

# Automated Detection of Retinopathy of Prematurity Using Convolutional Neural Networks

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**Abstract**— This paper introduces a robust deep learning framework aimed at improving the diagnosis of ocular diseases in low-resource settings, where access to high-quality imaging and expert evaluation is limited. The proposed method employs an ensemble of convolutional neural networks (CNNs) trained using transfer learning on a large-scale dataset comprising 38,727 high-resolution fundus images. The ensemble model is subsequently evaluated on 13,000 low-quality fundus images acquired through cost-efficient retinal imaging devices. Despite being trained solely on high-quality data, the model demonstrates strong generalization and achieves performance comparable to state-of-the-art systems in detecting key ophthalmic conditions such as diabetic retinopathy, optic disc excavation, and vascular anomalies. The results highlight the effectiveness of the transfer learning approach in bridging the domain gap between high- and low-quality imaging, offering a practical and scalable solution for automated retinal disease screening in under-resourced healthcare environments

## I. INTRODUCTION

Visual impairment is a global health concern, with billions of potential cases that might be mitigated through regular eye examinations[3]. Unfortunately, the lack of specialized eye care professionals in basic health units has led to a significant gap in accurate diagnoses, particularly for systemic or asymptomatic eye diseases[4]. This gap in healthcare provision has helped to create the rising incidence of preventable blindness, emphasizing the urgent need for creative answers to deal with this problem[13]. The research makes a substantial contribution by exclusively utilizing high-quality images obtained through high-cost equipment for training the predictive models. This strategic use of resources aims to optimize the training process while making certain that the resulting models maintain a high level of accuracy[9]. The study further pushes the limitations of the state-of-the-art by

achieving comparable results when tested with 13,000 low-quality fundus images[12]. This study ramifications go beyond technological advancements, as the proposed approach aligns with the practicalities and constraints of public health systems, especially those prevalent in emerging and under-developing countries[2]. By demonstrating the feasibility and effectiveness of this innovative transfer learning strategy, the paper seeks to provide a valuable tool for enhancing eye disease diagnosis in resource-constrained healthcare environments[5].

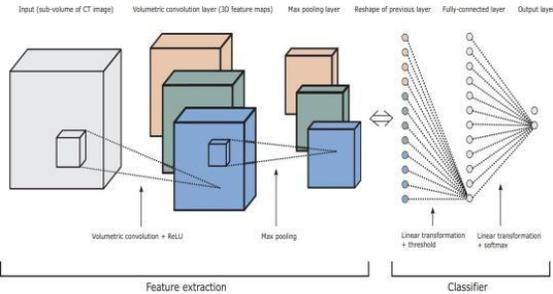
## II. LITERATURE SURVEY

A cataract data collection of fundus images was preprocessed and enhanced to make data collection that is more appropriate for feeding the deep network at first. The proposed network looked at layers, optimization techniques, loss functions, and activation functions to lower processing expenses without sacrificing model fidelity- Hind Hadi Ali et al(2022).[2]

Diabetic retinopathy (DR) occurs in individuals with diabetes, affecting their eyes. Diabetes patients frequently suffer irregular blood sugar levels. Normally, our bodies convert glucose into energy as we go about our Everyday routines and tasks. When blood glucose levels above the normal range normal range, it can harm organs like the organs under consideration include the retina, heart, nerves, and kidneys.[4] Ahmad Talha Siddiqui et al (2024).

Retinopathy caused by diabetes is the outcome of destruction of the retina's blood vessels. The two primary types Proliferative diabetic retinopathy is one kind of the disease with diabetes. (PDR) as well as non-proliferative diabetic retinopathy (NPDR). NPDR is characterized by microaneurysms In the blood vessels of the retina.[1] Arsha V Kumar et al(2022).

When compared to the state-of-the-art, the suggested method was able to generate correct findings; however, the validation process only used low-quality photos. Consequently, this tactic aids in direct choices



in the actual context of developing or poor nations, hence preventing blindness or visual impairments.[3] Gabriel D A Arsnha et al(2023).

Diabetes related micro vascular complications, such as diabetic retinopathy can cause blindness and other visual impairments. Hemorrhages, exudates, micro aneurysms, and retinal neovascularization are the main pathological indicators of DR. The imaging method most frequently employed by ophthalmologists to screen for and assess The seriousness of DR is the digital color fundus scan, which can show the existence of various lesions. In order to keep patients from experiencing vision problems, it is critical that DR be diagnosed early and treated promptly.[5] Yijin Huang *et al*(2023).

