Modular Neural Network for Detection of Diabetic Retinopathy in Retinal Images

Manish Sharma, Praveen Sharma, Ashwini Saini and Kirti Sharma

Abstract Modular feedforward network method is introduced to detect diabetic retinopathy in retinal images. In this paper, the authors present classification method; the Modular Feedforward Neural Network (MNN) to classify retinal images as normal and abnormal. Publically available database such as DIA-RETDB0 including high-quality normal and abnormal retinal images is taken for detection of diabetic retinopathy. Modular Feedforward Neural Network is designed based on the extracted features of retinal images and the train N times method. The classification accuracy by MNN classifier was 100% for normal retinal images and 86.67% for abnormal retinal images. In this paper, the authors have explored such a method using MNN classifier which can detect diabetic retinopathy by classifying retinal images as normal and abnormal.

Keywords Diabetic retinopathy · Modular feedforward neural network
Classification accuracy · Retinal images database DIARETDB0

M. Sharma (✉)
Delhi Technological University, New Delhi, India
e-mail: prof.manishsharma@gmail.com

P. Sharma · A. Saini
Global Institute of Technology, Jaipur, India
e-mail: praveen141sharma@gmail.com

A. Saini
e-mail: aasumi18@gmail.com

K. Sharma
Jagannath University, Jaipur, India
e-mail: kirtisharma259@yahoo.com

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1 Introduction

Diabetes is an infection that influences veins all through the body, basically in the kidneys and eyes. Diabetic Retinopathy (DR) is a circumstance when veins in the eyes are influenced. Diabetic retinopathy is a primary general medical issue and this is the fundamental driver of visual impairment in the world so far [1]. It is incited by changes in the veins of the retina prompted this issue.

1.1 Diabetic Retinopathy Has Following Major Symptoms

- Double vision;
- Development of a scotoma or shadow in your field of view;
- Eye floaters and spots;
- Blurry and additionally misshaped vision;
- Fluctuating vision;
- Eye torment;
- Near vision issues disconnected to presbyopia.

Diabetic retinopathy is a microvascular intricacy which may be discovered in patients having diabetes. Diabetic retinopathy's occurrence will bring about the aggravation of visual ability and can eventually lead to visual impairment. The more extended a man has untreated diabetes; there is higher shot of developing diabetic retinopathy as it might be changed over into vision misfortune. When high glucose harms veins in the retina, eyes can spill drain or fluid. This prompts to the retina to swell and shape stores in early phase of diabetic retinopathy. Alongside diabetes, high glucose levels in long stretches can influence little vessels in the retina. Diabetic retinopathy gets to be distinctly symptomatic in its further stage. In the early stage, diabetic patients usually unaware about the infection of the disease [2]. In this way location of diabetic retinopathy at first stage is critical to keep away from vision misfortune. Diagnosing diabetic retinopathy is normally directed by the ophthalmologist by utilizing retinal images of patients [3, 4].

Diabetic retinopathy may grow through mainly four stages:

1. Mild non-proliferative retinopathy—In this small zones of balloon like swelling in the retina's little vein occurs, called smaller scale aneurysms, emerge at this first phase of the illness. These microaneurysms may release fluid/blood into the retina.
2. Moderate non-proliferative retinopathy—At this stage, as the illness turns out to be more terrible; veins that support the retina may swell and mutilate. Their capacity to transport blood may be lost. Both circumstances cause characteristic changes to the presence of the retina and may add to DME.

3. Severe non-proliferative retinopathy—At this stage, numerous more veins are blocked, denying blood supply to ranges of the retina. These influenced areas emit development variables which flag the retina to develop fresh blood vessels.
4. Proliferative diabetic retinopathy (PDR)—During this advanced stage, development variables emitted by the retina trigger the expansion of fresh blood vessels, which develop along within surface of the retina and vitreous gel, the liquid/blood which fills the eye. The fresh blood vessels are delicate, that makes them more inclined to spill and drain. Also scar tissue can contract and further be the reason of retinal separation. The pulling without end of the retina from hidden tissues, similar to backdrop peeling is far from a divider. Retinal separation can lead to permanent vision loss.

In further stages, spillage from veins into the eye's unmistakable, jam like vitreous can bring about genuine vision issues and in the long run results in visual impairment.

In this manner, identification of diabetic retinopathy at introductory level is imperative to maintain a strategic distance from vision misfortune. Finding of diabetic retinopathy is typically directed by the ophthalmologist by utilizing retinal pictures of patients. Ophthalmologist can get retinal pictures from patients to be analyzed by utilizing a fundus camera [5]. From the picture, indications will be recognized physically by an ophthalmologist. In this manner, additional time is required to analyze more number of patients.

