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Diagnosis of Poor Eyesight based on Support Vector Machine and Artificial Neural Networks

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ABSTRACT

This research paper provides new methods to diagnose eyesight related problems for the people who have problems in their vision. The paper gives a method for detecting the Myopia (Short-Sightedness) or Hypermetropia (Long-Sightedness) eyesight problem in the vision and to define the problem (if it is found), by getting eyesight distance (SPH) and deviation (CYL) measurements. , whenever the measurements of SPH or CYL are in normal range then there is no problem for physician to diagnose, but when measurements any of each of them are out of normal range then- it is relatively difficult to diagnose and physician take more time to take decision.
Because of the importance of eyesight in human anatomy we design an approach to diagnosis this problem using Neural Networks and Support Vector Machines to detect the performance of the methods and to assist physician to take appropriate decision on time.

Keywords: *Support Vector Machine, Neural networks, Short-Sightedness, Long-Sightedness.*

1. INTRODUCTION

Artificial Intelligence elements like Artificial Neural Networks, Fuzzy logic, Expert Systems, Genetic Algorithms, etc. are tend to emulate the human brain.

The techniques used in this paper are SVMs and ANNs to diagnose eyesight related problems for the people who have problems in their vision.

Recently Support Vector Machines have been used in a range of problems including bioinformatics [1] text categorization [2], classification and pattern recognition [3,4,5]. The support vector machine is a method for dividing a feature space using an optimized hyper plane, whereas Artificial Neural networks have been successfully applied to problems in pattern classification, pattern matching, function approximation, optimization and associative Memories [6].

In Artificial Neural Networks the nonlinearity of transfer function gives the network capability to emulate nonlinear mapping properties [7,8,9]. In this research a feedback net mechanism has been used.

2. EXPERIMENTS DESIGN

Matlab 7.0.1 package has been used for Support Vector Machines and Neural Networks methods. The datasets of the Eyesight test (L-SPH, L-CYL, R-SPH, and R-CYL) used in this study were obtained from the archives of Dr. Hafiz Sabry Optical Clinic and Ibn Al-haitham eyeglasses shop. Since sphere (SPH) measures a long-sighted and short-sighted and cylinder (CYL) measures the astigmatism.

L-SPH is the left eye's sightedness measurement.
L-CYL is the left eye's astigmatism measurement.
P-SPH is the right eye's sightedness measurement
R-CYL is the right eye's astigmatism measurement

SPH in the range of [-6 to 6] as the following:
[-6 to -0.5] it means Short-Sightedness, [-0.25 to 0.25] it means Normal Eyesight and [0.50 to 6] means Long-Sightedness.

CYL in the range of [-4 4] as the following:
[-4 to -.5] it means Short-Sightedness (Myopia), [-0.25 to 0.25] it means Normal Sight and [0.50 to 4] means Long-Sightedness (Hypermetropia) [10,11].

We have collected required amount of data (90 datasets of left eye, 90 of right eyes for patients with Long-Sightedness and Short-Sightedness and 90 for persons with Normal Eyesight) for diagnosis and divided it into two groups for learning and testing.

Table-1 consist some samples of these data with concert criteria specially SPH and CYL for left eyes < L > and right eyes < R >, the third column AX for left and right eyes is not considered in our paper because it was measured as angle of deviation which can be used in future work.

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Table 1: samples of data with criteria SPH and CYL for left eye and right eye.

PATEINT NO.	Left eye< L >			Right eye < R >		
Criteria	SPH	CYL	AX	SPH	CYL	AX
1	+1.00	+2.00	60	+1.00	+0.75	2
2	+0.50	+1.00	98	+0.50	+0.50	30
3	+4.00	+0.50	63	+3.75	+0.75	88
4	+1.50	+c0.50	174	+1.25	+1.25	134
5	-2.25	-2.00	6	-1.75	-1.00	175
6	-1.00	-0.50	82	-1.25	-0.75	81
7	-4.00	-0.50	63	-3.75	-0.75	88
8	-3.75	-0.75	152	-2.25	-1.25	25
9	0.00	0.25	0	0.25	0.00	6
10	-0.00	0.25	0	-0.25	0.00	2
11	0.00	-0.25	2	-0.25	-0.25	8
12	0.25	0.25	3	0.00	0.25	4

Table-2 consist some training samples of short-sighted (myopia) and long–sighted (hypermetropia) for left and right eyes which used with both two methods (ANN and SVM).

Table 2: some training samples which used with both two methods (ANN and SVM).

