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# **Diabetic Retinopathy Detection using Machine Learning**

**Reeta Shaktivel, Radhemohan Mishra, Kevinraj Nadar, Ronit Pasi, Aman Khan**

Asst.Professor, Department of Electronics and Telecommunications, K.C. College of Engineering, Thane,  
Maharashtra, India

UG Students, Department of Electronics and Telecommunications, K.C. College of Engineering, Thane,  
Maharashtra, India

**ABSTRACT:** Diabetic retinopathy (DR) is a retinal disorder characterized by damage to the blood vessels in the eye, often leading to visual impairment or even blindness if not diagnosed and treated early. Automated detection methods are crucial for early intervention, as manual diagnosis is time-consuming and prone to human error due to the complexity of retinal structures. Various automated techniques have been introduced to detect DR from retinal images; however, many of these approaches struggle to identify subtle features, particularly in the early stages of the disease.

In this study, we introduce an advanced detection system based on deep learning. Our method utilizes a convolutional neural network (CNN) architecture that integrates two powerful pre-trained models—ResNet50 and InceptionV3. These models are used to extract features from retinal fundus images, and their outputs are combined and passed through the CNN for final classification.

To evaluate the effectiveness of the proposed approach, we conducted experiments using a publicly available dataset of fundus images. The performance of our model was measured using several key metrics, including accuracy, sensitivity, specificity, precision, and F1 score. The experimental results demonstrated that our framework outperformed existing methods, achieving an impressive average accuracy of 98.65%.

**KEYWORDS:** Machine Learning, Neural Network, Diabetic Retinopathy, Fundus Images.

## **I. INTRODUCTION**

Diabetic retinopathy is a condition that affects the small blood vessels in the retina, which is a part of the eye, and can cause vision problems or even blindness if not treated properly. In the whole world Globally, the issue of Diabetes is increasing day-by-day at a very fast pace rate with India being major contributor the case of Diabetic Retinopathy.

However, even if the cases are increasing, people tend to ignore it. Traditional methods can take a significant amount of time for the detection Retinopathy. Delays in identifying the condition can impede early intervention and lead to a lack of timely follow-up care. Non-proliferative diabetic retinopathy (NPDR), which is the initial phase of the condition, is characterized by retinal swelling, the formation of small blood vessels called microaneurysms, and the presence of fluid leakage. It can also lead to the closure of small blood vessels and macular ischemia, which can cause visual disturbances. Proliferative diabetic retinopathy (PDR) is the advanced stage of diabetic retinopathy and is marked by the development of new, abnormal blood vessels on the retina. These vessels are delicate and susceptible to ruptures, resulting in vitreous Hemorrhages that can cause visual disturbances such as floaters, blurriness, or even temporary vision impairment. In extreme cases, the formation of scar tissue can lead to macular damage or detachment of the retina. Numerous current diagnostic systems face challenges in identifying early-stage diseases effectively and are constrained by high computational requirements and subpar accuracy. To address these limitations, deep learning (dl) approaches have emerged as promising alternatives for automated dr detection using retinal fundus images. This research introduces a new framework that integrates two powerful convolutional neural network (CNN) models— inceptionv3 and resnet50—to extract features. The extracted features are combined and fed into an R-CNN model for classification, with the goal of enhancing diagnostic accuracy while keeping computational requirements manageable.

## **II. LITERATURE SURVEY**

Diabetic retinopathy is a condition that affects the small blood vessels in the retina, which is a part of the eye, and can cause vision problems or even blindness if not treated properly. In the whole world Globally, the issue of Diabetes is increasing day-by-day at a very fast pace rate with India being major contributor the case of Diabetic Retinopathy.

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## **III. PROBLEM STATEMENT AND OBJECTIVE**

1: Identifying and Treating the Disease at Its Earliest Stages Medical care for diabetic eye disease (dye) may involve. Substantially: Enhanced by recognizing the. Symptoms' first indications. Current detection techniques. For doctors to be labour-intensive, expensive, and time-consuming. Engaging, necessitating proficient experts for. Correct Evaluation. Despite advancements in technology, the gap between the rich and the poor continues to widen. Some: Experimental Result Research, Summary of Our Findings. Extensive Execution is still insufficient. This project strives to utilize a small model to identify particular. Visual anomalies in eyes of individuals with the condition effectively.

2: The goal is to develop a modern version. by employing machine learning, we aim to enable the prompt identification and treatment of. the illness. Automated screening techniques are employed. The potential for cost reduction and savings is considerable. The time, and reducing the amount of work. Given the increasing. Diabetes and the. Not Enough Accessibility: of eye Doctors. Particularly in remote regions or when local experts are available. Are overwhelmed, the requirement for such automated. The urgency of Systems is greater than ever.

