ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Special Issue 6, April 2017

Feature Extraction from MRI Images and Classification of Dementia using ANN

Akhila J A,
PG Scholar, Dept of ECE
Rajadhani College of Engineering and Technology.
Email: akhilaja@gmail.com

Christin Markose,
Head of Department, Dept of ECE
Rajadhani College of Engineering and Technology.
Email:hodec@rietedu.in

***Abstract*—Dementia,a disease causingreduction of cognitive abilities resulting due to degeneration of cortical and sub-cortical structures of brain is increasing globally. Accurate and early detection of the disease is therefore a need of the hour. Detection methods using Computer helps to diagnosethis neurodegenerative disease. Magnetic Resonance Imaging (MRI), an advanced technique formedical imaging,provides brain images with high quality.The paper proposes a method to classify Dementia with the help of Artificial Neural Network (ANN) .Techniques in Image Processing is used for the extraction of the statistical features from MRIimages of brain. Adoption of these statistical features and features extracted using discrete wavelet Transform and the usage of the classification property of Artificial Neural Network help to classify Dementia.The method outperforms other classifiers by efficiency and accuracy.**

***Index Terms*—Dementia, ArtificialNeural Network,MRI.**

I. INTRODUCTION

The number of people getting affected by Dementia is increasing at a very high rate worldwide.Dementiarefers to a group of symptoms that cause reduction in memory and thinking ability of a person which can affect his ability to fulfill day to day activities.Accuratedetection of dementia in its early stages and proper treatment is therefore required to reduce this tremendous increase.Practitioners do the diagnosis of dementia through examination of the patients' mental state and health.But this is not a stable and accurate method. Detection methods using computer provide a more efficient process.Various techniques such as PET,Computed Tomography(CT) Scan and MRI can be used for the same.

MRI is a medical imaging tool that provides a non-invasive method to obtain the images of brain and can also provide functional information of brain.Magnetic fields and radio waves are used in MRI to measure the water content in tissues, thus helping to differentiate the normal and abnormal tissues. MRI provides various information that are not given by other CAD methods.MRI produces a detailed digital image of the brain with high resolution,thus helping to identify even very small changes in its structure. Structural MRI can be used to monitor the changes in brain caused by normal aging or any type of dementia.MRI also provides an advantage of contrast of soft tissue.

As per literature,a classifier and selected features combined in a proper manner can give rise to better classification.Various features were used by different authors for classification.In [1],ANN is used for the discriminative feature extraction from X-ray images to classify them as different body parts.In reference [2], Gabor filter was used for the selection of features and Support Vector Machine(SVM) classifier for classification of dementia. But this method had low precision and accuracy.In [3],the authors have used an automatic method to classify patients into three classes,patients with Alzheimer's disease,patients with Mild Cognitive Impairment and Normal. The classification method used was hierarchical method.Dementia Classification was achieved in [4] using a SVM and a Bayes classifier.Theauthors used PCAfor the reduction of dimensions and forward feature selection technique was used. [6] discussed about efficient content-based medical image retrieval, dignified according to the Patterns for Next generation Database systems (PANDA) framework for pattern representation and management.

II. PROPOSED ARCHITECTURE

A. *Preliminaries*

Feature Extraction [5] aims at obtaining appropriate and important features from an image, thus transforming the data provided as input to a less dimensional space. Careful selection of features helps to extract all the adequate information from an image. Since, Dementia is characterized by the absence of brain cells,the proposed architecture extracts statistical features and features from the region of interest(ROI) selected in the MRI image for the process of identifying Dementia. These features can then be used to perform the desired classification.

Fuzzy C Means clustering algorithm is a popular image segmentation algorithm..FCM was proposed by Bezdek[19] and from then it has been used in image processing applications that require segmentation. The algorithm is used in this paper to segment the image given as input into different clusters based on intensity values.The image is divided into a

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Special Issue 6, April 2017

definite number of clusters known in advance. The probability that a pixel will belong to particular cluster is given by the distance of the corresponding pixel from the centroid.This probability is provided by a membership function.Low values of membership function mean the pixel is distant from the centroid.The central principle of FCM algorithm is to combine the data points to different clusters. This causes a reduction in noise.

Discrete Wavelet Transform helps to retrieve various characteristics of an image by filtering the image successively through high and low pass filters. The different steps in DWT followed in this paper are as follows.

Step 1: Decompose the image into 4 levels using DWT into approximation and detail coefficients

Step 2: The required features are extracted from the coefficients obtained from DWT.

The Approximation coefficients provide the details on local averages of an image. The Detail coefficients provide ideas on the differences between these local averages

Artificial Neural Network (ANN) is used for the classification.Artificial Neural Network can be considered as a group of processing units with an activation and output function for each unit.A network is initially trained with input vectors to determine the weights and other adaptable parameters of the network. This process is also called Learning of the network. . In this study, a feedforward ANN is trained using the back propagation algorithm.The algorithm calculates weight changes.The performance of the network is improved by updating the weights iteratively. The algorithm works with summed squared error functions.

