International Journal For Technological Research In Engineering
Volume 2, Issue 1, September-2014 *ISSN (Online): 2347 - 4718*

ARTIFICIAL NEURAL NETWORKS FOR DIAGNOSIS OF THYROID DISEASE

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Abstract: Artificial Neural Networks have been widely used for the purpose of medical diagnosis in the last decades. The diagnosis of diseases such as thyroid using artificial neural networks is an important research area because of the need of more and more accuracy in the crucial process of disease diagnosis. This paper presents a comparison of three artificial neural network algorithms viz. Multilayer Back Propagation (BPN), Radial Basis Function and Learning Vector Quantization for the diagnosis of thyroid disease using image dataset. Images are first processed through image processing steps to filter out noise to increase the learning rate of neural network .It has been found in this study that the radial basis function network is the best algorithm for the diagnosis of thyroid disease having the least no. of iterations and highest PSNR value.
Keywords: Thyroid disease diagnosis, Multilayer back propagation, Learning vector quantization, Radial basis function, peak signal to noise ratio.

I. INTRODUCTION

Thyroid hormones produced by the thyroid gland helps control the body’s metabolism. The thyroid gland produces two active thyroid hormones, levothyroxine (abbreviated T4) and triiodothyronine (abbreviated T3).These harmones are important in the manufacture of proteins, in the regulation of body temperature, and in overall energy production and regulation [9, 8]. The thyroid gland is prone to several very distinct problems, some of which are extremely common. Production of too little thyroid hormone causes hypothyroidism or production of too much thyroid hormone causes hyperthyroidism. Hypothyroidism, or an under active thyroid, has many causes. Some of the causes are prior thyroid surgery, exposure to ionizing radiation, chronic inflammation of the thyroid (autoimmune thyroiditis), iodine deficiency, lack of enzymes to make thyroid hormone, and various kinds of medication [5]. Hyperthyroidism, or an overactive thyroid, may also be caused by inflammation of the thyroid, various kinds of medications, and lack of control of thyroid hormone production. The seriousness of thyroid disorders should not be underestimated as thyroid storm (an episode of severe hyperthyroidism) and myxedema coma (the end stage of untreated hypothyroidism) may lead to death in a significant number of cases [9, 5]. Proper interpretation of the thyroid data, besides clinical examination and complementary investigation, is an important problem in the diagnosis of thyroid disease. The most common problem in the Field of automatic diagnostic is the diagnostics using fast and accurate algorithm which doesn’t require long time to run and give accurate and correct results [7]. To reduce the diagnosis time and improve the diagnosis accuracy, it has become more of a demanding issue to develop reliable and powerful medical diagnosis system to support the yet and still increasingly complicated diagnosis decision process.. In disease diagnosis the learning and detection of partial disease can be helpful when time and information constraints are present. Thus artificial neural networks provide a good means to partial diagnosis. This paper is thus organized as following in section II a brief introduction of the artificial neural network, in section III Previous related work works that had been done, in section IV thyroid data set that is used in this research has been discussed, in section V simulation tool used is described, In section VI an image processing steps used are described,, in section VII experiment results and discussion is given and in the last section we conclude the paper.

II. ARTIFICIAL NEURAL NETWORKS INTRODUCTION

Artificial neural networks (ANN) have emerged as a result of simulation of biological nervous system, such as the brain on a computer. Artificial Neural networks are represented as a set of nodes called neurons and connections between them. The connections have weights associated with them, representing the ―strength of those connections. Nowadays neural networks can be applied to problems that do not have algorithmic solutions or problems for which algorithmic solutions are too complex to be found. In others words the kind of problems in which inputs and outputs variables does not have a clear relationship between them. Most neural network architecture has three layers in its structure. First layer is input layer which provides an interface with the environment, second layer is hidden layer where computation is done and last layer is output layer where output is stored. Data is propagated through successive layers, with the final result available at the ―output layer‖. Many different types of neural networks are available and multi layer neural networks are the most popular. MLP popularity is due to more than one hidden layer in its structure which helps sometimes in solving complex problems which a single hidden layer neural network cannot solve.