	Left eye< L >		Right eye < R >	
Measure	**SPH**	**CYL**	**SPH**	**CYL**
1	-1.00	-2.00	-1.75	-2.25
2	+1.00	+0.50	+1.25	+0.75
3	+0.00	+1.25	+2.25	+1.25
4	+4.00	+0.50	+3.75	+0.75
5	+0.00	-0.25	-0.25	-0.25
6	-3.75	-0.75	-2.25	-1.25
7	-2.50	-0.50	-2.00	-0.75
8	+3.00	+0.50	+3.75	+1.75
9	+0.00	+0.25	-0.25	-0.00
10	-1.50	-0.50	-1.00	-1.25
11	+4.00	+0.50	+3.50	+1.25
12	0.25+	.00-0	+0.00	+0.25

3. RESEARCH METHODS

3.1 Artificial Neural Networks

A neural network has been used for classification and checking eye sightedness. The proposed designed neural Network has been trained by using Back propagation algorithm. Back propagation algorithm considers one of high ability algorithms which can be use in pattern classification. In practices the back propagation neural network is one of most popular methods which provides a powerful linear and capable of nonlinear mapping.

We have selected this algorithm because of the best results in classification using ANN especially that the second comparison method is Support Vector Machine which usually give precise results in classification [12]. The proposed designed network with back propagation algorithm using one hidden layer and given below are the parameters with which BP was in stability stage:

Input neurons 4, regarding to parameters for left and right eyes (L-SPH, L-CYL, R-SPH,R-CYL)

Hidden neurons 2
Output neurons 2
Initial weight in the rang [0:1]
Learning Rule: Standard Delta Rule
Learning rate: 0.2
Transfer Function: logsig
Iteration=12000
Performance :0.001

The basic BP architecture is shown in Fig.1

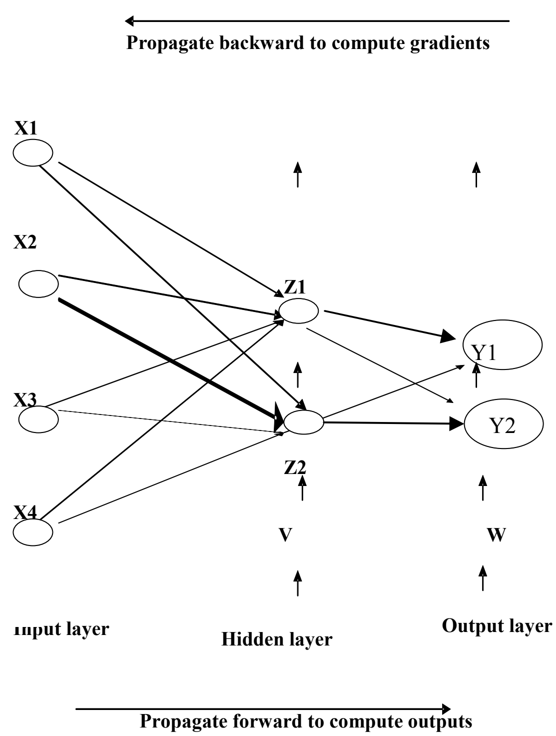

Fig 1: BP Structure

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Table 3: some samples of the testing data with target (output) using ANN

Eyesight State	Testing data	Testing result	Target
Myopia	-0.25 -2.25 - 1.75 -1.25 -4.00 -0.50 - 2.75 -1.75 -3.25 -2.50 - 2.75 -1.75 -1.00 -0.50 - 1.50 -0.50	0.1044 0.8125 0.0687 0.9463 0.0088 0.9887 -0.0021 1.0268	0 1
Normal	+2.00 +3.25 +1.75 +3.25 +1.25 +0.50 +1.50 +1.00 +3.00 +3.00 +1.50 +3.00 +2.00 +1.50 +2.25 +0.50	0.9711 0.0512 08785 0.0117 1.0200 - 0.0168 0.9988 0.0140	1 0
Hypermetropia	-0.25 -0.25 +0.00 -0.25 -0.25 +0.25 - 0.25 -0.00 +0.00 +0.00 +0.25 +0.00 -0.25 -0.25 - 0.25 +0.00	0.9853 0.9990 0.6332 0.8989 1.0068 1.1001 1.0288 0.9999	1 1

