A Survey on Diabetic Retinopathy and Glaucoma Retinal Diseases Using Retinal Fundus Images

D.Siva Sundhara Raja[1], P.S.Neethu[2]

[1] Lincoln University College, Petaling Jaya, Selangor Darul Ehsan-47301, Malaysia; Email ID: pdf.siva@lincoln.edu.my

[2] AI and Data Science Engineering, Christ University, Bangalore Kengeri Campus, Karnataka, India
Email ID: ps.neethu@gmail.com

Abstract: The human vision loss is occurred due to the retinal diseases Diabetic Retinopathy (DR) and Glaucoma. The diabetes is the main root cause for DR disease and hyper tension is the root cause for Glaucoma disease. In this paper, the conventional detection procedures and methodologies for detecting DR and Glaucoma disease using retinal fundus images are stated and discussed. The implementation of various machine learning and deep learning algorithms for the detection of these retinal diseases are discussed with the experimental results in this paper.

Keywords: Retina; fundus image; Diabetic Retinopathy; Glaucoma; blood vessels

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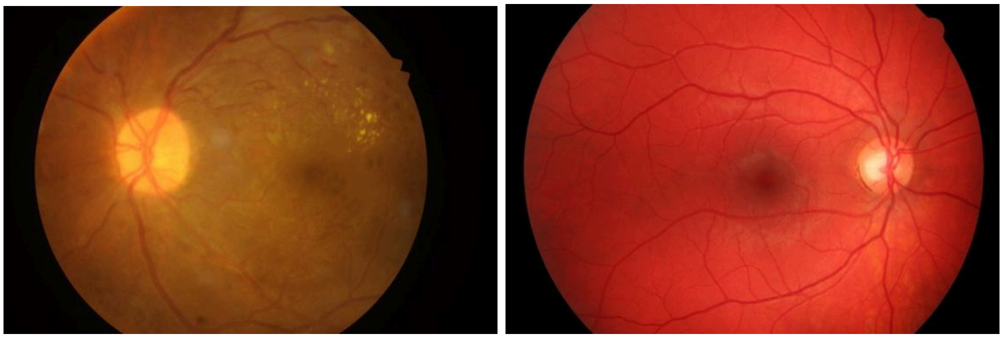
Introduction

In developing countries such as India, the diabetes are identified as life threatening disease which is the root cause for many diseases. Many of the human organs are affected by severe diabetes. The organs in human brain such as brain, liver, eye and kidney are the mainly affected. The retina is the main portion of the human eye which is responsible for human vision and it is affected by diabetes mellitus [1]. The Diabetic Retinopathy (DR) is a retina disease which is formed due to diabetes in the patients. Due to DR in patients, the vision has been severely affected. The retina is constituted with retinal vessels, Optic Disc (OD), Optic Cup (OC) and macula regions. The retinal vessels in the retina are started from the OD center and flows over the entire region of the retina [2]. It is very important for preventing vision blurness. The thick vessels are having the boundary with thick portion to carry the blood and hence it is not mostly affected [3]. The thin vessels are originated from the thick blood vessels and it is mainly affected by the diabetes. Due to the prolonged diabetes in patients, the blood flow in these thin retinal blood vessels is blocked and they are burst if the pressure level in these vessels is abruptly increased. The blood is leaked in the form of exudates and they are identified in yellow color. Hence, the detection of exudates lesions in the retina is very important for detecting the DR [4-5]. Fig.1 (a) shows the human retina with exudates and Fig. 1(b) shows the human retina without any abnormal lesions.



(a) (b)

Figure 1. (a) Retina with exudates lesions due to DR (b) Retina without any abnormal lesions

Glaucoma is a kind of retinal disease which is due to the high intraocular pressure in the retinal nerves. The OD and OC regions are affected due to Glaucoma and hence the detection and segmentation of these retinal regions are important to detect the Glaucoma in advance. In this paper, the conventional techniques used for detecting DR an Glaucoma disease using retinal fundus images are analyzed.

Literature Survey

Survey based on DR detection system using deep learning algorithms

Shahbaz et al. (2026) designed hybrid DR detection and diagnosis methodology using enhancement approach based DR detection. The authors combined EfficientNet CNN model and Vision Transformer Model (VTM) for increasing the DR retinal image detection rate. The EfficientNet CNN architecture was used in this work to compute and derive the feature maps from the various regions of the retinal images and then these computed retinal imaging feature maps were used by the VTM classification model for obtaining the DR retinal image classification rate or accuracy. The authors obtained 95.67% of DR retinal image detection rate on HRF dataset and 95.91% of DR retinal image detection rate.

Darwish et al. (2026) used Dynamic Grasshopper Optimization Algorithm (DGOA) for selecting the optimize feature maps from the non-linear set of feature maps. The premature convergence was neglected using the class balance optimized algorithm in this work. Multiple base models were used to neglect overfitting problem of the classification process. Then, the EfficientNet classifier was used to perform the classification process. The authors obtained 94.17% of DR retinal image detection rate on HRF dataset and 94%% of DR retinal image detection rate on DRIVE.