B. Data Acquisition

The MRI images required for this study was obtained from the Alzheimer's disease Neuroimaging (ADNI) database.ADNI was established with a goal to discover and develop clinical diagnosis methods for the treatment of Dementia. The data in ADNI is available to all researchers and designers, thus
helping to develop new technologies and scientific advancements to help treat the disease.

C. Modules

C.1 Training

Statistical features such as Kurtosis, Skewness are extracted.Kurtosismeasures the histogram flatness.Kurtosis is given by the equation

$$\sum_{i=1}^{N}\left(\frac{(X-Mean)^4}{N}\right)/s^4$$

Skewness is a measure of the symmetry of an image. Skewness can be defined as

$$\sum_{i=1}^{N}\left(\frac{(X-Mean)^2}{N}\right)/s^3$$

where s is the standard deviation and x is the input pixel value.

The images are clustered using Fuzzy-C Means clustering algorithm[8].In FCM Clustering, the steps followed for the segmentation are

1.The Fuzzy Partition Matrix is initialized.

2. The cluster centres are calculated using the formula,

$$v_i = \frac{\sum_{p=1}^{n}(u_{ip}^{q} y_p)}{\sum_{p=1}^{n}(u_{ip}^{q})} \quad \forall \ i$$

,

Where u_{ip} is the membership function that determines the membership of pixel $y_p$in p^{th} cluster

3.Update the membership function as per the equation

$$u_{ip} = \frac{1}{\sum_{j=1}^{r}\left(\frac{d_{ip}}{d_{jp}}\right)^{\frac{2}{q-1}}} \quad \forall \ p,i$$

By updating the membership function and cluster centre iteratively, image can be divided into different clusters successfully and the wavelet features are extracted using Discrete Wavelet Transform.

ANN is trained using these features extracted from the MRI images.

C.2.Testing

The input test image is preprocessed using the techniques of Image Processing [7]. Morphological operations of dilation and erosion are applied on the image to improve feature selection. After preprocessing, the Region of Interest is selected.The statistical features similar to the features extracted during training the images are extracted from the selected region.

The test image is clustered using the Fuzzy-C Means clustering technique and the Discrete Wavelet Transform is applied to retrieve the features. The statistical and waveletfeatures extracted from the test data are then provided as test input to the trained neural network to achieve the required classification.

III. RESULTS AND DISCUSSION

In this study, MRI Images from the ADNI database is used for the identification of dementia and classification into two classes 'NORMAL' and 'DEMENTIA'. The images from

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Special Issue 6, April 2017

ADNI database was used to train the ANN and images from the same database were used to test the network.

The features are extracted from the training images. Figure 1 display the command window in MATLAB displaying the images as trained into Normal and Dementia.The statistical features and the wavelet features extracted from these images were used to train the neural network.

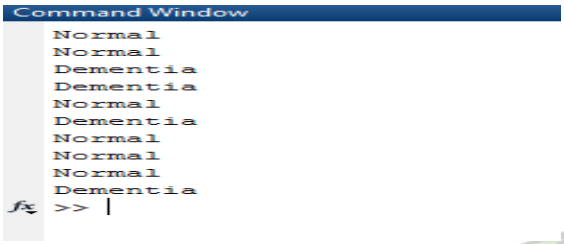

Fig. 1: MATLAB Command Window displaying the training results.

Testing is accomplished using a Graphical User Interface (GUI) as shown in the figure 2.

Fig 2: GUI for testing.

The test image browsed via the GUI is preprocessed using Image Processing Techniques. The images after each preprocessing technique such as morphological and filtering operations are displayed in figure 3 and figure 4.

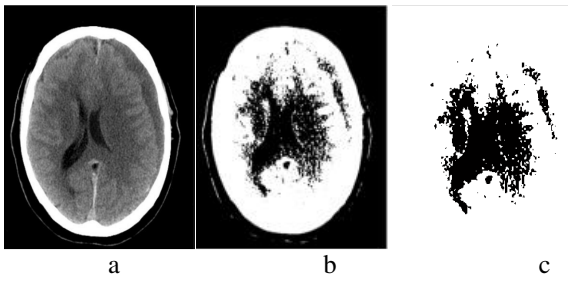

Fig 3: a) Input MRI Image,b) Binarised Image,c) Filtered Image

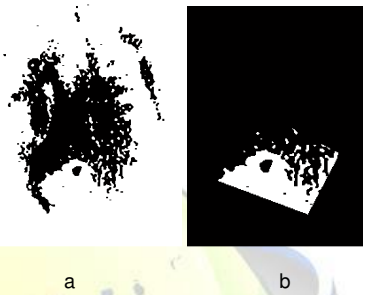

Fig 4:a) Image after Morphological operations, b) Region of Interest Selected

Statistical features are extracted from the selected ROI and stored in file.The features extracted by Discrete Wavelet Method after FCM clustering as shown in figure 5 is also saved to file.These features are then used to test the trained Neural Network.