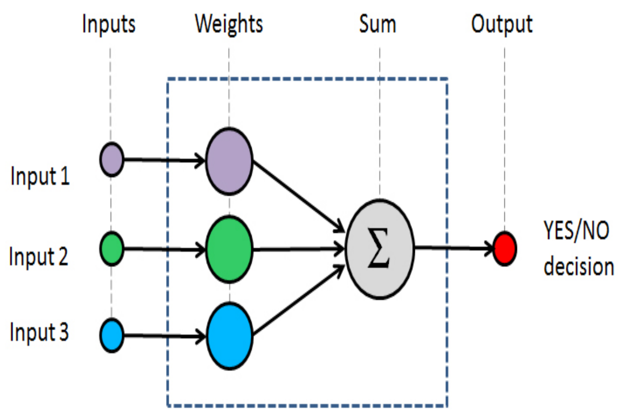


Figure 1 Feed Forward Architecture in Decision Making

III. RELATED WORK

There is a continuous study and research going on in this field of medical diagnosis. There is lot of work has been done on diseases like Cancer, Diabetes, Heart attack etc using neural networks. Rouhani M et al.[2009] present the Comparison of several Ann architecture PNN, LVQ and SVM on Thyroid Disease. The performance of each architecture is studied, and the best method is selected for each of classification tasks. In this paper PNN was selected best model for diagnosis [10]. Isa et al.[2010] had experimented for several activation functions such as Sigmoid, Hyperbolic tangent, Neuronal, Logarithmic and sine activation function for MLP neural network and determined the most suitable function to classify the thyroid diseases as hypothyroid or hyperthyroid. Hyperbolic tangent function had shown the capability of achieving the highest accuracy of an MLP performance [6]. Senol et al. had investigated a new hybrid structure in which neural networks and fuzzy logic are combined to diagnose thyroid diseases. Datasets were taken from UCI machine learning repository. Fuzzy CSFNN, Fuzzy-MLP and Fuzzy-RBF structures were constituted and their performances had been compared. Proposed hybrid schemes have better performances than ANFIS and non-hybrid schemes. The same method had also been experimented for breast cancer diagnosis [2]. Saiti et al., in [2009] had proposed SVM and Probabilistic Neural Network (PNN) as classifier. Genetic Algorithms (GAs) had been used for selection of good subsets of features for improving the diagnosis rate. The classification accuracies obtained by this method is better, but SVM has performed better than PNN.UCI machine learning database for thyroid gland had been used in this research [3].

IV. DATASET USED

The dataset consists of images of persons having thyroid problem. The first step involves the edge detection using the canny edge detector, then ellipse fitted image is created and extraction of infected part is done using the parameters of ellipse. After that image normalization is done. Then these images are passed to the training and testing phase for measuring the performance of various artificial neural networks.

V. TOOL USED

MATLAB ("MATrix LABoratory") is a tool for numerical computation and visualization. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows us to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar noninter active language such as C or Fortran. It also includes tools for developing, managing, debugging, and profiling M-files, MATLAB's applications. All the algorithms in this work will be implemented using MATLAB.MATLAB 2013a version will used for implementation purpose.

VI. IMAGE PROCESSING STEPS

A. Edge Detection: It first converts the RGB image to grayscale image and then edge detection is performed on an image. Edges in images are areas with strong intensity contrasts – a jump in intensity from one pixel to the next. Edge detecting an image significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image. For This purpose Canny edge detector is used.1.It first filter out the noise using gauss ion filter.2. Then apply a pair of convolution masks.3. Find the gradient strength and direction.4. Final step involve two thresholds (upper and lower).

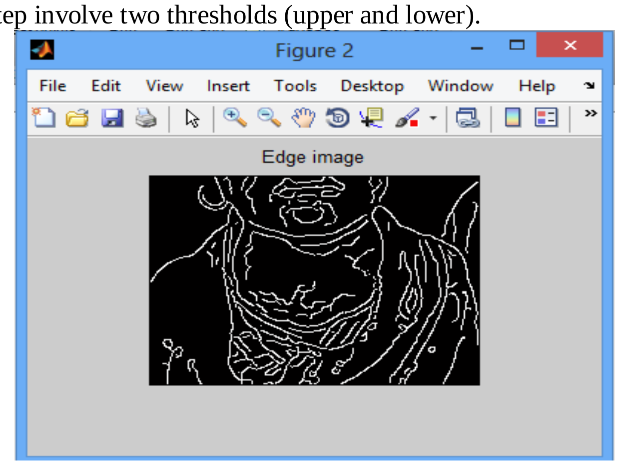


Figure 2: An Edge Image

B. Ellipse Detection:

1. An edge image is obtained from the input image. For this purpose canny edge detector is used.
2. The edge image is scanned again and again to utilize edge information. Since usually the number of edge points is much smaller than that of non- edge points in the image, an edge list that is a series of coordinates of all edge points is generated to avoid scanning non-edge points.
3. Center candidates are detected by voting mid- points of every two edge points using the formula: $x0=(x1+x2)/2$ and $y0= (y1+y2)/2$.
4. Slope candidates are detected by voting perpendicular bisectors of every two edge points using the formula: $\theta = \tan^{-1} (y2 - y1)/(x2 - x1)$.5.Axes candidates are detected by the result of voting the length axes for every edge point