Transfer learning for a limited number of target samples is based on CNNs. We employ several transfer learning techniques to tackle the DR fundus picture categorization challenge. First, we apply the parameters of several pre-trained CNN models to the domain-transfer CNNs. Image Net is used to train the pre-trained CNNs. The transferred CNNs are then adjusted using the fundus images. Second, we employ pre-trained CNN models as fundus image feature extractors. The classification job is solved by using the outputs of the last fully connected layer as features in conjunction with a support vector machine (SVM).[6] Xiaogang li et al(2017).

### III. METHODOLOGY

Multiple hidden layers such as pooling, convolutional, RELU, and fully connected normalized layers, comprise a Deep-CNN, a type of DNN. Weights in the convolutional layer, which lowers the memory footprint and improves network performance[14] [6].

CNN's 3D neuron sizes, shared weights and a local connection are its key characteristics. Convolution combining several sub-regions of the picture input using a trained kernel is how the The convolution layer produces a map of features. [1]. As soon as the mistake becomes low, a the ReLu layer, a non-linear activation function is subsequently applied to enhance the convergence properties. In the pooling layer, a section is chosen from the image or feature map, and the representative pixel is the one with the greatest amount or average values [10].

The sample size is thereby greatly decreased. Towards the stage of output, convolutional layers are occasionally combined with a standard Fully-Connected (FC) layer. CNN architecture usually uses some combination of pool and convolution layers. The pooling layer typically carries out two types of operations: max pooling and means pooling. In mean pooling, the average neighborhood is found within the feature points; in max pooling, it is found within a maximum of feature points. Mean pooling reduces the inaccuracy caused by the neighborhood size restriction while maintaining background information [7]. Max pooling reduces the amount of texture information that is lost. deviation-driven estimated error of the convolution layer parameter.

A system architecture for deep learning-based diabetic retinopathy diagnosis learning may involve several components, including,

**Image acquisition:** A retinal camera or imaging device is used to acquire high-quality patient retinal images.

**Preprocessing:** Methods for image preprocessing such as noise reduction, contrast adjustment, and image enhancement are applied to the pictures of the retina to improve image quality.

**Feature extraction:** Using deep learning techniques, preprocessed photos are used to extract relevant properties from the data.

**Training and validation:** A sizable collection of retinal pictures with labels for diabetic retinopathy is used to build a deep learning model. To evaluate the model's performance, a different dataset is used for validation.

**Testing and evaluation:** to assess the trained model's diagnostic performance and accuracy, fresh retinal pictures are used.

User interface: A user-friendly interface is developed to enable healthcare professionals to interact with the system and input patient information.

Patient database: A patient database is maintained to store patient information and retinal pictures for future reference.

Reporting: A reporting module is created to generate reports summarizing the outcomes of the recognizing and classifying people with diabetes Retinopathy for each patient.

Integration with EHRs: The system is integrated with an electronic medical documentation (EHRs) to facilitate patient care and management.

System maintenance and updates: The system is designed for easy maintenance and updates to ensure optimal performance and accuracy over time.

#### IV. CONVOLUTIONAL NEURAL NETWORKS

Convolutional, multiple Inner layer pooling, RELU, which creates a fully linked, normalized layer structure is one type of CNN that is among the DNN [2]. CNN improves the network's speed and lowers its memory footprint by sharing convolutional layer weights. CNN's 3D neuron sizes, shared weights and a local connection are its key characteristics[11]. Convolution between many subregions In order to generate a feature map, the convolution layer uses a learned kernel to construct an input picture[15]. As soon as the mistake is low, To improve the convergence qualities, a non-linear activation function is then added via the ReLu layer activation. In the pooling layer By choosing a portion of the representative pixel as the value among them or the average values, a 2x2 or 3x3 grid is converted to an image/feature map and assigned a single scalar value. The sample pixel with the largest size is thereby greatly reduced. The convolutional layers are sometimes coupled with the traditional Fully-Connected (FC) layer as it moves toward the output stage.

A CNN is composed of many kinds of layers:

The layer that is convolutional applies a filter that scans the entire image, a few pixels at a time, to produce a feature map that predicts the class probabilities for each feature.