A computerized screening framework can be utilized for completely automated mass screening [6]. Such frameworks screen an expansive number of retinal pictures and distinguish anomalous pictures, which are then further inspected by an ophthalmologist. This would spare a lot of workload and time for ophthalmologists, permitting them to focus their assets on surgery and treatment. Ordinary structures of retina are the optic plate, macula, and veins. The trademark elements of diabetic retinopathy are small-scale aneurysms, hemorrhages, and exudates [7]. From the arrangement of parameters like vessel proportion, proportion of exudates range to the aggregate zone of the pictures are appropriated into various gatherings like ordinary, extreme, mellow and irregular diabetic retinopathy, and so forth. Neural systems can be utilized viably in information characterization [8].

2 Database Acquisition

In order to conduct the experiment for detection of retinal images, in public database DIARETDB0 was used. The newest database has 130 colour fundus images out of that 20 are normal and remaining have signs of the diabetic retinopathy [9]. The images were taken in the Kuopio university hospital. The images were dedicatedly elected, however their distribution does not correspond to any typical population, images were captured with few fifty degree field of view digital fundus cameras with unknown camera settings. The images have an unknown quantity of imaging noise and optical aberrations (transverse, dispersion and lateral spherical, chromatic, coma, field curvature, astigmatism, distortion).

Difference over the visual appearance of changed retinopathy discoveries can in this manner be considered as maximal. In any case, the information compared to pragmatic circumstances, and can be utilized to assess the general execution of diagnosis techniques. The general execution relates to the circumstance where no adjustment is played out (no correspondence to this present reality estimations), yet where pictures compare to regularly utilized imaging conditions, i.e., the conditions normally experienced in healing centers. This data set is alluded as “calibration level 0 fundus images” [10]. The database was separated into two sections for training and testing.

A. Feature Extraction

Location of retinopathy includes nearness of exudates, clinical acknowledgment of widening of veins and injuries or whatever other irregularity in the retinal images. Fundus images give the data of these neurotic components with the exception of that anatomical data of the retina in eye. The elements watched are system of veins, macula, and the optic circle in a solid retinal picture. Any change because of diabetic retinopathy or other malady will bring about variety in above talked about components which makes it easy to analyze the sickness. Figure 1 describes about the retinal picture which is influenced with diabetic retinopathy while Fig. 2 describes about the sound dim level fundus picture [11].

In this investigation, diverse elements of retinal images were extricated. The removed elements were: DCT, Entropy, mean, standard deviation, Euler number, normal, relationship, difference, and vitality. Creator’s objective was to discover conceivable elements that can really separate retinal picture as typical or anomalous.

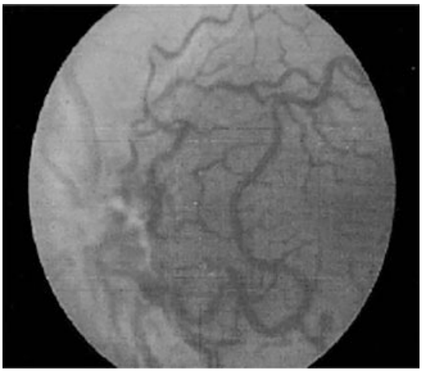

Fig. 1 Affected eye with diabetic retinopathy

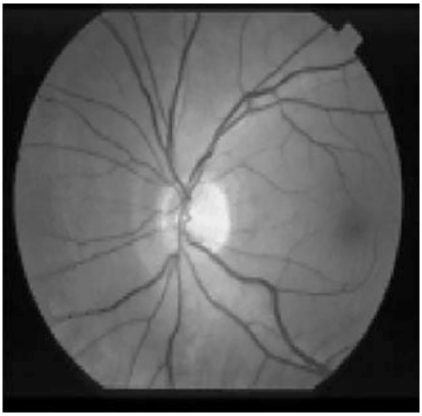

Fig. 2 Non-affected eye

3 Modular Feedforward Neural Networks

As the name shows, the particular bolster forward neural systems are unique instances of Multilayer Perceptron (MLPs) [12], with the end goal that layers are fragmented into modules. This has a tendency to make some structure inside the topology, which will propel specialization of capacity in every sub-module. In science, particular neural systems are exceptionally regular. Rather than the MLP, measured modular feedforward systems do not have full interconnectivity between the layers. In this way, a littler number of weights are required for a similar size system (a similar number of PEs). This tends to speed the preparation and decline the quantity of models required to prepare the system to a similar level of precision. Modular feedforward neural system is best reasonable model to be used [13].

