A CONVOLUTIONAL NEURAL NETWORK WITH ATTENTION FOR MULTI-STAGE DIABETIC RETINOPATHY DETECTION

PROJECT SYNOPSIS
OF MAJOR PROJECT

BACHELOR OF TECHNOLOGY
Computer Science and Engineering

SUBMITTED BY

Gaurav Payal - 2100290100066

Geetika Verma - 2100290100067

Jigyasha Bhushan - 2100290100075

Kanishk Rawat - 2100290100080

Project Guide
Prof. Bharti Chugh

KIET Group of Institutions, Delhi-NCR, Ghaziabad (UP)
Department of Computer Science and Engineering

May 2025

Table of Content

Introduction

Diabetic Retinopathy (DR) is a common microvascular diabetes complication and the major cause of blindness and vision loss globally, especially among working-age individuals. DR is caused by damage to the retinal blood vessels as a result of continuous high blood glucose levels. Minor manifestations of DR tend to be non-apparent in initial stages, but routine screening and prompt diagnosis are essential to avoid permanent loss of vision. Conventional diagnosis relies heavily on manual examination of retinal fundus images by ophthalmologists, which is labor-intensive, time-consuming, and prone to human variability and errors in interpretation.

As the global prevalence of diabetes increases, there is a need for automated, precise, and scalable methods to aid early detection and classification of DR. State-of-the-art developments in artificial intelligence and deep learning, especially in medical imaging, hold great potential as alternatives. In this project, we suggest a deep learning diagnostic model using the ResNet-50 architecture coupled with an attention mechanism. The ResNet-50, which is a powerful CNN, has been proven to perform feature extraction extremely well, particularly in dealing with intricate visual tasks.

The attention mechanism increases the model's capability of paying attention to important areas in retinal images, i.e., microaneurysms, hemorrhages, and exudates that are representative of the severity of DR. The model is trained to classify fundus images into five classes of DR: No DR, Mild, Moderate, Severe, and Proliferative. The proposed AI-based system can cut down diagnostic workload, make screenings faster and more uniform, and enhance clinical results by allowing early intervention for diabetic patients.

Rationale

Diabetic Retinopathy (DR) is a major cause of blindness worldwide, especially in patients with diabetes. Early DR tends to be asymptomatic, and timely diagnosis is critical to avoid irreversible blindness. Conventional diagnosis through manual analysis of retinal fundus images is time-consuming, and observer-dependent and error-prone. Given the growing number of diabetic patients worldwide, an urgent solution for automated, robust, and scalable diagnosis is needed.

This project meets these difficulties by suggesting a deep learning-based model in the form of ResNet-50 with the addition of an attention mechanism. ResNet-50 provides robust feature extraction ability, and the attention mechanism enables the model to attend to critical pathological characteristics like microaneurysms, hemorrhages, and exudates. In contrast to other models that lacked precision or clinical scalability, this architecture provides a high classification accuracy of 97.56%, as evidenced in the project. The suggested system can potentially aid ophthalmologists, decrease diagnostic workload, and facilitate early intervention through effective AI-based screening.

Objectives

1. To develop an automated system for early detection of Diabetic Retinopathy (DR).
2. To classify retinal fundus images into five DR stages: No DR, Mild, Moderate, Severe, and Proliferative.
3. To implement the ResNet-50 deep learning architecture for robust feature extraction.
4. To integrate an attention mechanism to improve focus on key retinal features.
5. To achieve high classification accuracy and reliability across varied image categories.
6. To preprocess retinal images for standardization using resizing and normalization.
7. To minimize human intervention and reduce diagnostic workload in clinical settings.
8. To compare the proposed model's performance against existing DR detection methods.
9. To ensure the model's adaptability for telemedicine and remote screening use cases.
10. To support healthcare goals by promoting early, scalable, and AI-powered medical diagnostics.

Literature Review

Numerous studies have explored the use of deep learning for Diabetic Retinopathy (DR) detection. Luo et al. proposed MVDRNet, combining CNNs with attention mechanisms, but it failed to significantly improve accuracy. Chen introduced a shallow multi-scale CNN for early DR detection, which lacked classification precision. Capsule networks and segmented fundus-based models attempted to enhance feature extraction but did not deliver timely and accurate results. ROI-based deep learning methods focused on lesion detection but required high system resources. Symmetric CNN architectures and multitask learning models were unable to support real-time clinical use or generalize well across datasets. Al-Antary et al. designed a multi-scale attention network, which improved localization but lacked deployment readiness. These studies highlight the limitations of existing approaches in accuracy, resource efficiency, and clinical scalability. In contrast, our project integrates ResNet-50 with attention mechanisms, addressing these gaps by enhancing feature focus, reducing error, and achieving high accuracy (97.56%) in DR classification..