Tang et al. (2026) created a DR identification system through the fundamental logical algorithms. The clinical labels were used to locate the DR images through the semi-automated methods. This work classified the retinal image into three categories as mild and moderate Non-Proliferative Diabetic Retinopathy (NPDR) cases and Proliferative Diabetic Retinopathy (PDR) case. The blood vessels in the retinal image were detected and removed which showed the abnormal and fine mild exudates patterns. Through this blood vessels detection and elimination process, the abnormal lesions were identified. By analyzing the counts of detected exudates and other abnormal lesions patterns, the severity categorization was done. The categorization was processed in this work by the CNN classification algorithm. The authors obtained 95% of DR retinal image detection rate on HRF dataset and 95.9% of DR retinal image detection rate on DRIVE. Gupta et al. (2025) analyzed the DR detection system through various deep learning architectures and models. The hybrid architecture was used in this work to improve the derived feature map counts and these generated feature maps were used to attain the higher DR retinal image classification accuracy. The classification architectures AlterNet-K and ResNet-101 were used in this work to differentiate abnormal case based on feature maps. The validation algorithm was applied and tested on the created retinal imaging datasets to validate the attained experimental results. The research work was used to validate the simulation results with respect to various significant DR retinal image detection parameters. The authors obtained 94.9% of DR retinal image detection rate on HRF dataset and 95.89% of DR retinal image detection rate.

Gelman et al. (2022) used conventional CNN architecture for detecting normal case or abnormal case based on the computed internal and external feature maps. The transfer function of the proposed CNN architecture was selected based on the final DR detection accuracy and the epochs were analyzed based on the learning rate along with the DR retinal image detection rate. The training case retinal images were split into biased algorithm and they were tested by the proposed CNN architecture in this work. The authors obtained 96.1% of DR retinal image detection rate on HRF dataset and 96.3% of DR retinal image detection rate on DRIVE dataset retinal images.

Survey based on Glaucoma detection system using deep learning algorithms

Lenka et al. (2025) implemented graph based deep learning method for obtaining the Glaucoma disease classification results using the retinal fundus images. This method progressively tested on larger retinal imaging datasets and the results of this method.

Gheisari et al. (2021) proposed a Glaucoma disease detection method using modified deep learning algorithm. This proposed work combined classical conventional neural networks and recurrent neural networks for the classifications of the retinal image into either Glaucoma or non-Glaucoma. The unbiased problem in the feature selection process was overcome by conventional neural networks and the non-linearity of the classification accuracy was overcome by recurrent neural networks. The dataset was split into three sequence sub sets and the proposed methodology was tested with each sub set. The proposed method obtained 95.9% of Glaucoma detection rate on sub set1, the proposed method obtained 94.9% of Glaucoma detection rate on sub set2 and also obtained 94.8% of Glaucoma detection rate on sub set3.

Chaitra et al. (2025) used Bilateral U-Net model for detecting and identifying the Glaucoma in retinal images for preventing the earlier vision loss in hyper tension patients. The Inception and ResNet deep learning algorithms were used to perform the Glaucoma detection. This method was tested on large retinal imaging for Glaucoma detection methodology. The results have been verified using cross-validation algorithm and they have been applied on different retinal imaging datasets to verify the experimental results. This Glaucoma detection method was tested on three independent dataset retinal images for getting classification accuracy of the developed frame. This method obtained 97.2% of Glaucoma detection rate on sub set1, the proposed method obtained 96.9% of Glaucoma detection rate on sub set2 and also obtained 97.3% of Glaucoma detection rate on sub set3.

Liao et al. (2020) diagnosed Glaucoma disease using the interpretable CNN architectural model with respect to various pre-defined clinical setup in this work. This method used pre-defined and pre-trained non-trainable parametric algorithm for detecting the Glaucoma from the non-Glaucoma disease using the retinal fundus images. The training model of this entire proposed classification model was analyzed using various hyper-parameters configurations in this research work. The proposed method obtained 94.3% of Glaucoma detection rate on sub set1, the proposed method obtained 94.1% of Glaucoma detection rate on sub set2 and also obtained 94.3% of Glaucoma detection rate on sub set3.

Li et al. (2020) used attention based deep learning algorithm for differntiating Glaucoma case or non-Glaucoma case in this work. The non-linearity of the intermediate feature maps were detected and removed using attention networking process which provided optimized set of classifications outputs. The proposed method obtained 93.2% of Glaucoma detection rate on sub set1, the proposed method obtained 93.8% of Glaucoma detection rate on sub set2 and also obtained 93.6% of Glaucoma detection rate on sub set3.

Conclusion

The development of Artificial Intelligence (AI) algorithms plays a significant role in medical image processing and its automated systems. In this paper, the machine learning and deep learning algorithms implementation are analyzed for retinal disease detection using retinal fundus images. The algorithms, methodologies and workflow along with the experimental results on various retinal fundus dataset are discussed in detail. The hyper parameters selection methods for improving the retinal image detection accuracy are also stated with results.

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