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# Retinal Abnormality Detection Using Artificial Neural Network

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***Abstract*— Glaucoma is the diagnosis given to a group of ocular conditions that contribute to the loss of retinal nerve fibers with a corresponding loss of vision.Glaucoma is the major cause of blindness in people above the age of 40. The Intra Ocular Pressure (IOP) increases because of the malfunction of the drainage structure of the eyes leading to Glaucoma. There are several methods to detect Glaucoma from a human eye in the initial stages. The proposed work automatically detects Glaucoma disease in human eye from the fundus database images. The feature extraction within images is done using Gray Level Difference Method (GLDM) and the classification is done by trained Artificial Neural Network. In this work, we achieved an accuracy of 86.66% with sensitivity at 93.33% and specificity at 80%.**

***Index Terms*— GLDM Feature extraction, ANN Classifier, Sensitivity and Specificity.**

## I. INTRODUCTION

The Aqueous humour that is secreted by ciliary muscles has immunoglobulins that protect the eye against pathogens and also maintain the shape of the eye. As the total amount of fluid within the eye increases, so does the pressure, similar to over inflating a tire, which damage retinal nerve fibers and hence the optic nerve cannot carry images to the brain. Loss of peripheral vision is the earliest symptom. If left untreated the field of vision will continue to narrow leading to tunnel vision. If detected early, loss of vision can most often be prevented. Glaucoma can be hereditary and diabetic people have double risk of getting affected by it.
There are two main types of glaucoma:

- Open-angle glaucoma: Also called wide-angle glaucoma, this is the most common type of glaucoma. The structures of the eye appear normal, but fluid in the eye does not flow properly through the drain of the eye, called the trabecular meshwork.
- Angle-closure glaucoma: Also called acute or chronic angle-closure or narrow-angle glaucoma, this type of glaucoma is less common in the West than in Asia. Poor drainage is caused because the angle between the iris and the cornea is too narrow and is physically blocked by the iris.This condition leads to a sudden buildup of pressure in the eye.

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II. LITERATURE SURVEY

Literature Survey is one of the most important steps in the course of execution of a project. It reduces the duplication of work.

L´aszl´o G.Ny´ul [1] devised a novel automated glaucoma classification technique, depending on image features from fundus photographs. In this study, data-driven technique does not need any manual assistance. First of all size differences, non uniform illumination and blood vessels are eliminated from the images. They then extracted the high dimensional feature vectors. Finally compression is done using PCA and the combination before classification with SVMs takes place. This scheme achieved 80% success rate.

J. Crawford Downs, Vicente Grau [2] proposed an algorithm that uses an anisotropic Markov random field (MRF). This algorithm had been tested on an artificial validation dataset that is similar to ONH datasets. It has shown significant improvement over an isotropic MRF. This algorithm provides an accurate, spatially consistent segmentation of this structure.

Georg Michelson [3] proposed an algorithm that undertakes a standard pattern recognition approach with a 2-stage classification step. In this study, various image-based features were analyzed and integrated to capture glaucomatous structures. This project achieved a success rate of 81 %.

III. PROPOSED METHOD

This paper is mainly focused on finding the glaucoma disease using the fundus image. The proposed system automatically detects the normal or glaucoma affected image with very high accuracy using ANN.

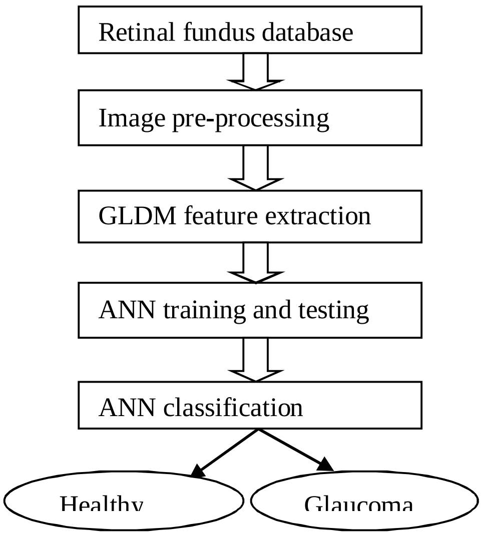


Figure 3. Proposed Methodology

*A. Retinal Fundus Database Collection*

To develop the algorithm for automatic detection of glaucoma, the first essential step is to obtain the effective database and for that purpose retinal images were collected from Sushrutha Eye Hospital, Mysuru. The 2D fundus digital image is taken by a fundus camera, which photographs the retinal surface of the eye. In comparison with OCT/HRT machines, the fundus camera is easier to operate, less costly, and is able to assess multiple eye. Many researchers have utilized the fundus images to automatically analyze the optic disc structures.

*B. Image Pre-Processing*

It involves 3 operations

- Image resize: The original fundus image is resized to 256×256 pixels which reduces the file size significantly without losing quality.
- RGB to gray conversion: A grayscale image is an image in which the value of each pixel is a single sample, that is, it carries only intensity information contrary to color image which has red, green and

blue components. Hence with Rgb to gray conversion we achieve ease of computation as complexity is reduced.