Feasibility Study

1. Technical Feasibility:

The proposed system leverages the ResNet-50 convolutional neural network, integrated with an attention mechanism, to classify diabetic retinopathy (DR) into five stages based on retinal fundus images. ResNet-50 is a proven deep learning model known for handling vanishing gradients and effective feature extraction in medical imaging. The use of attention mechanisms further improves localization and interpretability. The model achieves an accuracy of 97.56%, indicating strong technical capability.

2. Operational Feasibility:

The system automates DR screening, reducing dependency on ophthalmologists for initial diagnoses. It facilitates early intervention by quickly classifying DR stages, making it suitable for clinical settings and especially beneficial in under-resourced areas.

3 .Economic Feasibility:

Cost-effectiveness is high, as the model requires only standard computational hardware and open-source tools. By minimizing the need for specialist input in early screening, it can reduce the burden on healthcare systems.

4.Legal and Ethical Feasibility:

The system must address issues such as data privacy, fairness across demographics, and transparency of AI decisions. Visualization tools like Grad-CAM enhance trust and explainability.

5.Scalability and Future Readiness:

The model is scalable to larger datasets and adaptable to multimodal clinical data. Optimization for real-time performance and deployment on low-power devices is part of the roadmap.

Methodology / Planning of Work

The project follows a structured methodology aimed at developing an efficient deep learning-based system for the multi-stage classification of Diabetic Retinopathy (DR).

Work was carried out in the following phases:

1. Data Collection and Preprocessing:

A dataset of 2,760 labeled retinal images from Kaggle was preprocessed (resizing, normalization, filtering) to match ResNet-50 input needs.

2. Model Selection and Architecture Design:

ResNet-50 was used due to its deep learning capabilities and robustness. Attention mechanisms were added to enhance region focus.

3.Training and Optimization:

The model was trained using supervised learning and tuned using dropout, data augmentation, and learning rate strategies. Performance was evaluated using multiple metrics.

Facilities Required

The development of the proposed system requires a programming environment based on Python, utilizing libraries such as TensorFlow, Keras, OpenCV, NumPy, and Matplotlib for deep learning, image processing, and visualization. For effective model training and testing, the hardware setup should include a system with 8–16 GB RAM, a dedicated GPU (preferably NVIDIA GTX 1650 or higher), and at least 500 GB of storage. Stable internet access is essential for accessing datasets and cloud platforms. Platforms like Google Colab and Kaggle will be utilized for training the model, running experiments, and evaluating performance in a cloud-based environment.

Expected Outcomes

The proposed system is expected to accurately classify Diabetic Retinopathy into five stages using a ResNet-50 architecture enhanced with an attention mechanism. Achieving an anticipated accuracy of 97.56%, the model will significantly aid clinicians in early diagnosis, allowing timely treatment and preventing vision loss. It will reduce the workload on ophthalmologists by automating the screening process, thus improving efficiency. Furthermore, the model is designed to be scalable and can be integrated into teleophthalmology systems and mobile health platforms. This makes it highly suitable for deployment in remote or under-resourced areas where access to specialized eye care is limited.

References

[1] S. Hamid et al., “Early detection of diabetic retinopathy,” Surv. Ophthalmol., 2019. [2] Scottish Intercollegiate Guidelines Network, “Management of Diabetes: A National Clinical Guideline,” 2014.

[3] G. H. Bresnick et al., “Surveillance of patients with diabetes for retinopathy,” Ophthalmology, 2000.

[4] L. Hill and E. L. Makaroff, “Early detection and treatment of diabetic retinopathy,” Diabetes Res. Clin. Pract., 2017.

[14] X. Luo et al., “MVDRNet: Multi-view DR detection with DCNNs and attention,” Pattern Recognit., 2021.

[15] W. Chen et al., “Detecting DR via integrated shallow CNNs,” IEEE Access, vol. 8, 2020.

[50] S. Qummar et al., “Ensemble deep learning for DR detection,” IEEE Access, vol. 7, 2019.