Brain MRI Classification-An Evaluation on PSONN and PSOSVM

Dhanya. G. S[1] Dr. R. Joshua Samuel Raj[2] Sam Silva. A[3]
[1]PG Scholar [2]Professor [3]Assistant Professor
[1,2,3]Department of Computer Science and Engineering
[1,2,3]Anna University-Chennai, Rajas Engineering College, Tirunelveli, Tamil Nadu, India

Abstract— Advancements in technology produce huge amounts of data in various fields, increasing the need for efficient and effective data mining tools to uncover the information contained implicitly in the data. Such a voluminous store of data of diverse characteristics is mostly stored and made available in digitized form.Magnetic Resonance Imaging (MRI) plays a vital role in the diagnosis and treatment of diseases. Defect detection in Magnetic Resonance (MR) brain images is a tough task. The difficulty in brain image analysis is mainly due to the requirement of detection techniques with high accuracy within quick convergence time. Numerous automated techniques are developed to prevail over this drawback. Among these techniques, Artificial Neural Networks (ANN) and support Vector Machine (SVM) techniques are found to be highly efficient in terms of the performance measures. But, the major factor is that the merits are not simultaneously available in the same ANN or SVM technique. In this research work, several ANN and SVM techniques are studied for image segmentation and classification process. The authors have selected different features even if the method of segmentation is same. Based on that we have reached a conclusion that each technique has its own significance, but the features extracted from the segmented image play a distinct role in enhanced performance.

Key words: ANN, classification, MRI, segmentation, SVM

I. INTRODUCTION

Modern medical imaging technology has given physicians a non-invasive means to visualize internal anatomical structures and diagnose a variety of diseases. Among the imaging techniques, Magnetic Resonance Imaging is found to be much superior to other techniques especially for brain tissues. This type of scan uses magnetism to build up a picture of the internal parts of the body. The main advantage is that the soft tissue differentiation is extremely high for MRI which is essential for brain imaging. Compared to other techniques, MRI has high spatial resolution and contrast. Other advantages of MRI scans are that they are devoid of X-ray radiation and a single scan can produce many pictures. MRI is also better than Computer Tomography (CT) at showing how deeply the tumor has grown into body tissues. It can be particularly useful for showing whether tissue left behind after treatment is tumor or not. These MR images are used to find the different stage of tumor. The MRI scanner can be also used for cross section views of the body. Thus, these factors have stimulated the usage of MR brain images for the defect recognition process. These MR images can be collected from scan centre or can be downloaded from publicly available database [3], [10].This paper explores the evaluative study between Neural Networks and Support Vector Machine methods. A summary is described in the following sections.

II. EVALUATIVE STUDY

A few literature surveys are done to evaluate the performance. Vrushali Borase, Gayatri Naik, Vaishali Londhe suggested a method which detect the tumor and classify the type of tumor using Artificial Neural Network for MRI of brain. This method includes four stages namely the Preprocessing stage, Segmentation of images, Extraction of Features and its classification. The input MR images are applied with a high pass filter for noise removal and pre-processing. The segmentation step includes K-means, Otsu, fuzzy c-mean, and thresholding. Region growing is a simple region-based image segmentation method which involves selection of initial seed points. After recognising the connected components of the image, every set of connected pixels having same grey level values are assigned the same unique region label. In the next phase, knowledge base is created for comparison from the previously collected dataset consisting of the brain MRIs. Once the features are extracted, classification is done using Artificial Neural Network (ANN). The tumor in the brain MRI is identified and subjected to training to find whether the tumor is benign or malignant. Thus the authors conclude that complex and extensive mathematical modelling are required to model nonlinear relationships. Neural networks provide a comparatively easier way to do such analysis. Well design and training of neural network will provide high reliability exactly like an expert [1].