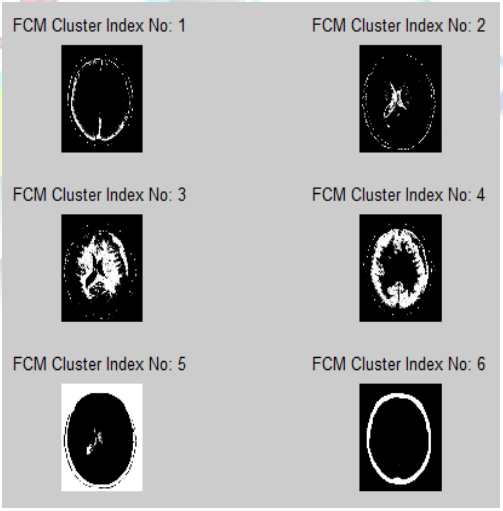

Fig 5 Image clustered using FCM Clustering Technique

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Special Issue 6, April 2017

The performance of the classification system is measured by determining the accuracy calculated as follows.

$$\text{Accuracy} = \frac{(TP+TN)}{(TP+TN+FP+FN)},$$

Where TP is True Positive,TN is True Negative,FN is False Negative and FP is False Positive.

The classification using Artificial Neural Network produced a classification accuracy of 84% when the features were extracted statistically.

IV. CONCLUSION

Successful identification of dementia data from normal brain was achieved with an accuracy of 84%.Using this technique, relevant features of researcher's preferencecan be extracted by statistical method. This classifier can help the radiologists to prioritize scans for further analysis. Further, the method can be expanded by increasing the number of features extracted statistically.

REFERENCES

[1] M.Srinivas; DebadityaRoy; C.KrishnaMohan,"Discriminative featu re extraction from Xray images using deepconvolutional neural net works",*2016 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP):*

[2] S. K. Aruna, S. Chitra,Machine Learning Approach for IdentifyingDementia from MRI Images, International Journal of Computer, Electrical, Automation, Control and Information Engineering Vol:9, No:3, 2015

[3] Elaheh Moradi, Christian Gaser, Heikki Huttunen, Jussi Tohka,MRI based dementia classi_cation using semi-supervised learning and domain adaptation

[4] Victor Miller, Stephen Erlien, and Jeff Piersol,Identifying dementia in MRI scans using machine Learning

[5] Gaurav Kumar, Pradeep Kumar Bhatia A Detailed Review of Feature Extraction in Image Processing Systems,Fourth International Conference on Advanced Computing & Communication Technologies, 2014.

[6] Christo Ananth, K.Kalaiselvi, C.Kavya, S.Selvakani, P.Sorimuthu Iyan, "Patterns for Next generation Database Systems - A study", International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE), Volume 2, Issue 4, April 2016, pp: 114-119

[7] Sargun and Shashi B. Rana ,A Review of Medical Image Enhancement Techniques for Image Processing,International Journal of Current Engineering and Technology,2015

[8] Keh-Shih Chuang a,*, Hong-Long Tzeng a,b, Sharon Chen a, Jay Wu a,b, Tzong-Jer Chen,Fuzzy c-means clustering with spatial information for image segmentation, Computerized Medical Imaging and Graphics 30 (2006),ELSEVIER

[9] Fu. Li-dong, Z. Yi-fei. Medical image retrieval and classification based on morphological shape feature. In Proc. IEEE Int. Conf. Intelligent Networks and Intelligent systems : 116-119, 2010.

[10] M. Srinivas, C. Krishna Mohan. Medical Image Indexing and Retrieval Using Multiple Features. In Proceedings of CIIT conference 2013;Elsevier.

[11] Srinivas, M and Mohan, C Krishna. Medical images modality classification using multi-scale dictionary learning. 19th International Conference on Digital Signal Processing (DSP), 2014, pp. 621–625,2014.

[12] M. Srinivas, R. Ramu Naidu, C. S. Sastry, Mohan, C Krishna.Content Based Medical Image Retrieval Using Dictionary Learning.

[13] Jianmin Jiang, P Trundle, and Jinchang Ren. Medical image analysis with artificial neural networks. Computerized Medical Imaging andGraphics, 34(8):617–631, 2010.

[14] M. M. Rahman, P. Bhattacharya, B. C. Desai. A frame work for medical image retrieval using machine learning and statistical similarity matching techniques with relevance feedback. IEEE Trans. Inf TechnologyBiomed : 11(1): 58-69, 2007.

[15] H. Pourghassem, H. Ghassemian. Content based medical imageclassification using a new hierarchical merging scheme. ComputerizedMedical Imaging and Graphics : 32(8), 651-661, 2008.

[16] Mark S. Nixon, Alberto S. Aguado, Feature Extraction and Image Processing, Newness Publisher, 2002.

[17] Rafael C. Gonzalez, Richard E. Woods, Digital ImageProcessing, 2nd edition, Pearson Education.

[18] Pedrycz W, Waletzky J. Fuzzy clustering with partial supervision.IEEE Trans Syst Man Cybern Part B Cybern 1997;27:787–95.

[19] J. C. Bezdek. Pattern recognition with fuzzy objective function algorithms. New York: Plenum Press,1981.