- Contrast Enhancement: For better visualisation of retinal image details.

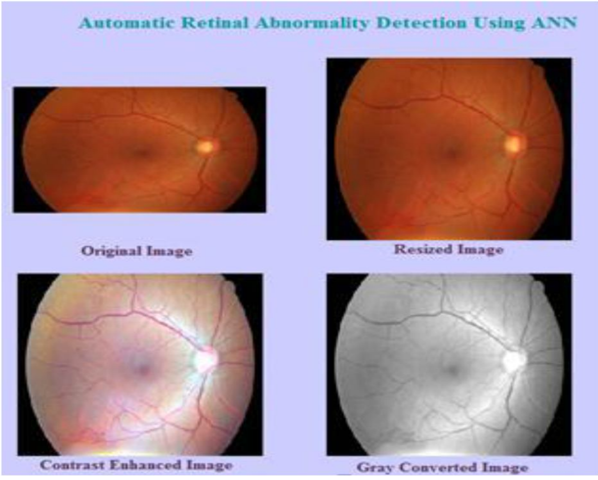


Figure 2. Image Pre-Processing

*C. GLDM Featue Extraction*

Texture contains important information, which is used by humans for the interpretation and the analysis of several image types.

The Grey Level Difference Method (GLDM) is very powerful method for statistical texture description in medical imaging, Ultrasonic, MR and CT image analysis.

The GLDM is based on the given absolute difference in gray level between two pixels which are separated by a specific displacement δ.

- In this analysis, four possible forms of the vector d will be considered: (0, d), (-d, d), (d, 0), and (-d, -d) where ‘d’ is the inter sample spacing.
- I(m,n) , Image intensity function
- $\delta=(\Delta m,\Delta n)$ ,any displacement vector
- $I'(m,n) = |I(m,n)-I(m+\Delta m,n+\Delta n)|$ is calculated for every displacement.
- $g(.|\delta)$ is estimated pdf of I'(m,n) which is calculated by counting no. of times each value of I'(m,n) occurs.
- Four probability density functions for four different displacement vectors d are obtained and the textural features are calculated for each of the 256 pixels giving 256×4=1024 texture features for each input image.

*D. ANN Training*

*ANN*

ANN is a group of interconnected nodes similar to the network of neurons in a brain. It employs mathematical weights to decide the probability of input data. The weights are adjusted by training the network.

*ANN Training*

There are generally 4 steps in training:

- Assemble the training data.
- Create the network object.
- Train the network.
- Simulate the network response to new inputs.