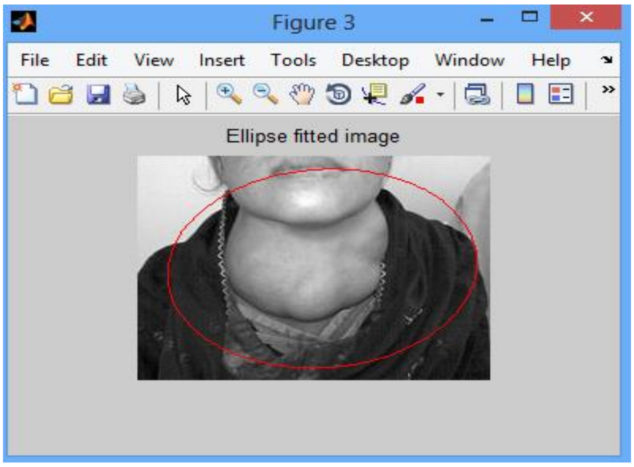


Figure 3: Ellipse Fitted Image

C. Extraction: Once the Ellipse is detecting using the edge map, then it is created using the various parameters like center, orientation, major and minor axes and length of the axes. Finally ellipse fitting part of an image is extracted for further processing using the various parameters of an ellipse as it will take lot of time to perform any operation on the whole image. Like in our work, ellipse is created around the infected part and only that part is extracted for further processing.

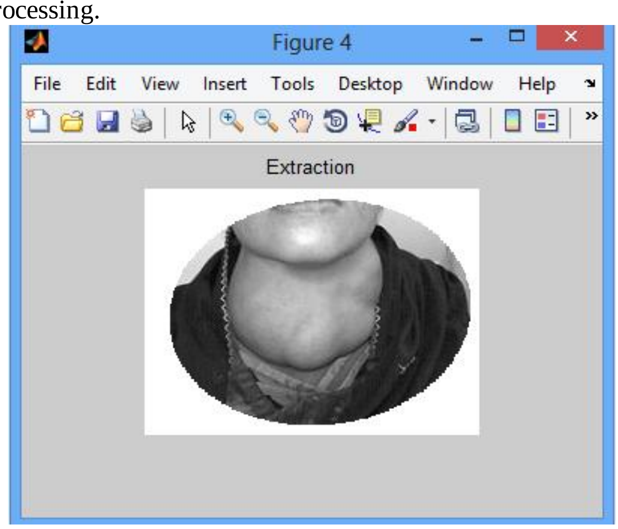


Figure 4: Extracted Ellipse Image

D. Normalization: The final step involves the normalization of all images both for neural network training and testing. Also each image should be about the same size. As we have already done the conversion from RGB to grayscale, each pixel represents one number. Therefore each pixel value is used as one input to the neural network. For instance, if we have images of size 16x16 pixels, our network would have 16*16 = 256 input neurons. The first neuron would see the value of the pixel at (0,0), the second at (0,1), and so on. Edge detection is performed before the normalization as it would increase the speed of learning and also make the detection more robust. So by extracting them as a preprocessing step, the network doesn't have to learn those features.