S.Mahalakshmi and T.Velmurugan proposed research work analyses about the recognition and partition of brain tumor using Particle Swarm Optimization (PSO), a heuristic global optimization method based on swarm intelligence. The algorithm works in four stages namely conversion, implementation, selection and extraction. The research effort starts with shifting the DICOM into image file format.PSO algorithm with the change in the values of segmentation level is the next stage. In the next stage the resultant image is selected based on time. In the final stage the tumor affected region is extracted with suitable filtering techniques. This work takes the axial and coronal stage of the brain MRI. Finally this work concludes with the extraction of the resultant image, which is taken as input and using the best filtering techniques the affected regions are identified and separated efficiently. This work also identifies the best suitable plane for the Particle Swarm Optimization (PSO) algorithm [4].

Riyazul Haque, Shrikant Lade, Dayashankar Pandey did a research work which searches the possibility of existing techniques for segmenting the MRI. The authors suggested a new methodology for tumor detection using morphological operations to address brain tumor from MRI in real time during surgeries. This work showed an analysis of various methods for segmenting an MRI, which relatively take lesser time than in the manual procedures. By means of abnormal images of a variety of brain tumours, this work shows that the projected method provides a strong technique in terms of accuracy and computation time, making it suitable for real-time processing. The results showed that the algorithm proposed in the paper is expert in producing one pixel width continuous edges with accurate positioning of particular region where tumor was identified [2].

III. PARTICLE SWARM OPTIMIZATION-NEURAL NETWORKS (PSONN)

A. Particle Swarm Optimization (PSO)

In 1995 Kennedy and Eberhart developed the Particle swarm Optimization (PSO) method. The Optimization precision to resolve variety of engineering optimization problems made PSO based approaches broadly proficient in image segmentation applications. Particle Swarm Optimization (PSO) is a heuristic global optimization method based on swarm intelligence. The idea of PSO is originated from the performance of particles of swarm and the group interaction between particles. While searching for the foodstuff, the birds get speckled or they move in flocks to find the food. The birds look for the food from one place to another; the bird which is closer to food can smell the food. The basic algorithm of PSO consists of n swarm particle, and the position of each of the particle denotes the possible solution. The swarm particle shifts its position according to the three principles.

1) Continue its inertia
2) Revise the condition with respect to its optimal po¬sition
3) Revise the condition with respect to the most opti¬mal position of swarm.

B. Artificial Neural Network (ANN)

ANN is a form of computing inspired by the functioning of the brain and the nervous system. Neural Networks represent highly idealised mathematical models of understanding biological nervous systems. The key element of this paradigm is the novel structure of the information processing system.ANN have been developed as generalizations of mathematical models of human cognition ,based on the assumptions that:

1) Processing of information occurs at many simple elements called neurons.
2) Signals are passed between neurons over connection links.
3) Each connection link has an associated weight, which, in a typical neural net, multiplies the signal transmitted.
4) An activation function (usually non linear) is applied to each neuron to its net input (sum of weighted input signals) to determine its output signal [1], [4], [7], [8], [9], [10].

The following fig. 1 shows the basic functioning of an ANN.