## **IV. METHODOLOGY**

### **Deep Learning-Based Feature Extraction for Diabetic Retinopathy Classification**

Deep learning (DL) has emerged as a transformative branch of machine learning, demonstrating remarkable success in fields that require complex pattern recognition, particularly in medical imaging. Applications such as object detection, image segmentation, and classification have greatly benefited from DL techniques. Unlike traditional convolutional neural networks (CNNs), which often rely on manual feature engineering, deep learning architectures are capable of learning discriminative features directly from raw data. This data-driven approach has enabled DL models to achieve superior performance across various domains, including bioinformatics, financial forecasting, drug discovery, healthcare, and education.

In the present study, we introduce an end-to-end hybrid framework for classifying diabetic retinopathy (DR) using two state-of-the-art deep learning models—ResNet50 and InceptionV3. These architectures are utilized for feature extraction from retinal fundus images. The extracted deep features are subsequently passed into a custom convolutional neural network for the final classification of DR stages.

### A. Feature Extraction with ResNet50

ResNet50, a deep residual network consisting of 50 layers, is one of the primary models employed in our approach for feature extraction. Its architecture is built around the concept of residual learning, which incorporates shortcut (or skip) connections between layers. These residual blocks help maintain the flow of gradients during backpropagation, thereby addressing the vanishing gradient problem that commonly affects deep neural networks. By facilitating the training of very deep architectures without significant increases in computational complexity, ResNet50 proves to be both efficient and effective. In our evaluations, ResNet50 achieved superior accuracy compared to other baseline models and was thus selected as a foundational component of our DR detection system.

### B. Feature Extraction with InceptionV3

InceptionV3, an advanced version of the Inception architecture originally proposed by Google, is another high-performing model frequently applied in medical image classification tasks. It introduces a novel architectural design that integrates convolutional filters of different sizes within the same layer. This multi-scale processing strategy enables the network to capture both fine-grained and coarse features while significantly reducing the number of trainable parameters and computational cost. In this study, InceptionV3 is used in tandem with ResNet50 to enhance feature diversity and boost the overall accuracy of DR classification.

By combining the strengths of both architectures, our proposed hybrid approach aims to deliver improved diagnostic performance in detecting and classifying diabetic retinopathy from retinal images.

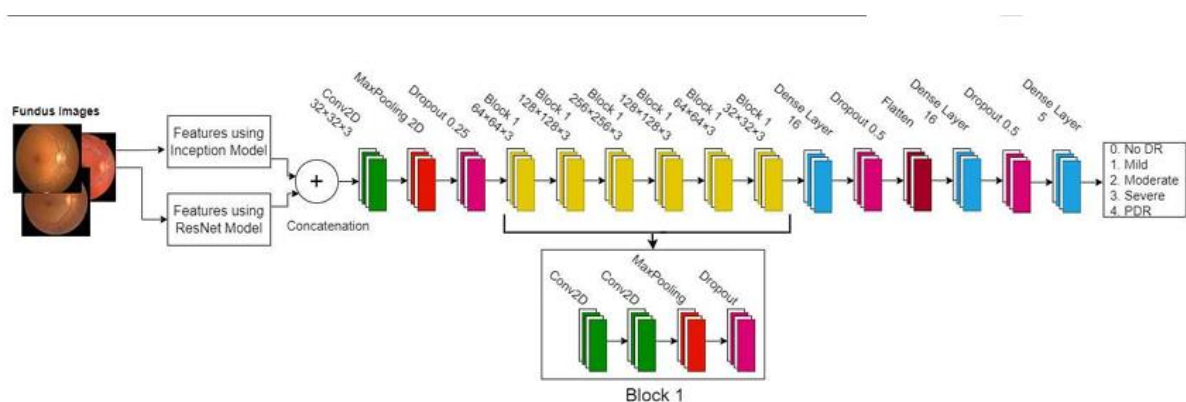
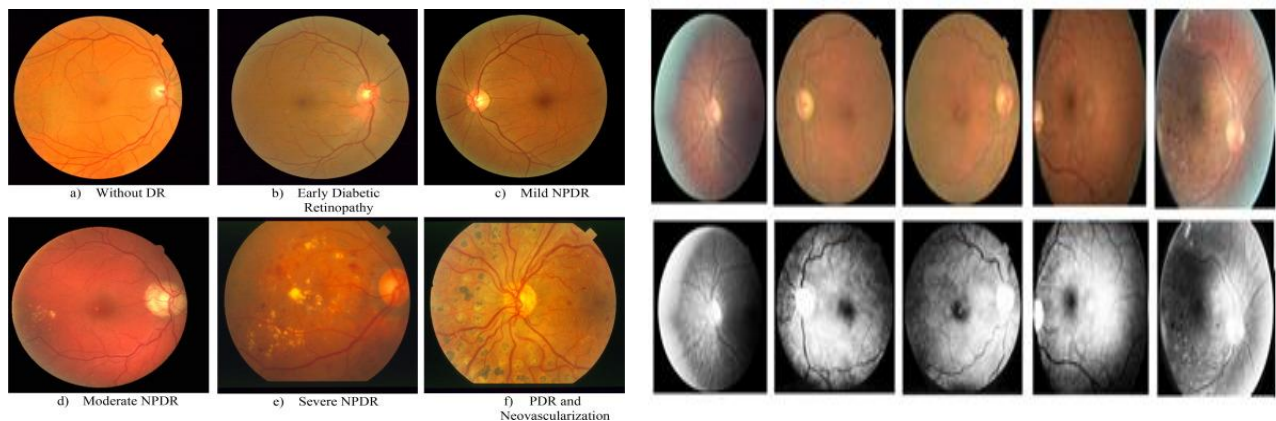