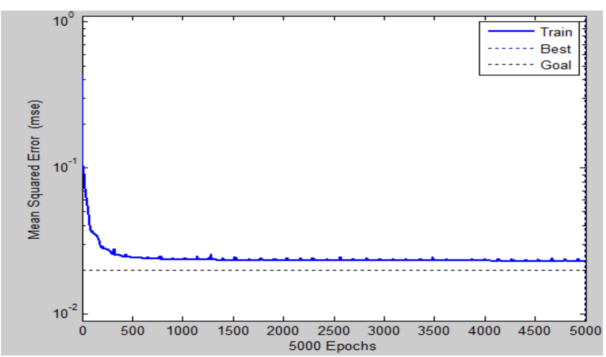

Fig 2: Mean squared Error

3.2 Support Vector Machine

The support Vector Machine (SVMs) were first suggested from concepts of structural risk minimization, statistical learning theory and support vector classifier formulation [13]. The support vector machine (SVM) is a method for dividing a feature space using an optimized hyper plane; it means that SVM classifies data by determining a set of support vectors with different class labels that are members of the set of training inputs that outline a hyper plane in the feature space. The target is to minimize complexity and error of the classifier. The usefulness of his functionality is that SVMs are excellent for modeling space with a few dataset. The simplest implementation of the support vector machine uses two classes (+1,-1) [14]. Classes with -1 denote negative diagnosis and class with +1 denote positive diagnosis. For example if there is no problem with vision viruses then Class with -1 is appear to represent negative diagnosis. If the feature space of these two classes is linearly separable, a hyper plane can be used to divide the data. but if the features space is not linearly separable, then the space can be projected into a higher dimensional metric space, known as the Hilbert space, since as the user must select one of a kernel function(linear , polynomial or radial) for the SVM during the training process that selects support vectors along the surface of this function. The ultimate goal is to find a dimension where the feature space will be linearly separable.

Table-4 consist some testing samples of short-sighted (myopia) or long–sighted (hypermetropia) or Normal regarding to training of Support Vector Machine.

Table 4: some samples of the testing data using SVM

	Left eye< L >		Right eye < R >	
Measure	**SPH**	**CYL**	**SPH**	**CYL**
1	-0.25	-2.25	-1.75	-1.25
2	-4.00	-0.50	-2.75	-0.50
3	-3.25	-2.50	-2.75	-1.75
4	-1.00	-0.50	-1.50	-0.50
5	+2.00	+3.25	+1.75	+3.25
6	+1.25	+0.50	+1.50	+1.00
7	+3.00	+3.00	+1.50	+3.00
8	+2.00	+1.50	+2.25	+0.50
9	-0.25	-0.25	+0.00	-0.25
10	-0.25	+0.25	-0.25	-0.00
11	+0.00	+0.00	+0.25	+0.00
12	-0.25	-0.25	-0.25	+0.00

Table 5: Results of Linear and Nonlinear SVM methods

Testing Criterion	Method			
	Standard Linear	Kernal Linear	Nonlinear using Polynomial Kernal function	Nonlinear using Radial Kernal function with g=0.00001
	Correctly classified instances in (%)	Correctly classified instances in (%)	Correctly classified instances in (%)	Correctly classified instances in (%)
Testing Result	**62**	**97**	**96**	**98**

Table 6: Summary Testing Results of SVM and ANN

Testing Criterion	Method	
	Nonlinear using Radial Kernal function	Neural networks (Back Propagation algorithm)
	Correctly classified instances in (%)	Correctly classified instances in (%)
Testing Result	**98**	**92**

4. RESULT AND DISCUSSION

In this paper we have used ANN and SVM specially because of their strength in classification , According to previous applied studies and researches in SVM ,the results of the use of SVM methods usually give high classification in test relevant results except linear functions , which show that it gives non high classification despite the strength of SVM mechanism. It has been shown that the linear methods require a large number of data to get high classification so classification's percentages of SVM which consists in Table-5 are close to each other except standard Linear classification result by standard linear is not persuasive, may be because of the not big enough amounts of data , Where there are great difficulties in massive data collection from Optical Clinics. Where as the Table-3 consist some testing samples of short-sighted (myopia)or long–sighted (hypermetropia) or Normal regarding to training and testing of Artificial Neural Network with small error regarding to Fig.2. The optimum classified instances of the experiments are summarized in Table-6, which shows that nonlinear SVMs is able to increase the specificity from 92% by use of Artificial Neural Networks up to 97%, that because the Kernel function of SVM use feature space for classification instead of input space ,moreover the maximum margin used in hyper plane gives better margin for the class.

5. CONCLUSION

This research paper represents very important achievement of selecting and using some fields of AI like Support Vector Machine and Neural network to diagnose the Eyesight state, especially Support Vector Machine, Because of its capability in classification Support Vector Machine in this study offers powerful tool for Short sightedness (Myopia), normal and long sightedness (Hypermetropia) diagnosis.

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