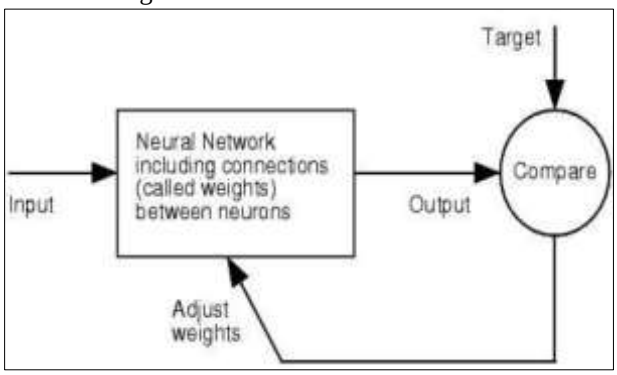

Fig. 1: Basic functioning of ANN

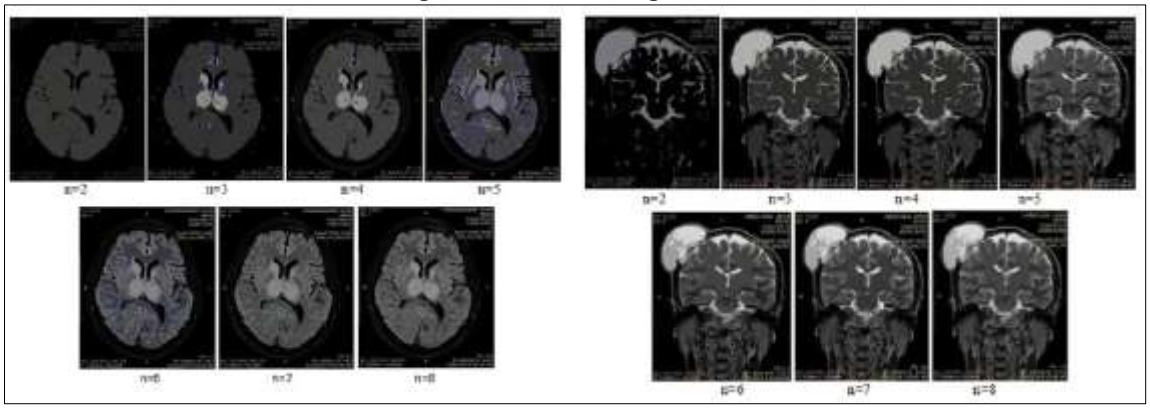

Fig. 2: PSO algorithm in the axial plane and coronal plane

The implementation of PSO in this research work includes four phases to identify the infected tumor region. The first step is to translate the Digital Imaging and Communication in Medicine (DICOM) file extension into image file format. The second stage is implementing the PSO algorithm by altering the value of n taking n=2 as default value. The third stage is based on the elapsed time in finding the best resulting image from the segmented images. The fourth stage is separating the tumor infected area of brain alone and the algorithm functions as follows.

- Step 1: Translate the brain medical images into DICOM image file format.
- Step 2: Treat with the same size of the brain medical imag¬es. Differentiate between normal and abnormal of the MRI images.
- Step 3: Using PSO algorithm process the data by taking default value for n=2 using equation 1 and 2.
- Step 4: Changing the n, which represents the segmentation level of seg¬mentation gives more accurate results.
- Step 5: The elapsed time is calculated and the best re¬sultant image is selected with equation 3.
- Step 6: The affected re¬gion can be easily separated using the above steps. In this method, the PSO works on both axial and coronal plane. The results obtained are shown in fig. 2 below [4]. The fig. 3 shows the results of abnormal growth of cells observed in the brain separately with the help of filtering techniques in image processing both axial and coronal plane [4].

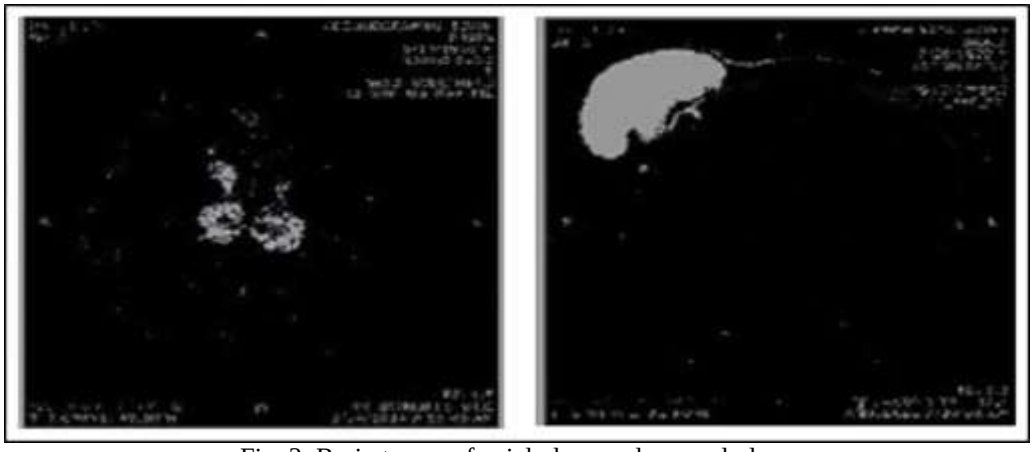

Fig. 3: Brain tumor of axial plane and coronal plane

Segmentation level(n)	Elapsed time of axial plane(sec)	Elapsed time of coronal plane(sec)
2	16.768196	15.176071
3	11.036001	10.29860
4	14.903781	12.149739
5	15.180892	14.202305
6	20.099203	16.996868
7	21.614491	19.874922
8	22.547372	22.407565
Average	17.449990	15.87230

Table 1: Elapsed time of axial and coronal plane [4].