4 Overview of Classifier System

It is proposed to build a choice emotionally supportive network for the identification of diabetic retinopathy utilizing the counterfeit consciousness procedure. The authors expect to utilize neural system for the discovery of diabetic retinopathy utilizing highlights separated from the retinal pictures. The fundus photos will be gathered from information storehouses. These photos were brought with a fundus camera amid mass screening and after that examined by a level bed scanner and spared as picture records. After that, the picture documents were broke down utilizing the calculations discussed further: Fig. 3 demonstrates the square chart of the proposed framework. It has eight modules: Retinal Fundus Image input, Pre-handling, Feature Extraction, Graphical User Interface (GUI), Modular nourish forward Neural Network Classifier, Parameter Acquisition, Graphical User Interface (GUI), and Results (Detection). Here information is the retinal pictures from

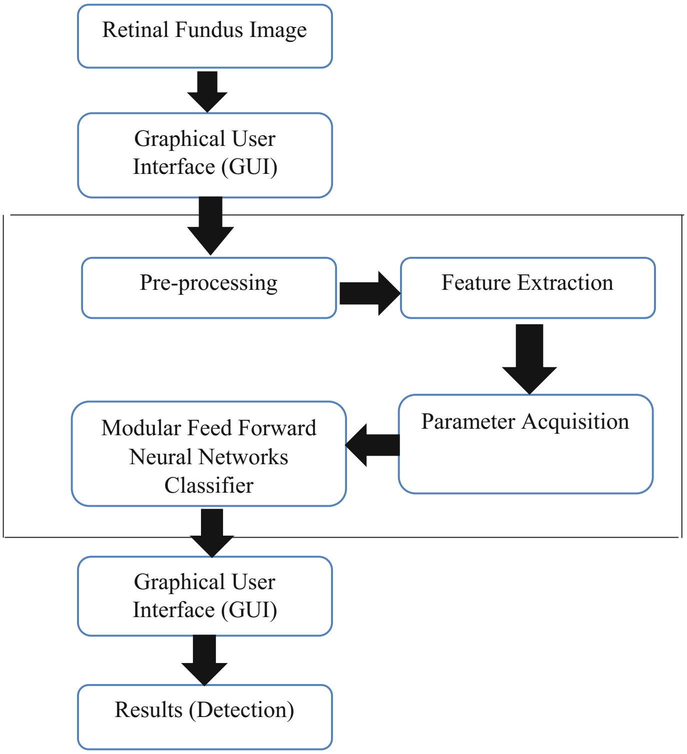

Fig. 3 Block diagram of the proposed system

Table 1 Modular feedforward network's recognition results

Output/desired		Normal (ON)	Abnormal (OA)
Training dataset	ON	19	0
	OA	0	95
Test dataset	ON	1	2
	OA	0	13

Table 2 Modular feedforward networks recognition result based on performance

	Performance	ON	OA
Training dataset	MSE	0.013698564	0.012000019
	Min Abs error	0.0013881	0.000860905
	Percent accuracy	100	100
Test dataset	MSE	0.155588824	0.160918599
	Min Abs error	0.019526124	0.003081384
	Percent	100	86.66666667

DIARETDB0 database [14] and in the wake of removing the picture highlights, modular neural system was prepared to recognize pictures as typical or anomalous yields (Tables 1 and 2).

5 Results

The modular feedforward neural network was used to test the proposed features of retinal images. The neural network was exhaustively designed using one hidden layer with a single neuron. Then progressively numbers of neurons were expanded. The same process was rehashed with two concealed layers. Numerous parameters were changed logically to set ideal neural system with best outcomes and slightest intricacy. The trial results are portrayed in taking after tables.

MSE: The average of the square of the difference of the required response and the actual system output (the error).

6 Conclusion

This paper proposes a system for detection of diabetic retinopathy using neural network. The authors have designed Modular Feedforward neural network for detection of diabetic retinopathy by classifying retinal images as normal or abnormal. Features of retinal images were based on the DCT, Entropy, mean, standard deviation, average, etc., and were given as the input to the neural network. The Train N Times training method was used to train the network. It was observed that with 02 hidden layers and 04 neurons the classification accuracy was 100% for normal retinal images and 86.67% for abnormal retinal images.

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