ANN Training Flowchart

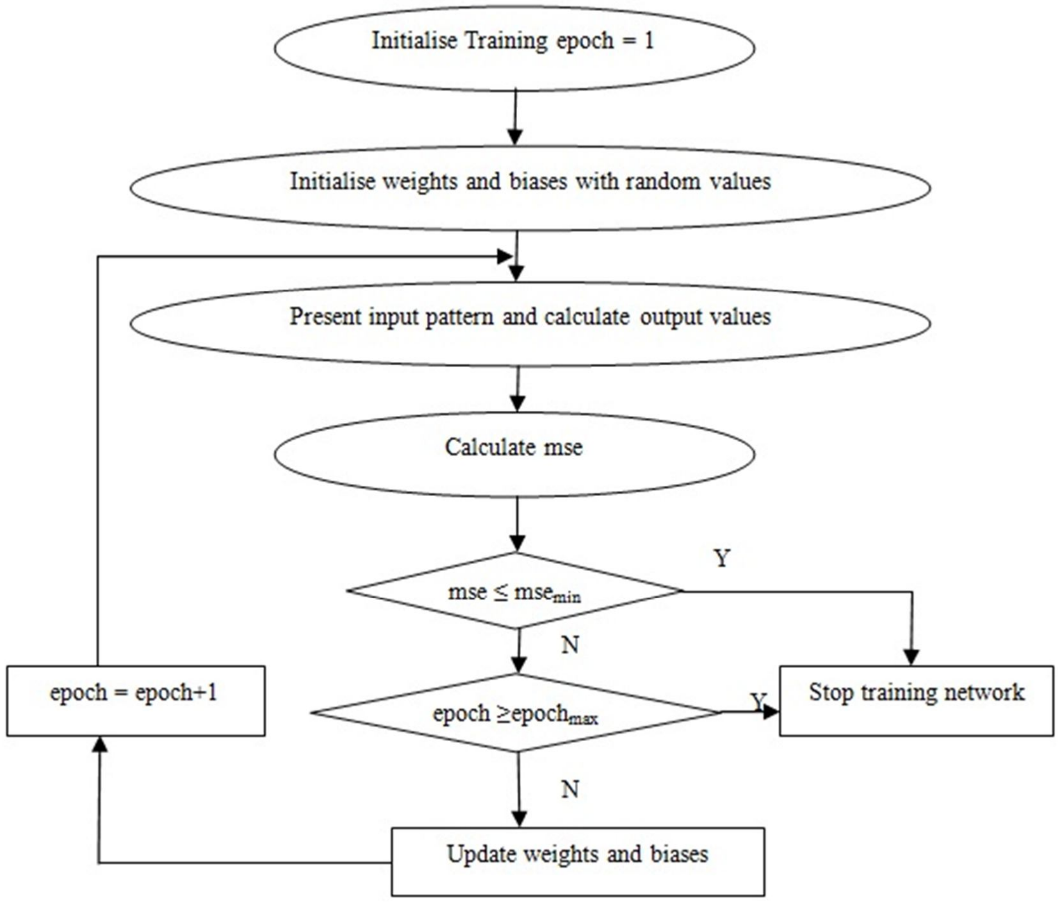


Figure 3. ANN Training process flowchart

*E. ANN Classification*

Classification is an important technique of image analysis which involves labeling of group of pixels based on the grey values or other statistical parameters. For understanding the contents of an image, image analysis functions are used.

A two layer back propagation network was employed for the classification of the disease. The network was trained using parameters of 30 patients. The training data was used to teach the network to classify the disease as Healthy, Glaucoma. Testing was done with parameters of 15 patients with glaucoma and 15 normal subjects including trained ones. Out of these 30 retinal images 26were identified correctly.

The proposed work achieved an accuracy (3) of 86.66% with sensitivity (1) at 93.33% and specificity (2) at 80%.This can be verified by analysing Table I.

$$Sensitivity = TPR = \frac{TP}{(TP+FN)} = \frac{14}{(14+1)} * 100 = 93.3\% \quad (1)$$

$$Specificity = TNR = \frac{TN}{(TH+FP)} = \frac{12}{(12+3)} * 100 = 80.0\% \quad (2)$$

$$Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} = \frac{26}{30} * 100 = 86.6\% \quad (3)$$

## IV. RESULTS

Retinal abnormality detection is performed using Artificial Neural Network and the results are as depicted below.

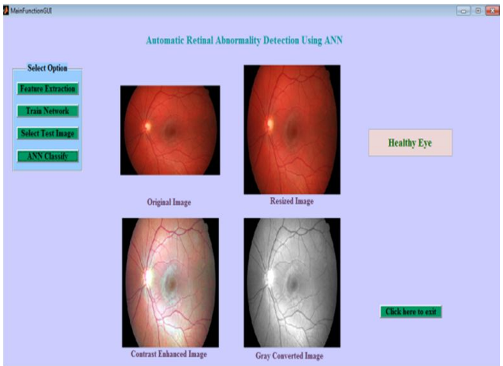


Figure 4. ANN Classification for Helathy Eye

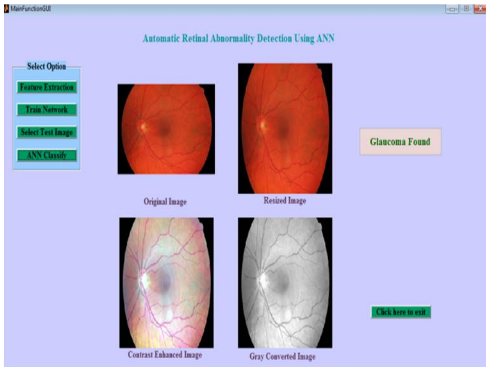


Figure 5. ANN Classification for Glaucoma Affected Eye

TABLE I. CONTINGENCY TABLE

| | | Predicted Condition | | | |
|---|---|---|---|---|---|
| | Total Population | Predicted condition positi | Predicted condition negati | Prevalence | |
| True condition | Condition positive | True positive(TP)=14 | False negative(FN)=1 | TPR=93.3% | FNR=6.7% |
| | Condition negative | False positive(FP)=3 | True negative(TN)=12 | FPR=20.0% | TNR=80.0% |
| | Accuracy =86.6% | Positive Predictive value PPV=82.4% | False omission rate FOR=7.7% | LR$^+$= TPR/FPR=4 | DOR= LR$^+$/LR$^-$ =57.5 |
| | | False discovery rate FDR=17.6% | negative Predictive value NPV=92.3% | LR$^-$= FNR/TNR=0.08 | |

## V. CONCLUSION

Glaucoma is caused due to the increased pressure within eye ball leading to the loss of vision. Here Matlab is used for training and simulating artificial neural network to detect the presence of glaucoma. The various parameters are easily extracted using Matlab and compared with standard values using neural network. The artificial neural network makes the Glaucoma detection accurate and adaptive. The advantage of the system is simplicity of operation. The manual segmentation is extremely difficult and moreover the reproducibility is low. This software intended to help the doctors in their decision making process. To make this more user friendly graphical user interface is also given which makes the handling of this tool very simple. The proposed work achieved an accuracy of 86.66% with sensitivity at 93.33% and specificity at 80%.

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