IV. PARTICLE SWARM OPTIMIZATION -SUPPORT VECTOR MACHINE (PSOSVM)

A. Support Vector Machine (SVM)

Support vector machines (SVMs) are a set of related supervised learning methods used for classification and regression. In simple words, given a set of training examples, each marked as belonging to one of two categories, an SVM training algorithm builds a model that predicts whether a new example falls into one category or the other. To be precise, a support vector machine constructs a hyper plane or set of hyper planes in a high dimensional space, which can be used for classification or other tasks.fig. 4 represent the basic architecture of linear SVM. This segment presents three major techniques of image segmentation for the identification of tumor in the MRI. The size of the image containing the tumor usually has more strength than the rest of image and they can visualize the area, nature and the dimension of the tumor in the image [2], [5], [6]. They have used these vital conditions to distinguish tumor and the steps are:

1) Take an input dataset of infected images.
2) Find the filtered image of the input.
3) Apply PSO-SVM classification approach.
4) Single iteration based is applied and multi level based segmentation classified image.
5) Classify the defected portion in the image

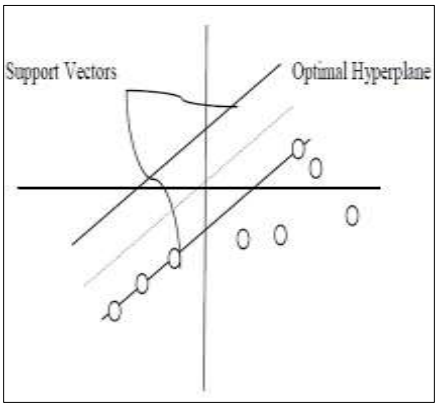

Fig. 4: Basic architecture of linear SVM

In pre-processing some important image enhancement and noise reduction methods are done. The fundamental steps in pre-processing are the following:-Image is transformed to gray scale image in first step. Noise is separated if any. The acquired image is then passed through a high pass filter to identify edges. Then the acquired image is added to original image to enhance it. In processing step, segmentation is made on basis of a threshold, due to which whole image is changed into binary image [2].

- Step1:- Translate MRI scan image into gray scale image.
- Step2:- The image is passed through a high pass filter for removing noise and other spike in the image.
- Step3:- The filtered image is then added to the gray scale image.
- Step4:- Translate the enhanced image (image of step3) in to binary image with a threshold value.
- Step5:- Split the tumor from segmented image by Watershed – Method up to the 10 iteration and used for the optimization method of SVM.
- Step6:- Choose only that part of the image from step4 which has the tumor (the part of the image having more intensity and more area).
- Step7:- Apply PSO-SVM classification approach.

The fig. 5 shows the results for PSOSVM method [2].

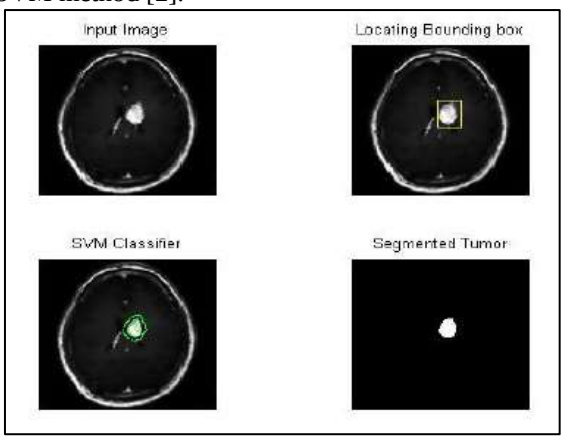

Fig. 5: Finding tumor from SVM classifier

Test Images	PSO-SVM with number of iterations (sec.)
Image 1	1.181893 sec.(7)
Image 2	1.928364 sec.(7)
Image 3	1.91458 sec.(7)

Table 2: Comparison of elapsed time in seconds

Table II shows the analysis of PSOSVM done on three images in which the elapsed time is represented in seconds.