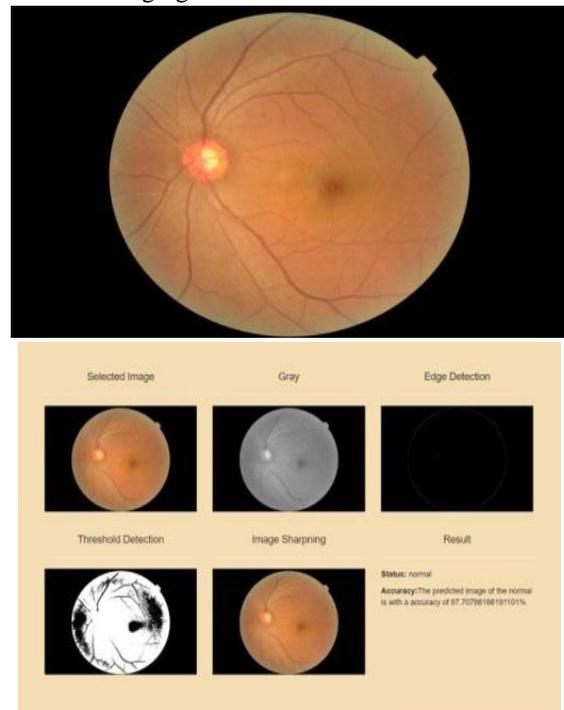
The pooling layer, also known as down-sampling, reduces the volume of data that The layer of convolution produces for every feature while preserving The most crucial information.

The outputs produced by Prior layers are flattened by the fully connected layer of input, which produces a single vector that for the subsequent layer [8].

Fully connected layer: Predicts a correct label by applying weights over the input created by the feature analysis.

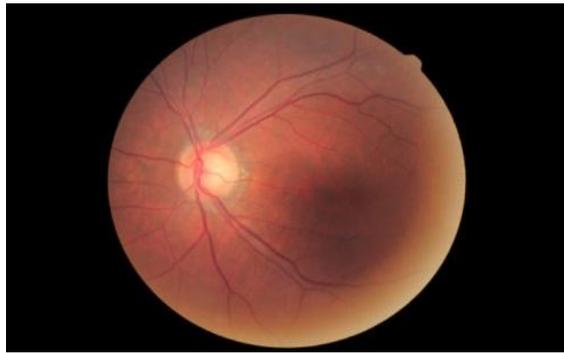
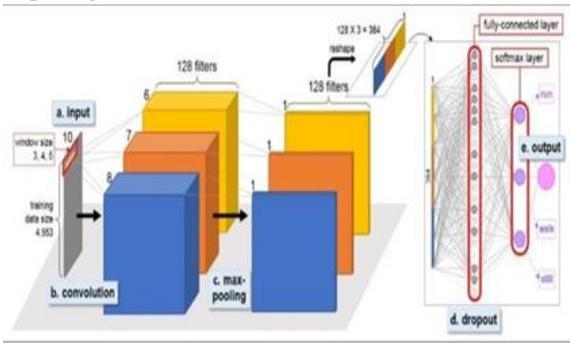
#### V. RESULT

Convolutional Neural Networks (CNNs) have significantly advanced the automation of retinal disease detection, particularly in identifying and staging diabetic retinopathy (DR). In this study, the proposed ensemble CNN framework—trained via transfer learning on 38,727 high-quality fundus images—was evaluated on a test set comprising 13,000 low-quality fundus images captured using cost-effective imaging devices.



The system analyzes retinal images through grayscale conversion, edge and threshold detection, and

sharpening to enhance diagnostic clarity. The result indicates a "Normal" retina with 97.71% confidence, requiring no intervention

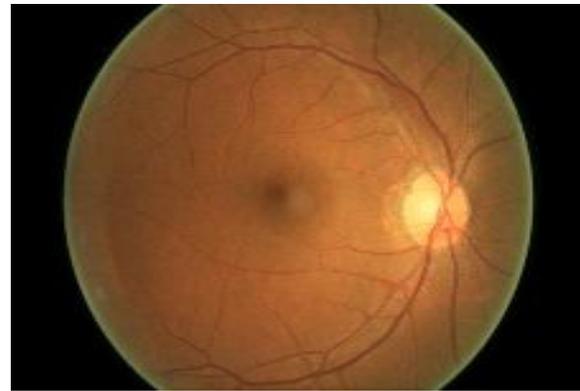


Selected Image	Gray	Edge Detection
Threshold Detection	Image Sharpening	Result

**Status:** Moderate  
**Accuracy:** The predicted image of the Moderate is with an accuracy of 99.99%  
**The remedies for Moderate are:**

