel Support Vector Machine", Progress In Electromagnetics Research, Vol. 130, 369–388, 2012.

[3] Zhang, Y., L. Wu, and S. Wang, "Magnetic resonance brain image classification by an improved artificial bee colony algorithm",Progress In Electromagnetics Research, Vol. 116, 65-79, 2011.

[4] Biosignal and Biomedical Image Processing, MATLAB-Based Applications, by JOHN L. SEMMLOW,ISBN: 0–8247-4803–4,Library of Congress Cataloging-in-Publication Data.

[5] Wavelet Theory and Applications ,A literature study, R.J.E. Merry ,DCT 2005.53 Prof. Dr. Ir. M.Steinbuch Dr. Ir. M.J.G. van de Molengraft.

[6] Mitra S., Pal S. K.: Fuzzy sets in pattern recognition and machine intelligence. Fuzzy Sets and Systems, 156, 2005.

[7] Nauck D., Kruse R.: Nefclass – a neuro-fuzzy approach for the classification of data. [in:] Applied Computing 1995. Proc. of the 1995 ACM Symposium on Applied Computing, ACM Press, 1995, pp. 461–465.

[8] Ashish Ghosh , B. Uma Shankar & Saroj K. Meher , "A novel approach to neuro-fuzzy classification" , Machine Intelligence Unit, Indian Statistical Institute, Kolkata, India, Neural Networks 22 (2009) 100–109, doi:10.1016/j.neunet.2008.09.011

[9] D. Jude Hemanth, C.Kezi Selva Vijila and J.Anitha , Application of Neuro-Fuzzy Model for MR Brain Tumor Image Classification , Biomedical Soft Computing and Human Sciences, Vol.16,No.1,pp.95-102 [Original article] Copyright©1995 Biomedical Fuzzy Systems Association (Accepted on 2009.07.07)

[10] N. Hema Rajini , R. Bhavani Classification of MRI brain images using k-nearest neighbor and artificial neural network, International Conference on Recent Trends in Information Technology (ICRTIT)2011, IEEE DOI: 10.1109/ICRTIT.2011.5972341

[11] Emin Tagluk, M., M. Akin, and N. Sezgin, "Classification of sleepapnea by using wavelet transform and artificial neural networks", *Expert Systems with Applications*, Vol. 37, No. 2, 1600-1607, 2010.

[12] Camacho, J., J. Pico, and A. Ferrer, "Corrigendum to `The best approaches in the on-line monitoring of batch processes based on PCA: Does the modelling structure matter?' [Analytical Chimica Acta Volume 642 (2009) 59-68]," *Analytica Chimica Acta*, Vol. 658, No. 1, 106-106, 2010.

[13] Chaplot, S., L. M. Patnaik, and N. R. Jagannathan, "Classification of magnetic resonance brain images using wavelets as input tosupport vector machine and neural network," *Biomedical SignalProcessing and Control*, Vol. 1, No. 1, 86-92, 2006.

[14] Marián Bakoš. "Active Contours and their Utilization at Image Segmentation". 5th Slovakian-Hungarian Joint Symposium on Applied Machine Intelligence and Informatics January 25-26, 2007

[15] Anupam Shukla, Ritu Tiwari, Rahul Kala," Real Life Applications of Soft Computing," Taylor & Francis, 2010.

[16] Camacho, J., J. Pico, and A. Ferrer, "Corrigendum to the best approaches in the on-line monitoring of batch processes based on PCA: Does the modelling structure matter?" [Analytical Chimica Acta Volume 642 (2009) 59-68], Analytica Chimica Acta, Vol. 658, No. 1, 106-106, 2010.

[17] Chaplot, S., L. M. Patnaik, and N. R. Jagannathan, "Classification of magnetic resonance brain images using wavelets as input to support vector machine and neural network," Biomedical SignalProcessing and Control, Vol. 1, No. 1, 86-92, 2006.

[18] Natteshan, N.V.S., Angel Arul Jothi, J.: Automatic classification of brain MRI images using SVM and neural network classifiers. In: El-Alfy, E.-S., Thampi, S.M., Takagi, H., Piramuthu, S., Hanne, T. (eds.) Advances in Intelligent Informatics. AISC, vol. 320, pp. 19–30. Springer, Heidelberg (2015)

[19] Detlef Nauck , Rudolf Kruse, NEF CLASS mdash; a neuro-fuzzy approach for the classification of data, Proceedings of the 1995 ACM symposium on Applied computing, p.461-465, February 26-28, 1995, Nashville, Tennessee, USA [doi>10.1145/315891.316068]

[20] Laurence C. Smith, Donald L. Turcotte and Bryan L. Isacks," Stream flow characterization and feature detection using a discrete wavelet transform" Hydrological Processes, VOL. 12, 233–249 (1998)

[21] Luo Juan & Oubong Gwun." A Comparison of SIFT, PCA-SIFT and SURF", International Journal of Image Processing (IJIP) Volume(3), Issue(4) pg 143-152

[22] Ms. Yogita K.Dubey and Milind M.Mushrif , " Extraction Of Wavelet Based Features For Classification Of T2-Weighted Mri Brain Images ", Signal & Image Processing : An International Journal (SIPIJ) Vol.3, No.1, February 2012.

[23] Russell Eberhart , James Kennedy A New Optimizer Using Particle Swarm Theory, Sixth International Symposium on Micro Machine and Human Science 0-7803-2676-8/95 IEEE

[24] Zhang, Yudong et al. "An MR Brain Images Classifier System via Particle Swarm Optimization and Kernel Support Vector Machine." The Scientific World Journal 2013 (2013): 130134. PMC. Web. 21 Feb. 2017

[25] R.J.E. Merry, Prof. Dr.Ir M.Steinbuch, Dr. Ir. M.J.G. van de Molengraft, Wavelet Theory and Applications A literature study Jun 2005, http://alexandria.tue.nl/repository/books/612762.pdf.

[26] Simon Haykin , Neural Networks A Comprehensive Foundation ,second Ed. Pearson ,2007.

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

[28] Rafael C. Gonzalez, Richard E. Woods,"Digital Image Processing" , third ed., Prentice Hall, 2008.

[29] Moradi P., Gholampour M. A hybrid particle swarm optimization for feature subset selection by integrating a novel local search strategy. Appl. Soft Comput. 2016;43:117–130. doi: 10.1016/j.asoc.2016.01.044.

International Journal of Computational Engineering Research (IJCER) is UGC approved Journal with Sl. No. 4627, Journal no. 47631.

Shrikant Burje. "Performance Comparison of Soft Computing Schemes for Classification and Detection of Brain Abnormalities in MRI Images." International Journal of Computational Engineering Research (IJCER), vol. 6, no. 9, 2017, pp. 19–27.