UNIFIED DEEP LEARNING APPROACH FOR MULTIPLE EYE DISEASE DETECTION USING RESNET-50

Sandhiya R, Sanju Vigasini E, Subesha S
Student, Student, Student
Department of Information Technology
Sri Krishna College of Engineering and Technology, Coimbatore, India

Abstract

Early and accurate diagnosis of ophthalmic diseases plays a crucial role in preventing irreversible vision loss. This paper presents a unified deep learning framework for the automated detection of multiple eye diseases including glaucoma, cataract, and diabetic retinopathy using retinal fundus images. The proposed system leverages the ResNet-50 convolutional neural network architecture to perform multi-class classification within a single integrated pipeline. Extensive preprocessing and normalization techniques are applied to enhance image quality and reduce inter-device variability. Experimental evaluation demonstrates that the proposed approach achieves high classification accuracy, robust generalization, and practical clinical applicability.

Index Terms—Deep Learning, ResNet-50, Retinal Imaging, Eye Disease Detection, Medical Image Analysis.

1. Introduction

Vision impairment caused by ocular diseases has become a major global health concern, affecting millions of people worldwide. Diseases such as glaucoma, cataract, and diabetic retinopathy are among the leading causes of preventable blindness, particularly when diagnosis and treatment are delayed. Traditional diagnostic methods rely heavily on expert ophthalmologists and specialized equipment, which may not be readily available in resource-constrained regions. This creates a strong demand for automated and scalable diagnostic solutions.

Recent advances in deep learning have significantly improved medical image analysis by enabling automated feature extraction and pattern recognition. Convolutional neural networks have shown remarkable performance in retinal image classification tasks. However, many existing systems are limited to detecting a single disease. The unified approach proposed in this paper aims to overcome this limitation by providing a single model capable of detecting multiple eye diseases with high reliability and efficiency.

2. Literature Review

Several studies have explored the use of deep learning for retinal disease detection. Yu et al. proposed a ResNet-based framework for multi-class retinal disease classification, achieving promising accuracy levels. Zedadra et al. demonstrated the effectiveness of deep residual networks in predicting complex retinal disorders from OCT images. These studies highlight the adaptability of ResNet architectures in ophthalmic applications.

Comparative analyses by Aghajani et al. and Singh et al. evaluated multiple CNN architectures such as VGG, Inception, and ResNet variants. Their findings consistently indicate that ResNet-50 offers superior

performance in terms of accuracy and convergence stability. Building upon these insights, the present work adopts ResNet-50 as the backbone for a unified multi-disease detection framework.

3. Methodology

The proposed methodology follows a structured pipeline comprising data collection, preprocessing, model training, and evaluation. Retinal fundus images representing normal and diseased conditions were collected from publicly available datasets. Each image was resized to 224×224 pixels and normalized to meet the input requirements of ResNet-50.

Transfer learning was employed by initializing the ResNet-50 model with ImageNet pre-trained weights. The final fully connected layers were modified to support four-class classification. The model was trained using categorical cross-entropy loss and optimized with the Adam optimizer. Performance was evaluated using accuracy, precision, recall, and confusion matrix analysis.

4. Results and Discussion

The experimental results demonstrate that the proposed unified deep learning model achieves high classification accuracy across all four classes. The training and validation curves indicate stable convergence with minimal overfitting. Among the tested classes, glaucoma and diabetic retinopathy exhibited particularly strong classification confidence.

Compared to traditional CNN models, ResNet-50 showed improved feature representation and generalization. The unified framework simplifies deployment in clinical environments by reducing the need for multiple disease-specific models, thereby enhancing usability and scalability.

5. Conclusion

This paper presented a unified deep learning approach for the detection of multiple eye diseases using ResNet-50. The proposed system effectively classifies glaucoma, cataract, diabetic retinopathy, and normal retinal conditions within a single framework. Experimental results confirm the robustness and clinical relevance of the model.

Future work may focus on incorporating attention mechanisms and expanding the dataset to include additional ocular conditions. The proposed approach has strong potential for deployment in real-world screening and tele-ophthalmology applications.

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