- Control Blood Sugar Levels
- Regular Eye Exams
- Laser Treatment or Injections
- Blood Pressure and Cholesterol Management

This retinal scan is classified as Moderate diabetic retinopathy with 99.99% accuracy, showing early pathological changes. Recommended care includes blood sugar control, eye exams, and laser or injection treatments

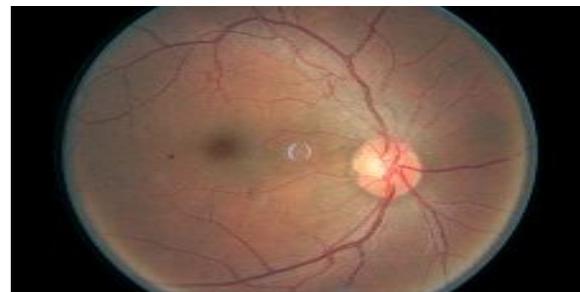


Threshold Detection	Image Sharpening	Result

**Status:** Severe  
**Accuracy:** The predicted image of the Severe is with an accuracy of 99.78%  
**The remedies for Severe are:**

- Medication
- Lifestyle modifications
- Vision aids and rehabilitation

This retinal image is classified as Severe with 99.78% accuracy, showing significant abnormalities through thresholding and edge detection. Recommended remedies include medication, lifestyle changes, and vision aids/rehabilitation.

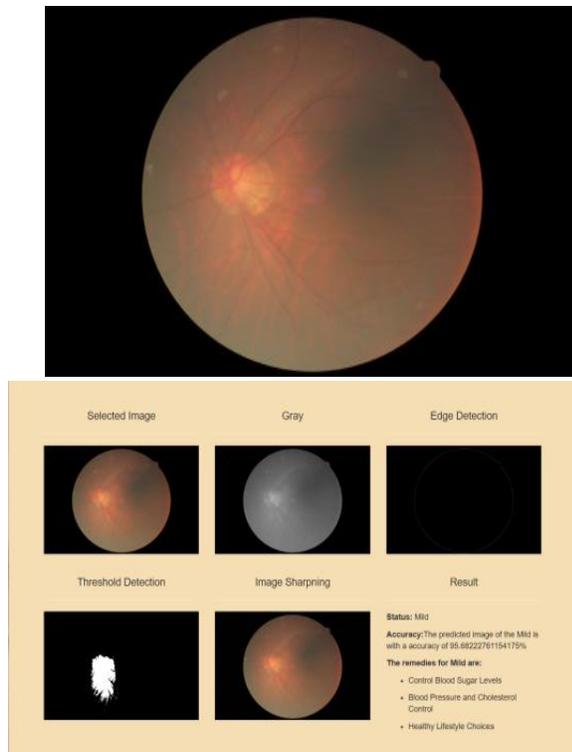


Threshold Detection	Image Sharpening	Result

**Status:** Proliferate\_DR  
**Accuracy:** The predicted image of the normal is with an accuracy of 98.52%  
**The remedies for Proliferate\_DR are:**

- Laser Treatment (Photocoagulation)
- Intravitreal Injections
- Vitrectomy Surgery
- Control of Diabetes and Blood Pressure

This retinal image is diagnosed as Proliferative Diabetic Retinopathy with 98.52% accuracy, showing abnormal vessel growth. Recommended treatments include laser therapy, injections, vitrectomy, and diabetes/blood pressure control.



This eye image is diagnosed as Mild diabetic retinopathy with 95.68% accuracy. Suggested care includes blood sugar control, BP/cholesterol management, and healthy lifestyle changes

## VI. CONCLUSION

This project implements a multiple approach for detecting eye diseases that uses deep learning. The setup involves Python, leveraging libraries like Open CV, Tensor Flow, Keras, Flask, and Tkinter. The system performs preprocessing techniques, builds a CNN model, and deploys a user interface for disease detection. The GUI allows users to upload images, and the backend processes them to predict diseases, providing results through a user-friendly application.

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