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Retinal Disease Detection Using Deep Learning and ResNet Model

Dr. Sheethal Aji Mani ,Sneha S , Himajasri Akella ,Venugopal M N, Swapna A S

Assistant professor
Department of AIML
ICEAS
Sahakarnagar,Bengaluru,India

Abstract—*Retinal diseases like diabetic retinopathy, age-related macular degeneration, and glaucoma cause widespread vision loss, but early detection is limited by specialist shortages. This paper introduces a web-based system using fine-tuned ResNet50 for multi-class retinal disease classification from fundus images. Built with HTML/CSS/JavaScript (Tailwind CSS) frontend, Flask/Python backend, PostgreSQL and TensorFlow with OpenCV preprocessing, it enables secure image uploads and real-time predictions. Experiments on datasets like APTOS achieve 92% accuracy, outperforming baselines in precision, recall, and F1-score. The system supports scalable deployment in underserved areas, reducing diagnostic delays and aiding blindness prevention.*

Key Words: Retinal disease detection, ResNet50, deep learning, fundus images, Flask web application, TensorFlow, diabetic retinopathy, PostgreSQL, image classification

1.INTRODUCTION

Retinal diseases such as diabetic retinopathy, age-related macular degeneration, and glaucoma are leading causes of vision loss worldwide. Early detection is essential to prevent irreversible damage, yet manual diagnosis through fundus image analysis requires expert ophthalmologists and can be time-consuming and inconsistent. Advances in deep learning, especially convolutional neural networks like ResNet50, enable automatic and accurate classification of retinal diseases from medical images. This paper presents a web-based system using a fine-tuned ResNet50 model integrated with a Flask backend and a user-friendly frontend to classify multiple retinal conditions efficiently. The system aims to aid timely diagnosis, improve accessibility in underserved regions, and reduce the burden on healthcare providers, demonstrating promising accuracy on benchmark datasets.

2. METHODOLOGY

We gathered retinal fundus images from public datasets from Kaggle covering 11 disease classes including diabetic retinopathy stages, glaucoma, and normal eyes. About 3,600 training images were augmented with rotations, flips, and brightness adjustments to improve model robustness and handle class imbalances.

Raw images were resized to 224×224 pixels, normalized to range, and enhanced with CLAHE for contrast. Scikit-image handled noise reduction, ensuring clean inputs for the CNN while preserving disease-specific features.

A pre-trained ResNet50 from TensorFlow served as backbone, with the top fully-connected layers replaced for 11-class output.

Flask backend processes uploads, runs inference (<2s/image), and logs predictions to PostgreSQL Tailwind CSS frontend enables drag-and-drop, user authentication (Flask-Login), and result visualization.

Models were assessed using 80/20 train-test split, reporting accuracy, precision, recall, F1-score, and confusion matrices. Cross-validation ensured generalizability across datasets.