FIGURE 1. The proposed IR-CNN model for diabetic retinopathy detection.

The diagram illustrates a proposed deep learning architecture, named R-CNN, designed for detecting diabetic retinopathy (DR) from fundus images. This model employs a hybrid feature extraction approach, combining the strengths of two well-established convolutional neural network (CNN) models: Inception and ResNet. The pipeline begins with the input of fundus images, which are fed simultaneously into the Inception and ResNet models. Each of

these models independently extracts deep features from the images, leveraging their unique architectural strengths—Inception for its multi-scale feature extraction and ResNet for its ability to train deeper networks via residual connections.

The results obtained from these two models are combined, resulting in a comprehensive feature map that encompasses a wide range of attributes from the input images. This combined feature representation is then passed through a sequence of convolutional blocks, each designed to refine and extract more detailed and abstract features. These blocks, which consist of convolutional layers (conv2d), max pooling, dropout for regularization, and RELU activations, aid in progressively transforming the input into a more informative and compact representation.

The network is composed of several blocks, numbered from block 1 to block 4, with each block consisting of convolutional operations, pooling layers, and dropout layers to avoid overfitting. Following these segments, the model transitions into fully connected (dense) layers. These compact layers further refine the flattened feature maps and guide the way toward the ultimate classification stage.

Multiple layers with a dropout rate of 0.5 are intentionally inserted to improve generalization and minimize the risk of overfitting. The output layer consists of five neurons, each representing a distinct diabetic retinopathy classification: 0 for no dr, 1 for mild, 2 for moderate, 3 for severe, and 4 for proliferative diabetic retinopathy (PDR). This advanced architecture empowers the model to efficiently learn and differentiate between various stages of the disease by harnessing the combined strengths of ensemble feature extraction and deep convolutional learning.

## V. EXPERIMENTAL RESULTS

Step 1 :-

DR Classifier

Choose Object...

Step 2 :-

Choose Object...



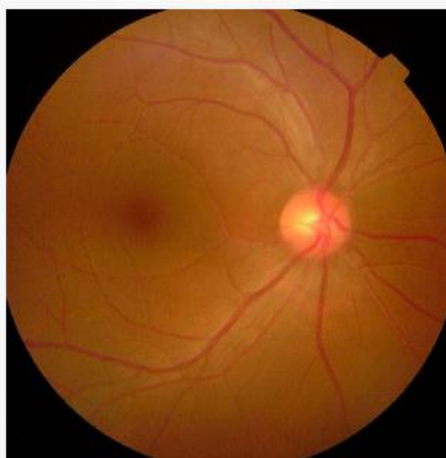
Predict Disease

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Step 3 :-

Choose Object...



**Result: Normal ✓**

## VI. CONCLUSIONS

Diabetic retinopathy (DR) is increasingly recognized as a major contributor to vision loss, particularly among adults of working age. Effectively managing DR extends beyond ocular treatment—it demands a holistic approach that includes proper control of blood glucose levels and blood pressure. The key to preserving vision in individuals with diabetes lies in detecting the condition at an early stage and intervening promptly with appropriate treatment.

The progression of DR is typically gradual, triggered by prolonged elevated blood sugar levels that damage the fine blood vessels in the retina. This vascular damage leads to leakage or bleeding, resulting in visible retinal anomalies such as microaneurysms, Hemorrhages, exudates, and changes in retinal texture. These features are critical in determining the disease's severity.

In this study, we propose a new deep learning-based system designed to automatically detect diabetic retinopathy. The model follows an end-to-end convolutional neural network (CNN) framework that synergizes the capabilities of two advanced architectures—InceptionV3 and ResNet50. These models are employed to extract a wide range of discriminative features from retinal fundus images. The outputs from both networks are fused using a concatenation technique and processed by a custom-built classification model, named R-CNN, which evaluates the severity levels of DR.

To enhance the model's effectiveness, a set of image preprocessing strategies—including image enhancement and data augmentation—were implemented. These techniques improve the model's robustness and its ability to handle inconsistencies in image quality. Experimental evaluation reveals that the R-CNN model achieves superior accuracy compared to existing approaches, establishing its potential as a reliable tool for early DR detection and helping to prevent diabetes-related vision impairment.

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