Application of Neural Network for Diagnosing Eye Disease

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Abstract— **This paper explores the neural network as an eye disease classifier. In this multi layer neural network and principal component based performance analysis is explored. Selection of the optimal parameters such as number of hidden layers, learning rules and transfer functions are taken into consideration. The classification results are obtained through rigorous experimentation. Diabetic retinopathy is an eye syndrome caused by the impediment of diabetes and it can be detected prior for effective treatment. The vision of patient may start to deteriorate as diabetes progresses and lead to diabetic retinopathy. In this investigation, the sets of parameters describing EEG eye states data set are taken. Thus the classification of eye status represented by the data sets becomes possible. An automated approach for classification of the disease diabetic retinopathy using images is presented. The performances are classified as normal and diseased. Testing grades were found to be complaint with the accepted results that are imitative from the physician's direct diagnosis. The states results verify that the proposed method could point out the capability of design of a new intelligent assistance diagnosis system. Result shows that this new neural network model is more accurate than the other NN models. These results suggest that this model is effective for classification of EEG eye states.**

Index Terms-- **Eye Disease Classification, Multi-Layer Neural Network, Sensitivity, Specificity**

I. INTRODUCTION

Many warning signs and circumstances of eye diseases that could cause damage and blindness if not detected and treated at early stage .Artificial Neural Networks have been employed as a widely used technique for designing decision support system. The reason behind is that people don't think machines to be much reliable when it comes to diagnosis of a disease. But ANNs can do well to ease and harmonize the work of medical experts.ANN are self organizing type and have learning capabilities .The decision support system (DSS) is any section of software that takes as input information about a circumstances and that produces as output inferences that can help practitioners in their conclusion and that would be judged by the program user. In medical diagnosis Artificial intelligence has been applied successfully. Medical error becomes universal matter of international society. Intelligently filtered specific information provided by decision support system to enhance health care. Reducing medical errors, improving the quality of healthcare and guarantying the safety of patients are the most staid duty of the clinicians. The clinical guideline can enhance the security and quality of clinical diagnosis and treatment. In 1990, clinical practice guidelines were defined as it is "systematically developed statements to assist practitioner and patient decisions about appropriate physical condition for specific clinical circumstances"[23]. They discover by instruction from past experience data and construct generalization on hidden data. For the ANN model they have been applied as tools and provide problem solving approach in real world applications such as gesture recognition, financial prediction, speech recognition, and medical diagnostics. The measure of medical error is incredible, most of medical errors occurred by human factor could be avoided by computer system. They have been used for skin disease diagnosis, fetal delivery, and metabolic synthesis. After biological neural systems artificial neural networks are artificial intelligence paradigms, which are loosely modelled machine learning tools. Back propagation is the most popular algorithm used for training neural networks which employs gradient descent learning.

II. EXISTING APPROACHES

Various neural network algorithms were used to develop diagnosis system such as Levenberg-Marquardt learning algorithm, classification tree analysis, Probabilistic Neural network , Bayesian Classification and Support vector machine and Multilayer Perceptron (MLP), Generalized Feed Forward neural network Many important eye diseases as well as systemic diseases manifest themselves in the retina. While a number of other anatomical structures contribute to the process of vision, this review focuses on retinal imaging and image analysis. Following a brief overview of the most prevalent causes of blindness in the industrialized world that includes age-related macular degeneration, diabetic retinopathy, and glaucoma, the review is devoted to retinal imaging and image analysis methods and their clinical implications. Image processing with matched filter response, Fuzzy logic methods using discrete wavelet transform are proposed for eye disease diagnosis. Decision trees were proposed for diagnosis.

Levenberg-Marquardt Learning Algorithm used by many researcher for classification.Povilas et al.[1] had proposed neural network as a eye disease classifier. Sets of glaucomatous and healthy eyes are taken for investigation.. The network activation function log sig and the Levenberg-Marquardt learning algorithm have been applied and the results are achieved. The network should be properly evaluated on a larger set of input vectors used for network training and validation. Aysegul et al. [4] explore a diagnostic system using artificial neural networks (ANN) methods to identify the macular disease from Pattern Electro Retionography (PERG) signals.

R.Priya et al [2] had describe three models of Probabilistic Neural network (PNN), Bayesian Classification and Support vector machine (SVM) and their performances are compared for diagnose diabetic retinopathy. S.Yan et al. [12] had

represented data mining framework to cluster optic nerve images obtained by Confocal Scanning Laser Tomography (CSLT) in normal subjects and patients with glaucoma. Data driven clustering approach presented with automated characterization [26].Self organizing maps and expectation maximization methods are used to partition the data into clusters which provided insights into potential sub-classification of glaucoma based on morphological features.

Alireza et al.[8] compare two methods for classification of retinal images after segmenting exudates regions. Support Vector machine and neural network classifiers are used to get good class separability between exudates and non-exudates classes. Results from both classifiers are nearly similar. Guven and kara had represented ANN based diagnosis system for subnormal eye through the analysis of Electrooculography (EOG) Signals. Authors implemented the Levenberg Marquart back-propagation algorithm was implemented. The designed classification structure has about 94.1% sensitivity, 93.3 % specipity and positive prediction is calculated to be 94.1%. Results are classified as normal & subnormal eye [4]. Hitzl describes a linear discriminant analysis with forward stepwise variable selection algorithm and classification tree analysis for potential glaucoma suspects with and without visual field defects. In this Humphrey visual field analyzer was used to test the visual fields and Scanning laser tomography measured the optic nerve topography. The generalization error should be reported both in training, test sample and methods should be applied to select a appropriate training sample size for valid generalization [5].