V. CONCLUSION

In this paper an overview of Particle Swarm Optimization Neural Networks (PSONN) with respect to axial and coronal plane is clearly discussed with the extensive literature and results obtained from some research works. Another methodology called Particle Swarm Optimization Support Vector Machine (PSOSVM) is also discussed in the similar way. Artificial Neural Networks (ANN) and support Vector Machine (SVM) techniques are found to be highly efficient in terms of the performance measures. But, the major factor is that the merits are not simultaneously available in the same ANN or SVM technique. In this research work, several ANN and SVM techniques are studied for image segmentation and classification process. The authors have selected different features even if the method of segmentation is same [10], [2], [4]. Based on that we have reached a

conclusion that each technique has its own significance, but the features extracted from the segmented image play a distinct role in enhanced performance and hence concluded this research paper.

REFERENCES

[1] Prof.Vrushali Borase, Prof.Gayatri Naik, Prof.Vaishali Londhe, "Brain MR Image segmentation for Tumor detection using Artificial Neural", International Journal of Engineering and Computer Science(ISSN:2319-7242)",vol 6,Issue 1,pp. 20160-20163,Jan.2017.

[2] Riyazul Haque, Shrikant Lade, Dayashankar Pandey, "Classification of MRI images using Particle Swarm Optimization Based Support Vector Machine for Tumor detection",COMPUSOFT,An internatyional journal of advanced computer technology(ISSN:2320-0790),5(12), vol 5,Issue12,pp. 2245-2253,Dec.2016.

[3] R.Bharathi, Dr.Divya Satheesh,"Improving MRI brain tumor classification and segmentation based on comparison technique",International Journal of Emerging Technology in Computer Science and Electronics(ISSN:0976-1353),vol 13,Issue 1,pp 560-569,March,2015.

[4] S.Mahalekshmi and T.Velmurugan,"Detection of Brain Tumor by Particle Swarm Optimization using Image Segmentation",Indian Journal of Science and Technology(ISSN:0974-5645),vol 8(22),pp 13-19,September ,2015

[5] Amita Kumari,Rajesh Mehra,"Hybridized Classification of Brain MRI using PSO & SVM" ,International Journal Of Engineering and Advanced Technology (ISSN:2249-8958) vol3,Issue 4,pp 319-323,April ,2014

[6] Iman Behravan,Oveis Dehghantanha,Seyed Hamid Zahiri and Nasser Mehrshad," An optimalSVM with feature selection using Multiobjective PSO",Journal of Optimization (Volume 2016),Article ID 305043,8 pages

[7] Selvaraj, D., Dhanasekaran, R., (2012): "MRI brain tumour detection using feed-forward neural network," Proceedings of EXCITE 2012, pp.171-174.

[8] Sheejakumari and A. Gomathi, "Healthy and pathological tissues classification in MRI brain images using hybrid genetic algorithm-neural network (HGNN) approach," European Journal of Scientific Research, vol. 87, no. 2, pp. 212–226, 2012.

[9] V.Sheejakumari and Sankara Gomathi, "MRI Brain Images healthy and pathological tissue classification with aid of Improved Particle Swarm Optimization and Neural Network (IPSONN)", Computational and Mathematical Methods in Medicine Volume 2015 (2015), Article ID 807826, 12 pages.

[10] Dhanya G.S and Sam Silva.A,"MRI Brain Images-A relative study between HGNN and IPSONN",International Journal of Innovative Science and Research Technology (ISSNNo:-2456-2165), vol 2,Issue 3,pp.79-82, Paper ID :IJISRT17MA31, March-2017.