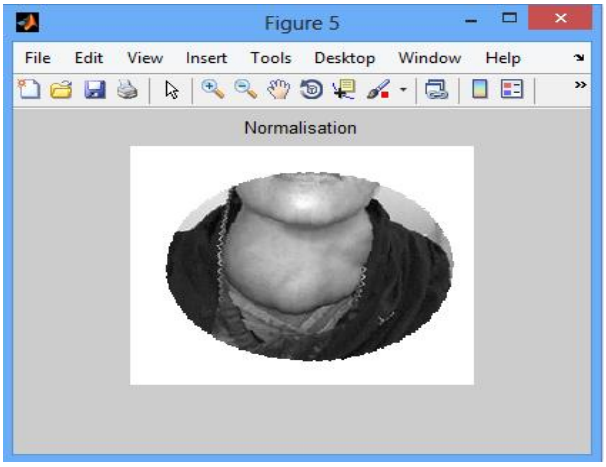


Figure 5: Normalized Image

VII. RESULTS AND DISCUSSIONS

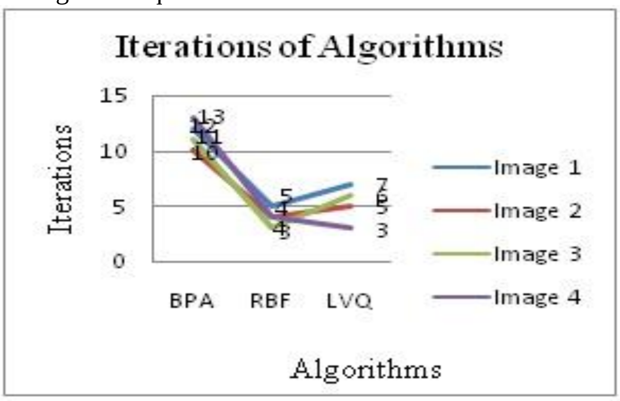
Algorithms	PSNR Value(db)	Iterations
Backpropagation	25.14	12
Radial Basis Function	50.41	4
Learning Vector Quantization	32.38	5

Table 1: Showing Averages of PSNR Values and Iterations of Algorithms Run on 4 Images

This table shows the PSNR value and no. of iterations for the three neural networks algorithms. Lower the no. of iterations means lesser time an algothim will take to give an output and to stop the neural network training. Logically, a higher value of PSNR is good because it means that the ratio of Signal to Noise is higher. Here, the 'signal' is the original image, and the 'noise' is the error in reconstruction. So, if an algorithm has lower mean squared error and high psnrvalur, that means it gives the best results.

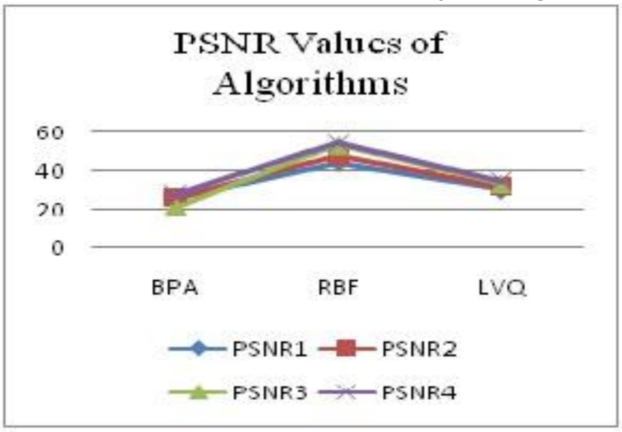
$$PSNR = 20 * \log10 (255 / \sqrt{MSE})$$

From the results,it is shown that the radial basis neural network has the highest value of psnr and minimum no. of iterations.So it is superior to the backpropagation and learning vector quantization.



Graph1 Graph Showing Iterations of Algorithms This graph shows the number of iterations different algorithms take to train a neural network. From the graph, it is shown that the

radial basis function neural network has least number of iterations. That means it takes lesser time to train a neural network. Therefore radial basis function neural network is efficient than the other two networks for thyroid diagnosis.



Graph 2 Graph showing PSNR Values for Different Algorithms

This graph shows the PSNR values for three artificial neural networks namely back propagation, radial basis function and learning vector quantization. From the graph, it is shown that the back propagation has lowest psnr value and radial basis function network has highest psnr value. The peak of all the curves shows the radial basis function neural network. Higher value shows that its mean squared error is low. That's why radial basis function is the best algorithm among the

VIII. CONCLUSION

The importance of using ANNs to diagnose disease is to increase the accuracy of performance. The appropriate selection of ANN architecture affects the network performance effectively to reach the high accuracy. In this work, we considered the different artificial neural networks so as to achieve the best result by comparing their performance on the basis of PSNR value to reach the best possible answer. In the work presented here, three neural network algorithms have been investigated for diagnosis of Thyroid Disease. From the above results we achieve our objective to find the best model for Thyroid diagnosis.

The radial basis function network is the best model for thyroid disease diagnosis. Its performance is 7.87e-18 with 4 iterations to diagnosis the thyroid disease. Its peak signal to noise ratio(PSNR) is 50.41db.Neither of other networks under consideration are superior in terms of performance and PSNR value to radial basis function algorithm. Even the error in radial basis function network is less than other two algorithms. Thus finally we come to conclusion that the Radial basis function algorithm is best algorithm for thyroid diagnosis.

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