Aliaa et al.[23] presented a method to automatically detect the position of the OD in digital retinal fundus images. The method starts by normalizing luminosity and contrast throughout the image using illumination equalization and adaptive histogram equalization methods respectively. Image Processing Techniques proposed for detection and testing in biomedical stream. Hoover et al. [18] described a method for automatically detecting new vessels on the optic disc using retinal photography. D.Vallabha et al. [20] proposed a method for automated detection and classification of vascular abnormalities in Diabetic.

The performances of three different networks in classification of eye disease data sets are compared in this article. Those include Multilayer Perceptron (MLP), Generalized Feed Forward (GFF) neural networks. MLPs are feed-forward neural networks trained with the standard back-propagation algorithm. It is shown that a network having a single layer of threshold units could classify a set of points perfectly if they were linearly separable [17]. Here you simply specify the number of layers, and the wizard will construct a MLP in which each layer feeds forward to all subsequent layers. In theory, a MLP can solve any problem that a generalized feed forward network can solve. In practice, however, generalized feed forward networks often solve the problem much more efficiently. A classic example of this is the two spiral problem. Without describing the problem, it suffices to say that a standard MLP requires hundreds of times more training epochs than the generalized feed forward network containing the same number of processing elements [17].

III. CLASSIFICATION

This study classifies eye disease using patient complaint, symptoms and physical eye examinations. The disease covered includes the following eye disease; eye conjunctivitis, Glaucoma, Cataract, Macular Degeneration, retinal detachment, Corneal ulcer, Colour blindness, Far sightedness, Near sightedness, and Astigmatism. The Artificial Neural Networks (ANN) has been widely used as tools for solving many decisions modelling problems. The assorted capabilities and properties of ANN like Input-Output mapping, Adaptively, Non-parametric, Non-linearity make it a superior alternative for solving inertly parallel distributive structure and difficult task in comparison of statistical techniques, where rigid assumptions are prepared for the model. Artificial Neural Networks being non-parametric, makes no assumption about the distribution of data and thus capable of letting the data speak for itself. As a result, where large database of relevant medical information are available ANN is solution for modelling complex medical problems. The extracted knowledge from neural networks is transformed as rules which will help experts in understanding which combination of symptom, physical eye examination and patient's complain constituents have a major role in the eye problem. The rules contain information for sorting eye diseases according to their symptoms, physical condition and complain from the patient and knowledge acquired by neural networks from training on previous samples.

For classification we have used multilayer perceptrons (MLPs) are feed forward neural networks (FF NNs) trained with the standard back propagation algorithm. They are supervised networks so they require a desired response to be trained. Most NN applications involve MLPs. They learn how to transform input data into a desired response, so they are widely used for pattern classification. They are very powerful pattern classifiers. With one or two hidden layers they can approximate virtually any input –output map. They efficiently used the information contained in the input data. A meticulous and careful experimental study has been carried out to determine the optimal configuration of MLP NN model. Table 1 displays the variable parameters of MLP NN Model.

Table 1-Variable parameters of MLP NN model

S.N	Parameter	Typical Range	Optimal value
1	Hidden Layer	1 to 2	1
2	PE	1 to 25	19
3	Learning rule Back propagation algorithm	Momentum, conjugate gradient, Levenberg Maequardt,Step,Delta-bar-delta	Momentum
4	Transfer function of output layer	Linear,Lineartanh, Tanh	Tanh

The architecture of the network used in this study was having a set of 10 hidden layers in the neural network was used with the number of inputs to the neural network (i.e. the number of neurons) is equal to the number of eye states. The neural network used is the feed forward back propagation with the performance function being the Mean Square Error (MSE) and the number of iterations was 1000 and the maximum allowed error was 10-5.

IV. RESULTS

The results for NN classification approach for testing samples were obtained using a NN classifier for different eye states of diabetic patients. In scrupulous, model achieved the highest overall classification accuracy, in which it achieved an overall accuracy of 94% compared to the 89.5% accuracy achieved. It can be concluded that model is the best overall model in this classifier in terms of accuracy and in computational time for both training and classification.

This ease and solidity in the structure indicates the feasibility of the MLP NN for the online implementation, and the hardware implementation. With chosen optimal parameters of MLP NN, the average (and best respectively) classification of 100 % (and 100%) 92.22% overall accuracy, sensitivity 98.67%, specificity 98.69% are achieved which shows consistent performance than other NN models and the system runs in a 0.000001 millisecond. It also implies that the MLP NN as a classifier for this work possesses more learning ability than the other NN's. It was found that the MLP neural classifier has the advantage of reducing misclassifications among the neighbourhood classes compared to other NN classifiers as per the confusion matrices. It has provided consistent classification accuracy for both, healthy and diseased instances.

V. CONCLUSION

MLP is the fastest network, simple in design and synthesis, lowest average MSE, highest accuracy and ROC analysis is perfect approaching unity. This learning confirms that MLP NN artificial neural networks outperforms previous NNs and offer a useful approach for diagnostic algorithms for diabetic patients. The dimensionally compact MLP neural network method has also proved to be consistent. Extra studies with larger numbers of real samples are required to better assess the usefulness of artificial neural networks. It is observed that MLPNN is the fastest network, simple in design and synthesis, the lowest average MSE, highest accuracy and ROC analysis is perfect approaching unity. Significant (49.5%) reduction in connection weights and (37.50%) reduction in training time are achieved. Advance developments in each step of algorithm are required to improve the overall performance of computer aided detection and diagnosis algorithms. The dimensionally compact MLP neural network method has proved to be reliable for implementing quantitative interpretation of diabetic eye diseases.

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