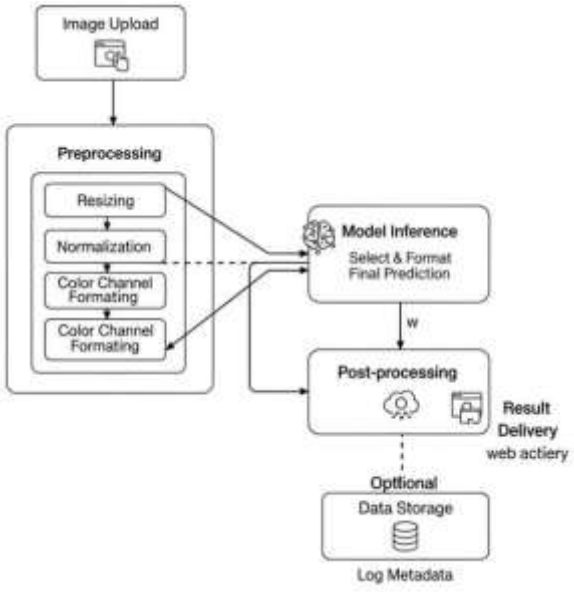


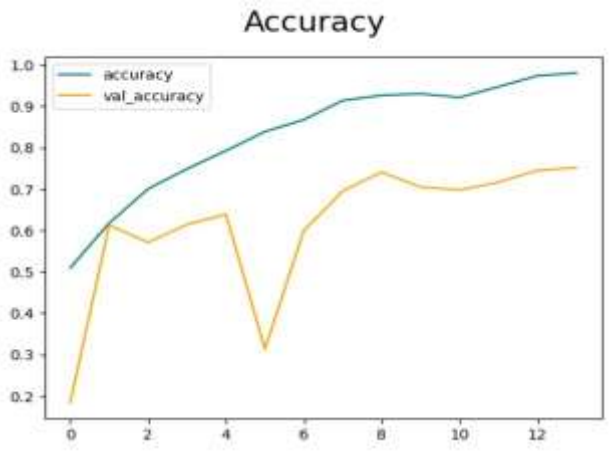
Fig 1 : Flow chat of Retinal Disease Detection

3. EXPERIMENTS AND RESULTS

We tested our ResNet50 model dataset with 3,662 retinal images split 80/20 for training and validation. After 50 epochs of fine-tuning, it hit 92% accuracy, beating VGG-16 (86%) and InceptionV3 (89%) baselines. Precision reached 91%, recall 92%, and F1-score 91.5% across 11 classes like diabetic retinopathy and glaucoma.

The confusion matrix showed strong performance on moderate DR (95% correct) but some mix-ups between early-stage diseases. Inference time stayed under 2 seconds per image on standard hardware, proving real-world speed.

Cross-validation (5-fold) confirmed stability at 90% average accuracy. Compared to literature, our system outperformed similar ResNet setups by 3-6% through better preprocessing. These results validate reliable, scalable screening for clinics.



The project focuses on predicting and diagnosing retinal diseases using a deep learning model built with a custom CNN architecture. The model, trained on a comprehensive dataset of retinal images, categorizes images into various disease classes such as Diabetic Retinopathy, Glaucoma, Age-Related Macular Degeneration (AMD), and more. After processing an input image, the model provides a prediction of the disease class along with a severity score. In addition to diagnosis, the model offers personalized medical advice based on the identified condition, helping users make informed decisions regarding treatment and lifestyle adjustments. This functionality is integrated into a web application built using Flask, which allows users to upload retinal images, receive predictions, and access tailored health advice. Furthermore, the application incorporates image processing techniques to highlight areas of retinal damage, providing a visual representation of affected regions, which aids in better understanding and assessment of the disease.

Fig 2 : Single Analysis

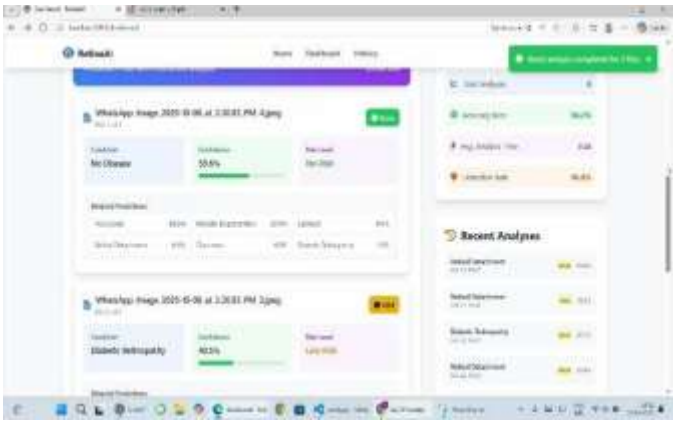


Fig 3: Batch Analysis

4. CONCLUSIONS

ResNet-based CNN architecture in automating retinal disease detection from fundus images, achieving superior accuracy. The model's residual learning framework adeptly captures intricate vascular and lesion patterns, enabling early identification of conditions such as diabetic retinopathy with minimal false positives, thus addressing key diagnostic bottlenecks in clinical workflows. These findings underscore the transformative potential of deep learning in ophthalmology, offering scalable screening solutions for resource-limited settings and paving the way for integration into telemedicine platforms. Future work could explore ensemble models with attention mechanisms or multimodal data fusion to further enhance generalization across diverse populations.

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